

33d CONGRESS, }
1st Session. }

HOUSE OF REPRESENTATIVES.

{ Ex. Doc.
{ No. 129.

REPORT

OF

THE SECRETARY OF WAR

COMMUNICATING THE SEVERAL

PACIFIC RAILROAD EXPLORATIONS.

IN THREE VOLUMES.

WASHINGTON:
A. O. P. NICHOLSON, PRINTER.
1855.

THE UNIVERSITY OF CHICAGO PRESS

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CONTENTS.

The first volume contains—

- I.—Examination by Captain A. A. Humphreys, Topographical Engineers, of the reports of the explorations to determine the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean.
- II.—Memoranda by Captain George B. McClellan, Corps of Engineers, upon some practical points connected with the construction and working of railways.
- III.—Letter of Major General Jesup, Quartermaster General U. S. A., upon the cost of transporting troops and supplies to California, Oregon, New Mexico, &c.
- IV.—Report of Governor I. I. Stevens upon the route near the 47th parallel.

The second volume contains—

- V.—Report of Lieutenant E. G. Beckwith, 3d regiment of artillery, upon the routes near the 41st and 38th parallels.
- VI.—Report of Lieutenant A. W. Whipple, Topographical Engineers, upon the route near the 35th parallel.
- VII.—Report of Captain John Pope, Topographical Engineers, upon that portion of the route near the 32d parallel from Preston to the Rio Grande.

The third volume contains—

- VIII.—Report of Lieutenant John G. Parke, Topographical Engineers, upon that portion of the route near the 32d parallel from the Rio Grande to the Gila.
- IX.—Extract from the report of Major W. H. Emory, Topographical Engineers, of a military reconnoissance made in 1846 and 1847.
- X.—Report of Lieutenant R. S. Williamson, Topographical Engineers, of explorations in California in connexion with the routes near the 35th and 32d parallels.

ALSO,

The report of F. W. Lander, Civil Engineer, of a survey of a railroad route from Puget's Sound, by Fort Hall and the Great Salt Lake, to the Mississippi river.

IN THE HOUSE OF REPRESENTATIVES,
August 3, 1854.

On motion of Mr. McDougall,

Resolved, That the Secretary of War be requested to procure a report from F. W. Lander, civil engineer, of a survey of a railroad route from Puget's Sound, by Fort Hall and the Great Salt Lake, to the Mississippi river, and that he cause a copy thereof to be furnished to this House.

Resolved further, That the reports of surveys for a railroad to the Pacific, made under direction of the Secretary of War, also the said report of F. W. Lander, be printed for the use of the House, during the recess.

Attest:

J. W. FORNEY,
Clerk of the House of Representatives U. S.

REPORT

OF

EXPLORATION OF A ROUTE FOR THE PACIFIC RAILROAD,

NEAR THE 38TH AND 39TH PARALLELS OF LATITUDE,

FROM

THE MOUTH OF THE KANSAS TO SEVIER RIVER, IN THE GREAT BASIN.

BY LIEUT. E. G. BECKWITH,

THIRD ARTILLERY.

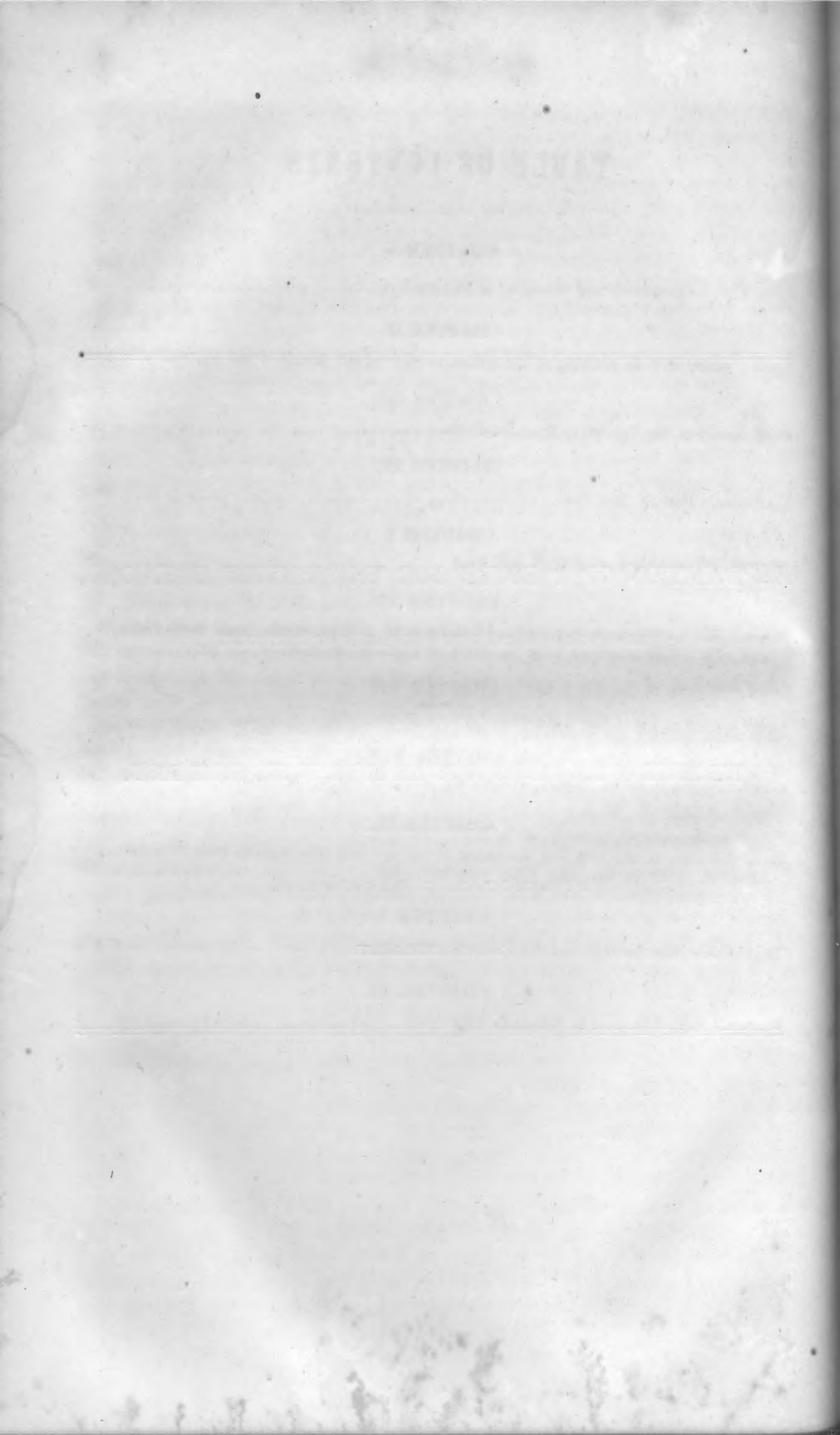


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REPORT.

CHAPTER I.

From Fort Leavenworth and Westport to Pawnee Fork.—June 15 to July 14, 1853.

WASHINGTON, D. C., *November 25, 1854.*

SIR: In submitting to the Department the accompanying report of the explorations for a Pacific railroad, conducted, up to the time of his death, (at the hands of the Indians,) by the late Captain J. W. Gunnison, topographical engineers, it is proper that I shall state that I have preferred the journal form in which to embody the labors of the party and the minute and general descriptions of the country, required by the specific object of the survey, as affording greater facilities for introducing the observations and conclusions of Captain Gunnison, in his own language, than could have been secured in any other form. I have intentionally adhered to details and repetitions, however monotonous, by which alone a faithful description of this great interior country can be presented; for, monotonous as it is in itself, and far removed from general fertility, no general description not made up of facts constantly repeated can convey a true picture of the country explored—an object deemed of the first importance in this report, in which I have endeavored to exhaust the material obtained for it, for which too much credit cannot be given to Captain Gunnison.

The report was written, in great haste, at Great Salt Lake, immediately after reaching that city, and forwarded to you on the 1st of February, 1854, but has been revised and materially improved since my return to this city. The computations of altitudes has been conducted since my arrival in Washington under the superintendence of Mr. Lorin Blodget, and the barometrical observations discussed by him with great care and superior intelligence, which will be apparent by a reference to his notes and the tables in this report.

I am, sir, most respectfully, your obedient servant,

E. G. BECKWITH,
First Lieut. 3d Artillery.

HON. JEFFERSON DAVIS,
Secretary of War.

SIR: In order that you may be put in possession, at as early a day as practicable, of the result of the investigations of the exploring party organized under your order of the 20th of May, 1853, by the lamented Captain J. W. Gunnison, of the corps of topographical engineers, who was barbarously massacred by the Pah Utah Indians, on

the 26th of October, on the Sevier river, and near the lake of that name, in the Territory of Utah, while in the performance of the duty assigned to him, I deem it my duty, as his assistant, to report the same—a duty upon which I enter with unusual diffidence; the more so as it is not contemplated, by the instructions referred to, that this duty should devolve upon me. There being with the party, however, no other person upon whom it can be devolved, and the importance of its being submitted within a specified time, seems to render this report necessary. But I should neither do justice to the memory of the dead, nor to my own feelings, in entering upon a report of the labors performed in their respective departments by those who fell in the fatal affair referred to above, (which has been before, however, officially communicated to you,) were I thus to pass it by. With Captain Gunnison also fell, of the scientific gentlemen of the party, Mr. R. H. Kern, an accomplished topographer and artist, and Mr. F. Creutzfeldt, botanist. Of the performance of his duties by my late commander, associate, and friend, it may not be proper that I should speak; yet I take pleasure in giving expression to the admiration of all their associates commanded by each of these gentlemen, in his respective department, up to the time of his death, by the active, faithful, and energetic performance of his duty. And we were in a position, encountering together as we had for so long a period, the labors, fatigues, privations, and exposures incident to an undertaking in which, from day to day, every quality of the mind and heart of one's associates is thoroughly developed, in which you, sir, are well aware that the strongest ties of esteem and friendship are formed and cemented; and in severing the ties thus formed, not only has this exploring party, and the department of science to which each was attached, suffered a severe loss, but the country itself has reason to mourn the loss of such experienced and energetic officers and citizens. Besides these, Mr. Wm. Potter, a citizen of Utah Territory, a resolute and determined man, who had joined the party as guide but a few days before the disaster, was killed, together with one employé, John Bellows, and three private soldiers of the escort, belonging to the regiment of mounted riflemen.

The following extracts from your orders and instructions, above referred to, will explain the duties assigned to this party:

“Under the 10th and 11th sections of the military appropriation act of March 3, 1853, directing such explorations and surveys as to ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean, the War Department directs a survey of the pass through the Rocky mountains, in the vicinity of the headwaters of the Rio del Norte, by way of the Huerfano river and Coo-che-to-pa, or some other eligible pass, into the region of Grand and Green rivers, and westwardly to the Vegas de Santa Clara and Nicollet river of the Great Basin, and thence northward to the vicinity of Lake Utah on a return route, to explore the most available passes and cañones of the Wahsatch range and South Pass to Fort Laramie.

“The following instructions relative thereto are issued for the government of the different branches of the public service:

“I. The party for this exploration will be commanded by Captain J. W. Gunnison, topographical engineers, who will be assisted by First

Lieutenant E. G. Beckwith, third artillery, and such civil assistants as the Secretary of War may approve.

* * * * *

“VI. The party being organized, will collect the necessary instruments and equipments. It will then repair with the utmost despatch to Fort Leavenworth, and with the escort proceed to the Huerfano river, making such reconnoissances from the Missouri river as will develop the general features of the country, and determine the practicability of a railroad across the plains, and its connexion with the eastern lines of commerce.

“The more minute reconnoissance will continue up the Huerfano into the San Luis valley, and thence through the most eligible pass to the valley of Grand river, and westwardly to the vicinity of the Vegas de Santa Clara, and thence, on the most advisable route, either along the Nicollet river, or to the west of the ranges of mountains bordering that stream, into the basin upon the route to the Great Salt Lake; thence to Utah lake, and through the Timpanagos cañon or other passes, and across the Weber and Bear rivers, by the Coal basin, to Fort Laramie.

“Competent persons will be selected to make researches in those collateral branches of science which affect the solution of the question of location, construction, and support of a railway communication across the continent, viz: the nature of rocks and soils—the products of the country, animal, mineral, and vegetable—the resources for supplies of material for construction, and means requisite for the operation of a railway, with a notice of the population, agricultural products, and the habits and languages of the Indian tribes. Meteorological and magnetic observations, the hygrometrical and electrical states of the atmosphere, and astronomical observations for determining geographical points, shall be made, in order to develop the character of the country through which the party may pass.

“On or before the first Monday of February next, Captain Gunnison will report the result of his investigations.”

Agreeably to these instructions, Captain Gunnison arrived at St. Louis on the 4th of June, and proceeded immediately to procure the necessary supplies and outfit for the party; in which he was greatly aided by Colonel Robert Campbell, of that city, whose well known courtesy, though severely taxed, was freely extended to us. These were shipped on the 9th, and landed on the 15th of June, at Kansas, which is near the western border of the State of Missouri, and about a mile and a quarter below the junction of the Kansas river with the Missouri, in charge of Mr. Kern, who was to transport them to some point suitable for a “fitting out camp,” while Captain Gunnison, whom I accompanied, proceeded to Fort Leavenworth on duty relating to the escort of mounted riflemen which was to accompany the party. We were surprised, on our arrival in the afternoon, to find that no orders had been received at the fort, relating to the escort, for it was known that they had been issued some time previous. The opportune presence, however, at the post, of General Clark, commanding the department, obviated any delay on this account, as, after proper statements and explanations, he gave the necessary instructions for the escort to be equipped and fitted out in anticipation of the receipt of the orders

referred to. At an early hour on the following morning we left Fort Leavenworth, which is situated on the right bank of the Missouri river, in the Indian territory immediately west of that State. The day was fine, and the high, beautiful rolling prairie from Fort Leavenworth to the Kansas river, a distance of twenty-two miles, was covered with luxuriant grass, and profusely sprinkled with flowers. We passed some fine Indian farms of the Delaware nation, and respectable herds of stock grazing near the road. The creeks and rivulets were lined with timber, in which oak largely predominated, extending back from the Kansas river, by our road, three or four miles. The descent to this river is abrupt at Delaware, a trading post among this people, where we crossed by a ferry, kept on the north side by themselves and on the opposite by the Shawnees, to whom the territory belongs. Crossing a timbered, sandy bottom of half a mile in width, our road led up a steep hill, finely timbered, and again through fine Indian farms to the open prairie, in all respects like that of the morning. Arriving near Westport we fell in with our camp, and with pleasure alighted from the wretched stage to begin our arduous march. Our encampment was some five miles from Westport and the western line of the State of Missouri, selected by Mr. Kern in a fine grove near a spring, and surrounded by fine grass and an open prairie, and in the midst of the various Shawnee missions, which appeared well. The approximate elevation of this point above the Gulf of Mexico, as indicated by our barometer, is 990 feet, or 613 feet above low-water mark at St. Louis, as deduced from Dr. Geo. Engelmann's valuable observations at that place, kindly furnished to aid the meteorological discussions in this report. The purchase of mules and horses and employing men suitable for the expedition occupied several days at this camp, and the breaking in of the teams and teamsters as many more, during which our camp was only moved to secure grass when the animals had fed it down near us. On the 20th, Brevet Captain R. M. Morris, first lieutenant, and Second Lieutenant L. S. Baker, with some thirty non-commissioned officers and men of the regiment of mounted riflemen, with the necessary subsistence train, joined us as escort. The 21st of June was spent, as the previous two or three days had been, in breaking in wild mules; no others could be obtained on short notice, so large had been the demand by emigrants going west of the mountains. Nor were we more fortunate in procuring capable teamsters, the large trains which annually cross the plains having preceded us; but by industrious drilling, and replacing incompetent men by the trial of the skill of others, we deemed ourselves at evening in a condition to move forward the following morning. But at an early hour it began to rain in torrents, and continued during the day, so that it was impossible to do more than to harness up a few of the wildest mules to habituate them to their labors. On the 23d the creeks and branches were still swollen by the rain of the previous day, and the roads slippery and soft. The advance, however, was ordered, and we pursued the usual Santa Fé road for eight miles, and encamped for the night on Indian creek, a small timbered stream; the character of the country being that already described—as beautiful and fertile rolling prairies as the eye ever rested upon.

The party, (the escort having been already mentioned,) which this day made its first marching essay for the exploration of the Central Pacific Railroad route, was composed of Captain J. W. Gunnison, topographical engineers, commander; First Lieutenant E. G. Beckwith, third artillery, assistant; Mr. R. H. Kern, topographer and artist; Mr. Sheppard Homans, astronomer; Dr. James Schiel, surgeon, geologist, &c.; Mr. F. Creutzfeldt, botanist; Mr. J. A. Snyder, assistant topographer, &c.; and Charles Taplin, wagon-master; besides the necessary teamsters and employés for the performance of the labors of the route.

The party was provided with the following instruments, viz: two sextants, two artificial horizons, one theodolite, two small surveyors' compasses, two reconnoitring spy-glasses, two surveyors' chains, two Buntén's barometers, two aneroid barometers, two thermo-barometers, one hygrometer, one box chronometer, one compensating balance watch, two viameters, and one grade instrument; besides thermometers and small pocket-compasses. Of these one of the surveyors' compasses proved imperfect and worthless, as did the thermo-barometer, which was graduated to high altitudes; and we were soon above the scale of the other, so that these instruments were of no use to us.

The civil engineer, whose services had been engaged by Captain Gunnison for the exploration, fell sick on the road before reaching St. Louis; and two barometers which he had in charge were necessarily left behind, as the season was already too considerably advanced to admit of further delay, especially as we were already well supplied with these instruments, should they prove good and no accident befall them.

The train consisted, for the party and escort, of eighteen wagons; sixteen of which were six-mule wagons, an instrument carriage drawn by four mules, and an ambulance by two horses, which were, however, changed for four mules before we had reached the mountains, the horses being broken down.

This method of transportation was determined upon in order, should the train pass successfully over the route, to demonstrate its practicability, at least for a wagon road.

The road to-day followed the general level of the country, leaving the Kansas river bottom (a favorable route for a railroad from the Missouri river) to our right. Nine miles from Westport we passed a finely wooded creek, near which was observed a fine spring of cool water, and near it a small cultivated field.

June 24.—A cool bright morning, with the thermometer at sunrise at 52° Fahrenheit. We were at an early hour again on the Santa Fe road, and arrived at 10 a. m. (not without several accidents to our loaded wagons, resulting in nothing serious, however) at Cedar creek, which has more water than Indian creek of our last camp, but is skirted with less timber. This creek has worn for itself a small ravine in the limestone which underlies this section of country, and which is here left in escarpments on either side of the stream. In this narrow ravine is the timber of the border, which can therefore be seen only at a short distance on the prairie. I observed among it oak and walnut, and cedar is said to appear a few miles below and continue to its mouth. The marked feature of the country to-day, as heretofore, is the graceful

grassy swells which extend as far as the eye can compass, and are lost in the blue line of the horizon. The latitude of this camp, as determined by Mr. Homans, is $38^{\circ} 52' 41''$.

June 25.—Following the Santa Fe road, we encamped this morning, at 10 o'clock, on Bull creek, the counterpart of that at our preceding camp: The road has thus far been very fine, following the general level of the country between the waters of the Kansas and Osage rivers. The country to-day was more than usually level, and the timber less abundant—if, indeed, abundant can be properly applied to so scarce an article. Quite far to the north and west, twenty or twenty-five miles, we at one time had a view of the Kansas valley, which appeared well timbered.

Mr. McClannahan, a gentleman whom we had met on the steamer in coming up the Missouri river, who had been favorably impressed with the reputed character and direction of the route we were to explore, and who was on his way by the Platte and Sweetwater route to California with a large flock of sheep, which had already reached the Missouri at St. Joseph when we met him, changed his route and here came up with us. He was accompanied by his partner, Mr. Crockett, and by two brothers, Messrs. Burwell, with a fine herd of cattle, also for the California market. Besides these, he was soon joined by two gentlemen, Messrs. Ross, with their families, destined for the land of gold. The lateness of the season, and the vast amount of stock which had passed up the Platte, sweeping away all the grass, had determined these gentlemen to follow our trail; believing that it would not only be found practicable, but shorter and more abundantly supplied with grass than any of the usually followed routes, and that they could easily keep near us, rendering their passage comparatively safe through the various Indian tribes to be passed to the east of the Great Basin.

It had been Captain Gunnison's intention, till last night, to turn off here with his party from the Santa Fe, and follow for a short distance the emigrant road to Salt Lake and Oregon, and thence up the Kansas on its south side, beyond the Big Bend of the Arkansas river, taking nearly a direct course for the mouth of the Huerfano. But after much inquiry about the country, of Indians and others who know something of it, and a long conversation with Major Fitzpatrick and Mr. Wm. Bent, whom we met here, he determined to divide his party at this point, and with a few men, an instrument wagon and a few pack-mules, to proceed himself partly by this route, directing me to proceed with the train and balance of the party, by the usual Santa Fe road to Walnut creek, and there await his arrival. Near our camp were the dwellings and farms of a few Christianized Indians.

June 26.—Captain Gunnison and party, consisting of Mr. Kern and Mr. Homans, also a teamster and a packer, with Captain Morris and a few of his men as an escort, moved off at the usual hour, 7 o'clock; by the Kansas river and Smoky Hill Fork route. The journal relating to this part of the survey is taken entirely from Captain Gunnison's notes, and much of it is an extract from them: "Contrary to the general rule, (it being Sunday,) we leave for Wahkarrussi this morning, having learned that the Indians are assembled there for church service or meeting, and start early to witness the occasion, never having been at

one of their missionary gatherings. Lieutenant Beckwith also moves off on the Santa Fe road—our men and animals having had nearly all the week to rest.

“At eight miles we came to a house and field, and descended a hill half a mile further on, where we crossed a fine creek which we had been nearing on our left for two miles. This creek is fringed by a dense growth of oak, elm and poplar. Passing over a fine plain for four miles, we crossed another stream which has beautiful groves along its sides, of red and white oak, sycamore and locust. Young hickory is also springing up along its banks, and it is to be hoped that fires will be kept off until it can contend successfully for existence, and add to the beauty and usefulness of this fertile country. After a ride of 14.89 miles, we camped on the southern side of the Wakharrussi, a tributary of the Kansas river. Half a mile above the crossing, which is a ferry at high water, a sandstone several feet thick, in horizontal layers, is cut through by the creek.

“*June 27.*—At 7 o'clock we were crossing the rich, alluvial bottom of the Wakharrussi. It is one and a half miles wide, covered with rich grasses. To our left, and on the other side of the creek, is the Wakharrussi mound, a hill that is a conspicuous land-mark for a great distance. Yesterday we were all day steering to the right of it. On the north side it is wooded from the brow to the stream. Five miles out we ascended the limestone ridge between the Kansas and Wakharrussi, and had a grand panoramic view of the adjacent country. The forest at the junction of the streams, and on both sides, will furnish oak, hickory, walnut, and other timber, for many miles of railroad; and the level bottom of the Kansas appears to advantage, inviting the theodolite and level of the engineer on its E.N.E. and W.S.W. course, for the track of the Central Pacific railroad. The fertility of these valleys, on either side, capable of supporting great numbers of people, is too obvious to mention.

“At a mile from the escarpment of limestone rock, on the left-hand side of the road, there issues a fine, cool spring, a curiosity on the top of this narrow ridge, one hundred feet above the bed of the stream. At sixteen miles from camp we came to a wooded dell, called Coon Point, the proper place to take wood for a march to Big spring. Twenty-one miles along the ridge brought us to this spring, which is on the north side of the road, and two hundred yards from the main track. It is situated in a hollow, and there are several small jets from the bank. Indeed, in all the ravines we entered, a short distance from the brow on either side, water can be had by clearing out the oozy mud at the edge of the thin strata of limestone which crop out. Some portions of the road to-day were covered with loose stones.

“At 11 a. m., barometer 28.80; thermometer 81°. At sundown, barometer 28.70; thermometer 77°; dew-point 70°.

“*June 28.*—The water of Big spring seems to have affected badly more than one of the party. The wind blew a gale all night, and this morning we had a little rain, and it remained cold and cloudy all day, with lightning in the south. The country was very rolling on the higher table-land, from which we descended shortly after leaving the Big spring, and steered our course towards a hill fifteen miles from

camp, and made, opposite to it, Stinson's trading-house, on Shunga Munga creek. Here the road to California branches off to the middle ferry, which is three miles to the northwest. The valley of the Kansas was visible a part of the way, or rather the Kansas bottom, for people in this region make a difference in this matter. The level meadow, or prairie, in which the river winds from hill to hill, is called the 'bottom;' and all the land, hill and meadow, drained by the stream, is called 'the valley.' The river is said to impinge frequently against the bluff hills on the south, in this part of its course. We nooned for half an hour at a small creek, heavily wooded, by a fringe one hundred yards wide, with the usual varieties of timber. On the west side are boulders of granite, serpentine, and red quartz rock. At 3 o'clock p. m. we arrived at Mission creek, where there are all the requisites of wood, water, and grass, for encampments, for a long time to come. Day's march twenty-three miles. Some Indian log-houses were passed at a distance to the right; and fine fields of corn, wheat, and potatoes, on Shunga Munga creek, give promise of what can be expected when these rich lands are cultivated 'in the sweat of the brow,' according to the dispensation of the order of nature. Just at our supper-dinner, Entho-kipe and Wah-hone, the guide and hunter of the Smoky Hill Fork trip, came to camp. They have been waiting two days on a creek two miles ahead, and were starting to look us up. The guide speaks a little English, but it is difficult for him to understand us; he has therefore brought another Delaware with him, who speaks English well. As soon as they had satisfied their appetites and taken a stock for to-morrow, they returned to their camp to await our arrival. I have this evening a severe attack of my old illness on the plains.

"June 29.—Very cloudy and warm. Thermometer at 6 a. m., 62°. I passed a bad night. At Union Town, to which we came after a ride of 7½ miles, there is a street of a dozen houses, where the traders reap their harvests at the time of the national payments. We could get no information about our route here. At Six Mile creek we stopped a few minutes only, as it began to rain. We have here an abundance of wood. At fourteen miles we crossed a fine, swift stream from southwest, 100 feet across, and averaging one foot in depth; timber and grass abundant. Il-a-heek-con-a-sa is the Indian name of the creek. Thence for three miles we travelled westwardly on a beautiful bottom which borders the stream. The prairie is purple with rich flowers, variegated with yellow. We made but 18¾ miles to-day; leaving the road at Union Town, and deflecting from the Kansas a little to the left, following a trail. The Indians, viz: Jno. Moses, guide; Wah-hone, hunter; and James Sanders, interpreter, joined us, and began their functions of guides when we left the road. It is necessary to take three, in order that they may be strong enough to return safely. Our camp is on a branch of Il-a-heek-con-a-sa.

"June 30.—It rained all night, making the roads heavy; the prairie giving under the carriage-wheels. In about 3½ miles we came to another branch of the Il-a-heek-con-a-sa, and had an hour's delay in cutting a crossing; and two miles further on we had another delay of a similar character. There is the usual strip of woods on these branches. We had at one time a view of the Kansas valley, four

miles distant. Crossing another branch, which is at times a torrent, but now a mere rill, we ascended a ridge by gentle ascents at 12.68 miles from camp, where we had a magnificent view of the Kansas valley to the northeast. We then descended quite abrupt hills to ——— creek, which is about twenty feet wide, and well wooded along its margin. Here we were detained an hour, and then began another ascent, which soon brought us again to the vision of the beautiful Kansas valley, and the hills, with clumps and rows of trees, sloping up on the north side of the river. We experienced much difficulty in crossing gullies on our route, for it is without a trail, and Ent-ho-ki-pi takes his 'bee-lines' across the country. This has been a hard day's work for the carriage mules; the ground soft and yielding, and the hills, though gentle of ascent, are long, and in many places rocky. It looks very inviting to descend to the Kansas bottom; but the streams cut deep chasms in the alluvion, rendering it almost impossible, without bridges, to cross them.

"July 1.—This morning displayed a sorry-looking camp. There was a storm of three hours' duration during the night, such as the plains only can exhibit. We are without tents, having only three tent-flies for sixteen men. These flies, stretched over poles, leave the ends open, affording but little protection against driving rains. The thunder-storm burst at midnight in fury upon unprepared, or, at least, unprotected individuals. One fly fell prostrate over three men, and in the darkness, lighted by fitful flashes of intense lightning, which was as blinding as the darkness itself, they could not re-erect their frail tenement, but quietly endured their drenching. We ascended the ridge again for $2\frac{1}{2}$ miles, when a band of half a dozen antelopes, for the first time, greeted our sight on a distant summit. We then began a long descent, and in three miles were in the valley of White Oak creek, which is formed by several branches to our left, at the junction of the two principal of which we crossed. These little branches are difficult to cross, and they occur frequently. We then ascended, perhaps 300 feet, to a dividing ridge, which we followed for seven miles; and then, descending to a branch of the last creek, encamped at 4 o'clock p. m. Water is found in pools, and a spring issues from under an escarpment of white limestone 100 yards from camp; but we are nearly without wood. The road on the hills has been hard for the cattle, on account of the sharp, pebbly limestone scattered thickly over the ground. The rock splits into fragments by the effects of the sun and rain, and having no attrition, these fragments are sharp and flinty in appearance. We have unintentionally left the Kansas far on the right, probably striking across the bend opposite the mouth of the Blue river.

"July 2.—We had another rainy night. This morning we travelled northwest for $4\frac{1}{2}$ miles, and encamped. Captain Morris left for the Republican Fork of the Kansas, northeast; but after four hours' traveling, returned, the guide having mistaken Blue river for that stream. We again moved forward, and crossed No-Nome creek, as Ent-ho-ki-pe calls it—an operation of no small labor. The escort, in endeavoring to follow, mired one horse and injured another, by which they were so long detained, the wagon having gone ahead, that they could not follow its trail after dark, and they therefore slept on the hill all night, a

mile from camp, without food or water. The road wound up the high hills to the top of a dividing ridge between two creeks, affluents of the Kansas, and we had a fine view of the groves of that river, and soon came in view of the long-desired fort on the Republican. But we had a frightful hill to descend, and just at dark arrived on the brow of the bluff, where trees whose tops are nearly on a level with us are growing in the valley of the creek. Here we encamped, or rather laid down.

"*July 3.*—The escort came in at sunrise, and we crossed the Mahungasa creek, which is 100 feet wide and 3 deep, with a swift current, and is the largest creek we have yet crossed. It is rightly named Big Stone, for at the ford we found its bed covered with boulders. In two and a half miles we arrived on the bluff opposite the new fort on the Pawnee river, (or Republican fork,) and prepared for the rest of Sunday. We communicated with our friends at Fort Riley. The fort is to be built of white limestone, quarried or lifted from the escarpment of the bluff; and the soldiers' barracks, in a half-finished state, already make a fine appearance from a distance.

"*July 4.*—We were notified by a rifle report, at daylight, of the arrival of the national anniversary. After numerous discharges of fire-arms, we started for the Kansas river for the purpose of crossing to the opposite side. This was determined upon because the north side of the Smoky Hill fork had not been examined, while there have been several surveys made of the south side. An India rubber ponton, procured from Fort Riley by the kindness of Major Ogden and Lieut. Sergeant, acting assistant quartermaster, was placed too low for our light vehicle, and it upset while floating across—a small incident for the 4th of July. Our horses were crossed by swimming, and we arrived about noon at the fort. This is placed at the junction of the Pawnee river with the Kansas, and not in the forks of the Smoky Hill and Pawnee, as we were before informed. There is a noble spring near the site, which appears to be well chosen at the head of navigation on the Kansas, from whence supplies can be sent to the posts in the Indian country and to New Mexico. A ferry across the Pawnee river (as the officers call the Republican fork) conveyed our wagon over; which was a difficult operation, however, but safely accomplished under the direction of Mr. Homans, while I was indulgent enough to myself to accept the invitation of Captain Lovell, commanding, to dine at the officers' mess, which I enjoyed as a great luxury. Lieut. Sergeant, acting assistant quartermaster, &c., did all that he could to supply our wants, and started us with fresh supplies. After a short nooning, I proceeded 7.59 miles to a spring in the bottom, near the Smoky Hill, passing one of delicious cool water, out from the bottom and under the bluff a half mile back, but where there is, unfortunately, no wood. After having crossed Pawnee river we entered upon the bottom in the forks, which is a mile and a half in width, and of rich alluvial soil. In seasons when not overflowed—and it is believed it rarely is covered with flood—it would produce fine fields of hemp. For two miles from this bottom, the ascent is so gentle as hardly to be discernible. At the junction of the two forks there is a body of large cotton-wood, with elms intermixed; and the ravines on the hill-sides are also well filled with small oaks, which are useful for fuel, but few are suitable for building pur-

poses. The valley of the Smoky Hill fork is on our left, and is from one to two miles wide, with the circuitous river-bed in it fringed with poplars, presenting a lovely picture, and is very favorable for the construction of a railroad.

"*July 5.*—Leaving the beautiful spring at which we had encamped, we crossed the bottom and skirted along the hills S. 75° W. for 2.26 miles, and then, continuing the same course, ascended the slight undulation which slopes up from the bottom, until we came to Deep or Sycamore creek. Here we found the water too deep to cross, and turned north two and a quarter miles to the first ripple, where, with a little cutting and aiding down the wagon, we crossed safely; and after ascending for four miles, we passed again S. 72° W. to the bottom, where we found the slope of the hills very fine sand and heavy pulling. Deflecting to S. 80° W., we struck off along the beautiful flat, which reminded us of the Nebraska. It is here about five miles wide, the Smoky Hill fork skirting the south side. Wagons from Fort Riley should keep on the brow of the slope from Pawnee river to Sycamore creek; then passing over the point to cut off a bend, they should follow the bottom land, near the foot of the slope, for seven miles, to the creek upon which we are encamped. These creeks can be easily bridged. Coming to a creek with little water, but a deep eastern bank, we lowered the wagon down it and made camp just before dark. Distance by route, 22.50 miles.

"*July 6.*—Thermometer at sunrise 70° Fahrenheit; barometer 28.91. We continued our course S. 70° W. along the flat. The hills are composed of fine sand, and would become heavy roads for loaded wagons. A ride of ten miles brought us to Nepeholla or Solomon's fork: the road along the base of the sand-hills is good, the hills themselves being of too loose sand for wagons. The river we found swollen by a flood at least eight feet above low water. There was no alternative but to look around for material with which to construct a raft—a matter of some account, as we were only provided with two dull axes. But with two dead trees, already water-soaked, we laid the basis of timbers, and bound on these such dry small willows as we could find; and by making some twenty trips we got all safely over. The carriage body being tight, floated across easily. The Delawares rendered great service, swimming about, carrying ropes, and towing horses over all the afternoon. They seemed to delight in the watery element. The grass is becoming shorter, and the timber less in quantity and varieties, the cotton-wood being the prevailing tree, and this is confined in patches to the margins of the creeks.

"*July 7.*—A cool, delicious morning, the river still rising. We travelled S. 70° W. across the level plain, between the Kansas and Nepeholla, for four miles, to the foot of a dividing slope, opposite which, on the south side of the Kansas, is a square butte. A wagon road could be well maintained on this meadow all the year. After riding seven miles we struck the Saline fork in the meadow. This stream is also swollen by a flood, and looks like the boiling Missouri. Continuing our course for two miles, we halted on one of the bends of this stream and cut two dry cotton-wood logs, which we lashed to the outside of our wagon wheels, and thus made a ferry-boat of our carriage. With this we

ferried over the stream, which is 150 feet wide and 9 feet deep, with a rapid current. The guide represents it as being usually 20 feet wide and 2 feet deep. It is surprising to see such a freshet without any visible cause. Stretching away to the west for some hundreds of miles; the river has no doubt received the product of heavy rains. The Nepholla rose six inches yesterday, and this river as much during the seven hours we were most laboriously engaged in crossing it. Without our Delawares, we could not have effected this work. They plunged into the boiling current with the ropes on their necks, and stretched them across the streams for us, and then passed along the same to slip the noose over the knots—for we have only our picket ropes for this purpose, which being tied together, were long enough to pull back and forth, which greatly facilitated operations, and without which we could have done nothing to advantage. Our hunter killed a noble fat buck, which, with a cup of black tea for supper, soon refreshed us from one of the most fatiguing days we have yet experienced. Plats of buffalo-grass appear occasionally, and we soon expect to be on the trail of these animals.

"*July 8.*—We started this morning over the grand meadow of Saline and Kansas rivers, bearing S. 45° W. between the two streams, which at this point diverge rapidly. The Kansas has a trend as you go up its stream to the southward, passing around the famous Smoky Hill, which was full in sight, with its azure hue, on the east of it. This hill has given the name to this part of the Kansas, but our guides do not know it by the name of the Smoky Hill fork. The hill may be 100 feet in elevation above the plain. We kept our course up a branch of the Saline, southwest, on a plain so gently rising that the ascent was scarcely perceptible, and nooned on its banks, 13.50 miles from our last night's camp. Signs of buffalo are very numerous, and their trails quite fresh. A party of Pottawatomies has preceded us, and probably driven them further into the buffalo ranges. In fifteen miles we came to ferruginous sandstone ridges on either side of our course, which is remarkably direct, up a plain valley in which a creek meanders.

"*July 9.*—Gradually ascending this branch, it soon brought us near the main stream; and by passing a low divide we came into the main valley, where there is quite a large quantity of wood, and, at this season, water. Water in pools continued nearly to the summit of the next divide; beyond which, in the distance, are oak and cotton-wood trees of small growth, on a stream running southeast into the Kansas. At half-past 10 o'clock we reached this river, which we found to be falling, having been eight feet higher than at present within two or three days. We came to a good ford, in a low stage of the water, which we call the Lone Oak ford, as there is here a remarkable solitary oak tree in the bottom. We remained here till 1 o'clock, and then passed over, the wagon body just clearing the water, and ascended the slope for a mile, but turned down again to cross a creek near the bottom. From the top of the ridge we discovered a lone butte, S. 33° W., and another S. 25° W. Our course bore thence over the heads of a creek well wooded with a stunted growth of ash, walnut, oak and cotton-wood. Here we found the choke-cherry ripe. Keeping up the ridge for some time on the right of this creek, we found no signs of passing over to Walnut creek, as

promised by our guides, and therefore we turned a little more westwardly and down the slope to a nearly dry creek. On the way we passed a small spring coming from under a sandstone bluff, but preferred to go a half mile further to the creek, on which the walnut tree prevails, interspersed with oak, elm and cotton-wood. At the place where we crossed the Kansas the valley is not more than a quarter of a mile wide; and though it widens in places above, as we could see from the hills, the course of the plain is more winding than below, and probably it will be found advisable in the construction of a railroad to deflect to the mouth of the Huerfano from near this point of the river. It will, however, require minute exploration to find the best point and to obtain the best grade for a railroad, as the creeks coming in from the south make deep indentations in the rolling prairie. The rise from the Kansas is not abrupt; the hills sweep down gracefully, and no serious difficulties are in the way of a good track. But the timber has become more scarce and dwarfish. The hills are composed of a hard red clay, with occasional beds of gray or white clay. They are sometimes covered with fragmentary sandstone; and escarpments at other places show the stone in situ and stratified. We here discovered a very cool spring, the water appearing chalybeate, from which we hope for some happy effect upon several persons of the party who are slightly ill. The spring bursts up in considerable volume near the dry bed of a creek.

"July 10.—Remained in camp to rest man and beast. In the afternoon we were visited by one of those violent rain and wind storms which are well known to travellers of the plains. The ground was soon covered an inch deep with water. The dry bed of the creek flowed with a strong muddy current, which continued till we left on the following morning. We gathered wild cherries, (choke,) currants, and gooseberries, and the wild grape-vines were loaded with green fruit.

"July 11.—Starting at 6.30 a. m., we had a wet, foggy morning till 7. In a few miles we came to the summit of the ridge between the waters of the Kansas and Arkansas rivers. Here we had a broad, level country before us, and in the distance a ribbon of trees was visible on Cow creek, to which we gently descended. The creek is swelled by yesterday's rain to twelve feet in width and two in depth in the centre. Barometer's reading at 9 a. m., before passing the summit, 28.237; thermometer 80°; and on the plain, at 11 o'clock, after passing, 28.276, thermometer 89°. Here we saw the first buffalo, which the hunter killed. It proved to be a bull feeding alone, but as he was pretty fat we had some of it cooked for dinner. At 12 m. we arrived at the 'Sand-Banks,' which border the northwest branch of the Little Arkansas. This stream is very muddy and swollen by recent rains, being now forty feet wide and two feet deep in the centre. We had now traversed, for fifteen miles, a plain with gullies cut deep by the branches of Cow creek—our general course having been S. 50° W. The rise from camp to the summit was very gentle, and it was so slightly marked that it was not observed till we had passed it some distance. The 9 o'clock barometrical reading given above will determine the altitude of this summit-level with accuracy. After noon we crossed the creek below the drifting sands, which are on the south side, and extend one mile in length and a half mile in breadth; we then crossed them diag-

onally, and continued on uneven sand-knolls, which are fixed by vegetation, for a mile. A variety of shrubs grow on these sand-hills, among which is the wild plum, very much dwarfed, but loaded with unripe fruit. We then descended slightly to a flat, which is clayey and too low for a road for wagons. At a short distance from the base of the knolls the helianthus grows densely, extending northwest over a field of several square miles in extent, with grass and saline plants intermixed. We attempted to cross this sun-flower field, but were very soon forced back to the high ground, for the water was rushing over it, being backed up by the rise of a creek five miles before us, showing the extent of yesterday's rain. After travelling twenty-nine miles we came upon a torrent of muddy water, running in banks too deep and sharp for crossing without labor, and, in our vicinity, too deep also to ford, and we therefore encamped much fatigued by the day's work. The quartermaster's road from Fort Riley should strike higher up the Kansas, and cross the ridge to the west of our line.

"July 12.—The Arroyo creek had fallen so much that we passed safely over it this morning, and afterwards met two Indians hunting buffalo. From them we could only learn, by signs, that their people were encamped over the next ridge, on Walnut creek. Crossing Mosquito creek in two-and-a-half miles, which is a branch of Cow creek, and is dotted here and there with ash, elm and cotton-wood trees, we came in a short time in sight of the elms and ash of Walnut creek. It is difficult to cross this creek with wagons above the ford for the Santa Fe road, which is near its mouth. We crossed over, however, and followed down the west side, and found the party under Lieutenant Beckwith in camp, waiting for us since the ninth instant. Here we also found Brevet Major Johnson, sixth infantry, in command of a camp, being about to build a fort upon the creek; the fort on the Arkansas, 100 miles west, from whence his present stores are received, being about to be abandoned. In the night Colonel Sumner, Majors Morris and Hagner, returning from New Mexico with an escort, arrived at camp. Our Delaware guides were here discharged. I furnished for Major Ogden, A. Q. M., a description of the country his guides had shown me from Fort Riley, with the distances travelled, and advised him that with proper bridges a fine and remarkably level track could be found thus far on our route for the location of any kind of a road. Of course the relative merits of the two sides of the Kansas I cannot discuss. The four bridges on the main streams would be an item of cost; but if Fort Riley, on the Kansas, is at the head of the steamboat navigation, then this is the proper way for a route to New Mexico south or north, for wagons or for a railroad. The character of the country changes materially in soil, climate and productions at the ridge between the Kansas and Arkansas rivers. Some buffalo-grass, scattered in patches, was noticed after crossing the Saline; now it is the prevailing grass."

The following extracts from my own journal descriptive of the country which I traversed on the Santa Fe road, on a line some 20 or 30 miles distant, and nearly parallel with that followed by Captain Gunnison, are added, to show that the fertility he has described along the valley of the Kansas river and its main tributaries, extends far back over the rolling prairies towards the sources of the small streams and

rivulets of the country, and that its general character is such that a railroad may be carried over it in any desired direction.

June 26.—As stated by Captain Gunnison, we moved out of camp as his party set off on the route of the Kansas river and Smoky Hill fork, and nine miles out passed Black Jack creek, in which there was but little running water, and, skirting its banks near the crossing, a few scattered trees; and generally in the early part of the day timber was very scarce, but afterwards became more abundant a few miles from the road, and at times extending quite up to it. We had at one time a beautiful view of a finely-wooded valley to the south; and later, of one to the north, finely timbered, opening and extending far to the west. This valley we judged to be that of the Wahkarrussi, a tributary of the Kansas river. Major Emory in his report says: "On a branch of the Wahkarrussi, where the Oregon trail strikes it, a seam of bituminous coal crops out. This is worked by the Indians, one of whom we met driving an ox-cart loaded with coal, to Westport." In the early morning the prairie was quite level, but later became finely rolling, and was all abundantly covered with grass. After a ride of $20\frac{1}{2}$ miles we encamped at Willow spring, where we had fine cool water, but the nearest wood was distant a mile. Mr. Ross with his family encamped about fifty yards from us, and at half-past 9 o'clock was seated with his party around his fire, with his horses picketed between his tent and mine, when, without any apparent cause, six of them pulling up their picket-pins, dashed off at a frightful speed, and in a moment were far away over the prairie, and out of sight. One of them, however, trembling with fright, fortunately ran into a neighboring camp, and was secured.

June 27.—The country continued of the same character as heretofore, with less wood and water, and we only passed a little of the latter in pools two or three times during the day, during which we were often elevated on the rolling prairies high above the surrounding country, of which, to the south and north, we had extended and beautiful views. Little timber was, however, visible. The road was fine, there having been no rain recently, and the grass luxuriant. Nine and twelve miles out we passed Rock creeks, but they were nearly dry, having no running water, and were without wood. We encamped, after travelling 24 miles, on what is known as the 110-mile creek, which is lined with an unusual amount of timber; and there is in it, at present, running water, with holes large enough for bathing, as there was also four years ago, when I passed it. Near our camp are a few Indian houses and cultivated fields.

June 28.—Eight miles from camp we crossed Dwissler's creek, a fine little branch, with steep and well wooded banks; four miles then brought us to the first Dragoon creek, quite like the last, but with low banks. One mile from the last is the second Dragoon creek, with less wood and water. At 1 o'clock we arrived at Prairie Chicken creek, where there is an abundance of wood, water and grass. Distance marched, 21 miles.

June 29.—To-day, a mile from camp, we passed a little branch in which there was water, but the line of timber on its banks was thin. Three or four miles further on we crossed Elm creek, with fine wood

and running water; and still another, called the 142-mile creek, about six or eight miles out; and after a ride of thirteen miles, we crossed Bluff creek, where there are fine and abundant water and wood. At 3 o'clock we encamped on Big Rock creek, which is well timbered. As usual, the grass to-day was everywhere luxuriant. Distance twenty miles.

June 30.—It rained heavily during the entire night, and continued to do so until 8 o'clock this morning, accompanied by heavy thunder. At 10 o'clock we left camp, and without halting at Big John spring, famous on this part of the route, and of which I have cooling and refreshing recollections, passed on seven miles to Council Grove, and encamped on Elm creek, three-fourths of a mile beyond it. The roads were very slippery and the mud deep to-day. The Neosho creek, upon which Council Grove is situated, is a fine little stream, with timber more abundant than any stream we have seen since we left the Kansas river, of which the timber is similar, and the fields of corn are remarkably luxuriant and fine. We here came up with a large number of government officers, both civil and military, on their way to their respective posts of duty. Among them was the Hon. D. Merriwether, governor of New Mexico, in whose life occurs a singular incident connected with the political changes which have transpired between this country and Mexico. In 1819 he was, as he informed me, an Indian trader, and accompanied a war party of the Pawnees too far into New Mexico. The Pawnees were nearly all slain in fair fight; but himself and servant were made prisoners and taken to Santa Fé, where he was for some time confined a prisoner in the "palace" of that Territory to which he now goes as governor, and will soon again occupy the same palace. Judges and Indian agents for New Mexico were also of the party, and General Garland was in command of the military camp, of recruits for the 9th military department, in charge of a number of officers, and a large military train.

July 1.—To-day at the usual hour we moved on again over heavy roads from the excessive rains of the previous day or two. The country differs in nothing from that east of Council Grove, except that the soil is more firm and less miry in the gullies. Eight miles out we crossed Elm creek, (on which we had encamped last night,) its waters having subsided several feet since the previous evening, when wagons could not have crossed it; and at 2 o'clock, having ridden but sixteen miles, the train was well encamped at Diamond spring, where we enjoyed the luxury of cool water in abundance, but the supply of fuel was limited.

July 2—The threatening state of the weather detained us in camp this morning until 8 o'clock; but as the heavy showers in sight and the distant thunder at that hour receded, we started again over heavy roads. We passed a branch of water dotted with trees on its banks, a mile from camp, and then saw nothing more of wood or water, except the rain-water of the previous day, until we arrived at Lost spring, after riding sixteen miles. The water here is quite good, but not cool, like that of last night. Not a tree or a bush is here anywhere to be seen; but we encamped, our previous knowledge of the place having caused us to bring a sufficiency of fuel for cooking. The country

to-day was more level than heretofore, and the roads consequently not so well drained, and, as I have already said, not so well watered and timbered; but in all things else this wide, wide world of prairie is always the same, ever green and luxuriant with grass, and dotted with flowers, gently swelling here and sinking away there in soft lines and rounded figures, which it needs not the fancy of man to shape into lovely landscapes. Snipe literally swarmed on our path, and two or three fine dogs which belonged to our party were "pointing and setting" at every turn.

July 3.—At half-past 6 o'clock our train was on the road, which had been dried, and consequently greatly improved, by the hot sun of the previous afternoon. Passing over a country destitute of timber, but from the recent rains covered with abundant pools of water, and sensibly rising as we travelled forward, we selected our camp on Cottonwood creek, seventeen miles from Lost spring, and at 12½ o'clock our animals were grazing—at least those of them that could endure the bites of the innumerable flies and mosquitoes without losing their appetites. This creek is but slightly timbered, chiefly by trees which its name indicates. The day is oppressively hot, with scarcely a breeze. The thermometer in the shade of a wagon, but not well situated, indicates 100° Fahrenheit.

July 5.—We yesterday remained in camp for the benefit of our animals, one of which, however, at the usual hour of marching, took matters into his own head, and, pulling up his picket-pin, took the road, and encamped at the next usual camping ground with a train he found there. To-day we continue to ascend even more perceptibly than on our last day's march, and only passing a few pools of water and Little Turkey creek, eighteen miles out, we encamped, after a ride of twenty-two miles, on one of the Turkey creeks, of which, at times, there are three. At this camp we have no wood, and the water is indeed miserable, stagnant, and green.

July 6.—Starting at 6 o'clock, and travelling, generally, over a very level country, we arrived in twenty-three miles at a fine camp on the Little Arkansas, where, however, we are seriously annoyed by flies and mosquitoes. We passed Big Turkey creek an hour out this morning, and during the day many stagnant pools. These pools do not usually exist during the summer, but are caused by recent rains. The road over which we are now passing would be very heavy during damp, rainy seasons, and we therefore congratulate ourselves on passing over it just after it is well dried from the recent heavy rains. All day, to the south, the sand-hills and shrubbery of the Arkansas river bottom or vicinity have been visible. On the Little Arkansas there is but little fuel, and I can see that near the road it has perceptibly diminished since I was here in 1849.

July 7.—Moving over a level country for ten miles, brought us to a bushy gully in the prairie, honored with the name of Charez creek; for what reason, however, no one can tell, unless it be because it *never* has water in it. It is also sometimes called Owl creek. Six miles from this we came to Little Cow creek, another bushy stream, with an occasional tree to ornament its banks. There is at the road-crossing no

water; but turning to the left, towards a fine clump of bushes and trees, I observed General Garland's large camp, with many animals, and doubtless an abundance of water. We, however, continued our march for three miles to Big Cow creek, which crosses the road at the bottom of a deep gully, with banks twenty feet in height—firm and easily ascended—in a little rivulet of warm dirty water. A few bushes and fewer trees mark its course to the north and south of us. It soon unites with Little Cow creek. The grass is now thickly interspersed with plats of buffalo-grass, and the whole vegetable growth is smaller and less luxuriant than we have heretofore passed. The days are oppressively hot, and the dews very heavy every night. Prairie-dog towns of large extent begin to make their appearance, with their various inhabitants—dogs, snakes, and owls. The country passed to-day is very level, with but one or two small rises. From our last camp to the present—both off the road—the distance is 20 miles.

July 8.—We left camp at half-past 6 o'clock this morning, and were more forcibly struck with the change in the character of the soil and vegetation than on any previous day; the former being more dry and sandy, the latter smaller, finer, and very short—not the grass only, but most kinds of plants, which have a wide range of prairie on which they flourish. The sand-hills of the Arkansas come into the road about twelve miles west from Big Cow creek; but they were soon passed, and we struck the level bottom of that river, which we had observed to the south of us all the morning, marked in its course by a few scattered cotton-woods along its shores and on its islands. It is a broad stream where the road first approaches it, divided by islands into two or three channels. Its current is rapid, its waters yellow, and its bed full of quick-sands; so that, it is not always easy to ford it. It varies in depth. At present its waters are unusually high, being from one to six feet in various places as it is crossed. The road travelled is generally very dry at this season of the year, but to-day water filled every hole and buffalo wallow; but the road is finely dried from the recent rains. The cotton-wood on the northern bank of the Arkansas, at our camp, has been nearly all consumed for fuel by the caravans and travellers who annually pass here. We occasionally see a few Kansas Indians, who, at this season, frequent this part of their hunting grounds to hunt the buffalo, which are usually found here in large numbers. We have as yet, however, seen but a few scattered bulls, and have no hunters ambitious enough to pursue them. Distance from Big Cow creek to the Arkansas, 18 miles; to camp, 20 miles.

July 9.—Just as we were leaving camp this morning our train took fright at a rabbit pursued by a dog, and took to the prairie in every direction, at full speed, and, however serious to us, it was an amusing sight. The teams were, however, quieted in a few moments, and brought back to the road, which, in a couple of hours, brought us to Walnut creek, where we encamped just after 8 o'clock in the morning, among a motley host of Kansas, Osage, and Sac Indians, of all ages, sexes, and conditions. Walnut creek this morning is three feet deep, and some ten yards or more in width. There are fine cool springs in the banks, which, after so much pool and stagnant water, we enjoy very greatly. General Garland's command passed our camp at 11

o'clock, all in fine health; and we also parted here with Governor Meriwether and party, in equally fine condition. Our morning's march was only seven miles. While remaining in this camp we have suffered from mosquitoes beyond anything we have ever before experienced, or of which we have ever read; and, although our sentinels were doubled in number, we had repeatedly to turn out and quiet our animals to prevent their running off to escape the agony of the bites. Fortunately, during the last evening that we remained, a fresh wind sprung up, and we experienced no further trouble from these insects. Our camp, of all points in the neighborhood, was the most free from this curse. In the middle of the day, in riding into Major Johnson's camp on the opposite bank of the creek, our horses would become frantic; and such was the case for miles around. The land is low on the creek, and subject to be overflowed, as is evident from the drift-wood scattered upon the prairies.

July 13.—As we moved forward this morning, Captain Gunnison rode up Walnut creek with Major Johnson to see the site selected by this officer for building a military post. It is on the ridge between Walnut and Cow creeks, raised considerably above the level flat which borders Walnut creek, extending to the Arkansas river, which overflows far above the point near the road which, it is said, was first selected for this post. The site chosen by Major Johnson, five miles from the road, has the advantage also of being nearer the proposed road from the mouth of the Republican to New Mexico; but if water can be obtained still higher up, this latter road might be made still more direct. There is on Walnut creek no timber suitable for building purposes, but an abundance for present uses for fuel. The elm, ash, and cotton-wood trees are here frequently two feet in diameter at the base, but, four or six feet above, branch off into crooked gnarly trunks. The section passed to-day is generally very level. We passed Pawnee Rock, a noted topographical feature in this part of the country, during the morning. It is to the right of the road, about two miles from the Arkansas river, and terminates a ridge from the north in a bluff escarpment of highly ferruginous sandstone, twenty feet in height, on which many names of passers-by are inscribed. Shortly after leaving Pawnee Rock we crossed Ash creek—a dry bed, lined with the usual amount of timber—and encamped on Pawnee fork, after a march of twenty-eight miles. The grasses during the day became hourly poorer until we came upon this creek, where they are more fresh. The soil is also less fertile. Its surface is composed of fine sand mixed with vegetable mould, which, by the rains, becomes soft mud, and turning up in ruts, hardens, but is easily crushed again by the wheels. The water in Pawnee fork is twenty feet in width by from one to two in depth, with a fair current. During the day we passed water only in a few pools. The timber on this creek, like that of all the streams hereabouts, is small, scattered and ugly—more of bushes than trees—looking in its tortuous lines not unlike the lining to the fences of some thrifless New England farmer, who gives a wide margin to blackberry and elder bushes, interspersing them with an occasional elm. This camp, 293 miles by the Santa Fé road and 322 miles by the Smoky Hill route, from our camp near Westport, is 972 feet above that camp, giving, be-

sides the usual inequalities of a rolling prairie country, which have been duly noted, an average grade or ascent to the mile of about three feet three inches, and three feet, respectively, for these distances. Large numbers of Kansas and Osage Indians, on their usual buffalo hunts, are encamped to the southeast two or three miles on the Arkansas river, and their large herds of horses are scattered over the plains for miles. They are filthy, dirty beings, and quite as impudent and pilfering as their wilder brethren to the west. This morning they visited the party of officers spoken of as returning from New Mexico, a few miles from our camp on Walnut creek, and helped themselves to several light articles before the men who were sleeping in the wagons could be got out to disperse them.

CHAPTER II.

From Pawnee Fork to crossing of the Arkansas river at the mouth of the Apishpa.—July 14 to August 2, 1853.

July 14.—Five miles from camp the road forks, (we are still upon the Santa Fé road,) and one branch follows nearly the windings of the Arkansas, to secure grass and water, while the other appears to push off for a "short cut" and "dry route" to Fort Atkinson, near which they again unite on the Arkansas river; but this appearance is deceptive; for after going a few miles it abruptly turns southward, and follows but a few miles from, and parallel with, the other road, keeping it generally in sight, as it does also the trees and sand-hills upon the banks of the Arkansas river, and is, except in the rainy season, without good grass and badly watered. We followed the cut-off route, and having made 21 miles, searching diligently for the last five or six for water, yielded to our fortunes, and encamped on the headwaters of Coon creek, on buffalo-grass and buffalo-wallow water, where we are surrounded by immense herds of these animals, which afford us a happy relief from our salt meat diet. We passed the Sacs, Osages, and Kansas Indians, on the extreme verge of their hunting grounds, at Pawnee fork; and here intervenes a tract of undefined dimensions, the Neutral Ground, which separates them from their Comanche and Kioway neighbors. The buffalo are this season more than usually crowded on this tract, which causes the Indians to extend their camps to their extreme border creeks—an unmistakable evidence that the buffalo, hunted by all, is rapidly disappearing. The country rises gently on this route for ten miles, and then gradually descends to our present camp. The short, dry buffalo-grass alone grows over the whole surface of the country, with here and there a few scattered weeds and flowers; but nature has here lost all her freshness and sweetness, and at this season only wears a gray, sterile, and forbidding aspect. On this route we see no wood, which, for fuel, is supplied, in dry weather, by the bois de vache, which was in 1849 an article of important local traffic among the Zuni Indians, in the western part of New Mexico, as I passed through their

pueblo. A thunder-storm swept over us, and heavy showers of rain during the night prevented the use of the transit theodolite, which we had set up in the evening.

July 15.—A fine badger was killed near camp this morning, but it was too much injured for preservation. Soon after leaving camp we were enlivened by the sight of a wolf in hot pursuit of a rabbit. It was an animating sight, which quite aroused the sympathy of the party, as the intended victim, panting with exertion, and straining every nerve for life, pursued by his rapacious enemy, snapping at him at almost every jump, crossed and re-crossed the road a few yards in front of us, but by his skilful angular turns he avoided these deadly bites until he had nearly arrived at his burrow; but here the pursuer had posted an accomplice, and the rabbit was forced to make another long turn, which he accomplished successfully, darting into his burrow heartily cheered by the party, while his pursuers resumed their characteristic look of meanness, sneaking away to their covers. The day has been very sultry and cloudy, the scorching sun-rays, however, occasionally pouring out upon us oppressively. The country over which we rode is undulating, the arid buffalo fields wearing the same uninteresting aspect as yesterday, unrelieved by a single tree, except on the distant banks of the Arkansas; and the water collected in pools is barely drinkable, either on the road or at our camp. Day's march, 18 miles.

July 16.—A ride of 18 miles, over a country in all respects like that of yesterday, brought us to the Arkansas river, where we found two hundred and eighty lodges of Comanches encamped, their horses and mules in large droves grazing far and wide over the river bottom. Hosts of men, women, and children immediately surrounded us, as we passed their female sentinels, upon the bluff near the river. Some of their chief men accompanied us to camp, out of courtesy and *respect* to the party and government, liberal presents being expected in return. Camp was pitched a mile west of Fort Atkinson, where we found an abundance of grass, but were indebted to Major Chilton, 1st dragoons, commanding at the fort, for a supply of fuel for cooking our bacon and coffee, the river bank here being even destitute of drift-wood for many miles above and below. The river is unusually high, being from one hundred and fifty to two hundred yards wide; and the Indians, in crossing it, are occasionally seen swimming; while two years ago, at this season, I am told by officers of the army and others who were then here, that it was necessary to dig in the bed of the river for water to drink. This sinking of the stream during low stages of water is not peculiar to the Arkansas, as is well known, and it is believed that water can be found always in abundance by digging in the bed of this stream. Opposite to our camp, on the southern bank of the river, the old men and the women and children of the Kioways are encamped, their warriors having joined the Cheyennes, the Arrapahoes, and the Jicarilla Apaches, with a few Comanches and others, in a war party, which it is boasted is to "wipe out the Pawnees." The Comanches are anxiously awaiting the arrival of Major Fitzpatrick, Indian agent, from whom they expect large presents, after having made a treaty. Our camp is constantly thronged with them, and though anxious to purchase horses, we have entirely failed in persuading them to sell us even a half-dozen.

Shaved Head, with some of his principal men, paid us a visit just as Captain Gunnison and myself were dining. Blankets were spread for them in front of the Captain's tent, and they did ample justice to the fare spread before them—carrying off, as usual, what they could not eat at present. After the usual amount of talk, smoking and ceremony, they took their leave, which, with Shaved Head—the principal chief of the Comanches of the plains—is a peculiar ceremony which he extends to all whom he esteems or deems of importance. He assumes an air of gravity and solemnity of features I have never seen equalled by more civilized performers, and taking you by the right hand, gives three shakes as slow and deliberate as the time to a funeral dirge, pressing your hand with a firm grasp, and looking steadily in your eye; releasing your hand, he passes his arm through yours to the elbow, and thus facing in opposite directions he presses your arm firmly to his side; then the left arms perform the same measured functions; and during the whole of this leave-taking he repeats, “bueno,” “mucho bueno,” with a grave accent. Among those who came to camp we observed two or three Mexicans and others, who at some early period of their lives have been captured and are now slaves of these bands. Among them were a brother and sister, of perhaps ten years of age, but I think much younger. These children are said to have been left destitute upon the plains by the death of their parents, and to have been several years with these bands, who found them in their destitute condition and have since provided for their wants. However much our sympathy must be diminished by the knowledge that these children have not, from early childhood, perhaps, known the mild, gentle and improving kindness of civilized parents and society, and that now they are little less savage than their masters, it is not the less humiliating to see that the arm which this enlightened and powerful nation extends to redress such wrongs, and to protect its exposed citizens, is impotent. From Pawnee fork to this camp, 68 miles by our path, the ascent is 418 feet, or about six feet and two inches to the mile. By following the river the distance would be increased slightly, and the grade thereby diminished; or by taking a more direct line the distance would be lessened, slightly increasing the grade. Our camp is under a bluff of sedimentary pebbles, deposited in layers of a few inches in thickness, interspersed with a coarse sand, and the whole cemented into a single mass. A short distance above the fort a coarse limestone crops out. The short and fine, but rich and nutritious buffalo-grass covers the hills, while tall and rank grasses spread over the bottom on the river.

July 19.—After remaining two days in camp to recruit our animals, make repairs, and procure necessary supplies, we this morning took leave of our hospitable friends at the fort, and very reluctantly parted with two young gentlemen from St. Louis, Messrs. Collier and O'Fallon, who have accompanied us for several weeks on the plains for the recreation and the sports of the chase. Four and a half miles above camp we ascended the bluff, and passed for two miles over a ridge, which extends to the river at a single point, where a road can easily be cut in the aggregated pebbly deposit, by which the distance would be shortened, and the ascent of a hill of half a mile in length be avoided. These ridges which approach the river are of a whitish sand and clay,

overlying the coarse friable sandstone of the bluffs. These bluffs are generally from one hundred yards to half a mile back from the river, rising from ten to forty or fifty feet above it, and extending back in a high, dry, and uninteresting prairie, covered with a thick mat of buffalo-grass, too fine and short for grazing draught animals, but excellent grazing for sheep and buffalo. On the river bottom heavy grasses of the blue-joint and wheat kinds grow luxuriantly, mingled with various weeds and herbs. The stream is filled with low islands covered with grass and rushes, and nearly submerged. Seventeen miles from the fort there is a ford, sometimes used by trains and parties going to and from New Mexico by the Cimmaron route; but the principal ford for that route is eight miles above this, and to reach it the road leaves the river bottom, passing over the high bluff or prairie land. We encamped about two miles above this ford on a fine field of bottom grass, which our horses eat with avidity. Had it not been necessary for us to procure supplies at Fort Atkinson, we could have arrived at this point by a shorter route than the one followed, if the appearance of the country and our recent Delaware guides, who have been frequently over it, may be relied upon, by following on and in the vicinity of Walnut creek and Pawnee fork, which rise to the north of our present camp, the latter at a distance of not more than five or seven miles. If this route is practicable—and there seems to be no reason to doubt it—the proposed road from the fort at the mouth of the Republican fork should follow it. But as a large portion, if not the whole of this route, was understood to have been examined by officers of the topographical corps, and already reported upon, Captain Gunnison did not deem it advisable to delay the mountain exploration to examine it.

July 20—This was a cool morning, the clouds which last night prevented astronomical observations still lowering above the hills. The road was heavy for fourteen miles with loose coarse sand, and we crossed a few beds which were deep, but of small extent. Beyond this our road became firm for five miles to our camp.

July 21.—The bottom here, as it is generally called, or land on the borders of the river below the bluffs, has two distinctly-defined plains. The lower is subject to overflow, but is at present about eighteen inches above the water, which has, however, receded from it within the last two or three weeks. The second plain is dry, and about three feet above the first at the edge, rising slightly back to the low sloping hills. On this the artemisia is now the characteristic plant, but we also observed two or three varieties of the helianthus, thistle, and geranium. Eleven miles from camp the river has cut away for a mile nearly the whole second bottom, back to the rolling plain, which on this part of the river is but slightly elevated, rising gently back from the bottom. On its southern bank the country is more than usually sandy. Returning again to the bottom land, we encamped on the soft damp soil, after a march of twenty-two miles. Our men are obliged to cross to the islands and opposite bank of the river for fuel. With our tents pitched a few feet from the river, we enjoy the luxury of bathing. The river bed is very uneven, the whole of which is a shifting sand. Nothing can exceed the dull monotony of a journey along the Arkansas. Neither in the character of the country nor in any department of science do we

find a variety in a day's march of twenty miles. A gradual change is going on, however, of which we feel sensible; the vegetation of the rolling prairie being already parched and dry, and the earth of the hills is so compact and hard that it rings under our horses' feet, and it is often impossible to drive a tent-pin of wood into it. To-day, for the first time, we have felt the southeast wind, which travellers on this route have so often noticed in summer, and the remembrance of which is still agreeable to me; and to-day it is intermixed with hot, enervating gusts, which remind us of descriptions given of the winds of arid deserts.

July 22.—The wind blew a gale during the night, and, flying clouds partially obscuring the sun, a fresh breeze made the morning march pleasant; but before noon the wind subsided, and the day became oppressively hot. We travelled all day on a fine road, crossing several dry beds of creeks, along which, here and there, might be seen a few scattered trees. We encamped, after a march of twenty-two miles; near the river, on a dry creek, where we found a few trees, and evidences of large Indian encampments, of a very recent date. This point, eighty-nine miles from our camp, near Fort Atkinson, is four hundred and seventy-two feet above it—an average ascent of five feet three inches to the mile. Altitude above the gulf, 2,852 feet.

July 23.—Our journey to-day of twenty-four miles has been on a barren plain, at the foot of the main plateau; and, although commenced with a cool, cloudy morning, was the most oppressive from heat we have yet experienced, which was greatly increased by the reflected rays of the sun from the smooth, clayey surface, almost bare; and for much of the distance quite destitute of vegetation, except a few scattered weeds and sun-flowers. Near our present camp we passed two dry creeks, on which there are a few scattered clumps of cotton-wood, with a few trees of large diameter, but crooked and short, with large, unsound branches. On the river banks, also, there is more than the usual amount of this timber, while the sand-hills on the southern bank come close in to the stream, and, like the rolling prairie hills to the north, increase in height.

July 25.—Captain Gunnison made an unsuccessful effort to procure specimens of prairie dogs for preservation, by pouring water into their holes, in a village near camp; nor was he more successful in digging for them, as they easily eluded his search, (although he had a large number of men at work,) in their burrows, which are formed of numerous passages, which they extend rapidly when pursued beneath the surface of the ground. The amateur hunters of the camp were equally unsuccessful, and after scouring the neighborhood for game, returned to their coffee, bacon and bread, only with good appetites.

Yesterday we were oppressed with heat, and to-day, with the same clothing, should shiver with the cold. Prairie dogs, which are the most abundant live creatures along the road, are, to-day, torpid. The road followed the base of the hills from our last camp, at a distance of from one to three miles from the river. At fifteen miles from camp we found salt efflorescing on the surface of the ground, and salicornia growing abundantly on the bottom. At the base of the hills, which

are here gentle and sloping, "in the tertiary drift, are cylinders and rounded nodules of iron ore, similar to those larger ones found on the Chugwater, at the base of the Black Hills." Day's travel, twenty-one miles.

July 26.—The night was cool, with a slight fall of rain at daylight; and, although the thermometer in the early morning stood at 59° Fahrenheit, it was so material a change from 96° in thirty-six hours, as to be uncomfortable. Seven miles from camp we reached what is called the Big Timber, a section of the river of about twenty-four miles in length, on the islands and banks of which more than the usual amount of cotton-wood grows. It deserved the name, however, only when compared with this river as I have described it a few days back. The trees are scattered over the bottom, in numbers, not unlike those of the new cotton-fields of Georgia and Alabama, with inviting shades; but they are not thick enough to obstruct the view, and the opposite bank of the river discovers the same dry hills as heretofore. Three miles of heavy sand, and six in the rain, over very slippery clay, added greatly to the labor of the day's travel, and we encamped at the end of twenty miles. In the afternoon the sun came out, but as yet we have had no glimpse of the mountains. Altitudes of Jupiter and Antares were obtained here for latitude; but the early hour of the day, and misty state of the atmosphere, prevented taking occultations or eclipses of Jupiter's satellites.

July 27.—A dense fog hanging over the valley until 10 o'clock, concealed the sterile hills of the opposite side of the river, and, leaving in view only the line of timber as we rode near it, awakened remembrances of the beautiful forests which sometimes skirt the western prairies. A mile from camp we passed two or three log-houses, occupied as a trading station by Mr. Wm. Bent, during the past winter, but now left vacant, and, as yet, undestroyed by the Indians. Here the bluff lands for a short distance come quite in to the river, and disclose sandstone in horizontal strata, of a reddish, argillaceous character, which we observed during the remainder of the day on both banks of the river. Thirteen miles brought us to the termination of the Big Timber, where the argillaceous sandstone hills again approach the river, and the road passes quite frequently over these small spurs. The bottom of the river at times quite disappeared, and was lightly covered with grass, or destitute of it entirely, after leaving the timber. Our camp is on a very coarse grass, under a sandstone escarpment, in a large meadow bottom—by far the poorest camp we have yet made. Mr. Creutzfeldt found to-day the skin of a snake seven feet in length, which it had cast, leaving the eye and every scale perfect.

July 28.—Three miles from camp we passed opposite to the mouth of Purgatory creek, an affluent to the Arkansas, and timber appeared more abundant upon it than upon the river, which it enters in quite a large bottom, which, from a distance, is apparently well wooded, and grass is abundant. We encamped, after a march of fifteen miles, three miles below Bent's Fort. Latitude by meridian observation to-day, $38^{\circ} 3' 24''$. Mr. Homans, who has been suffering seriously from being poisoned with ivy, has very nearly recovered. He was too ill for many days to mount his horse, and could only ride in a carriage with the

greatest difficulty. Deer, antelope and turkeys were seen along the river to-day, and near camp a cow was found which had been abandoned by its owners, her feet being too sore to travel. Our elevation at this camp is 3,671 feet above the gulf, and our average ascent for the last 105 miles, from our camp of the 22d, has been $7\frac{3}{4}$ feet to the mile.

July 29.—Between camp and Bent's Fort, grass was very abundant. We spent an hour in examining the river at the fort for a practicable ford, but the excellent one which formerly existed here it was found impracticable to cross, in the present stage of the water. Mr. Bent abandoned his fort about four years ago, but not until he had destroyed it. Its adobe walls still stand in part only, with here and there a tower and chimney. Here, beyond all question, would be one of the most favorable points for a military post which is anywhere presented on the plains. There is an abundance of pasturage, fuel, and building material in the neighborhood, for the use and building of the post. It is of easy access, from its central position from the east, from Santa Fé, from Taos through the Sangre de Cristo Pass, and from Fort Laramie. It is on an emigrant road from southern Missouri and Arkansas, either by the North Park or Coochetopa Pass; and it is in the heart of the Indian country, accessible to the resorts of the Comanches, Cheyennes, Arapahoes, Kioways, some bands of Apaches, and even occasionally of the Utahs of New Mexico.

We moved on at half-past 8 o'clock and encamped, having marched twenty-four miles, on miserable grass—not being able, after hours of searching, to find better. Indeed, during this day's march, after leaving the fort, we saw no good grass, for this country even, on either bank of the river. A few miles above the fort we passed opposite the mouth of Timpas creek, marked on the southern bank by a break in the hills and a tree or two only. It is small and often dry, or nearly so. Most of the day the road led over the higher land, which is here considerably broken. "Still it is easy to grade a railroad along the edge of the bottom." "On the southern side of the river a broader flat is seen, which, in the event of a railroad being made here, should be its site, crossing the river a few miles above Bent's Fort, and passing over the angle between the Huerfano and the Arkansas rivers." The atmosphere for many days has been so cloudy that we have seldom had a distant view; and for the last two or three, smoke has quite obscured the whole country, so that we could see but a very few miles. A small opening in the clouds and smoke, however, an hour ago, gave us a first but not very distinct view of the Spanish Peaks, bearing nearly southwest; but it was only a momentary view, and we were again left to gaze on barrenness and a circumscribed horizon. The bluffs above the fort for several miles are underlaid by a whitish, argillaceous, friable sandstone, in nearly horizontal strata, which crumbles easily; the whole base of the hill being covered upwards for several feet with fallen fragments. Our camp is in the midst of fields of artemisia of several varieties, the principal of which are known as sage and greasewood; and, to add to our discomfort, it began to rain at sundown, softening the clay and rendering it so slippery as to make walking very uncomfortable.

July 30.—To give time for the rain of last night to dry up to some extent, our departure was delayed an hour, which Captain Gunnison and myself, with a number of men, spent in search of a ford, but without any favorable result, the depth of water and rapidity of the current being too great, although the bed of the river was firm, being of water-worn stones of a small size. Our route again followed the high prairie for seven miles, and then descended to the river bottom, where we soon came to fine fields of coarse grass; but we were anxious to reach the Huerfano, that astronomical observations might be taken while we found the means of recruiting our animals and of crossing the Arkansas. According to the maps we had with us, and in the opinion of several men of the party who had passed here before, the Huerfano was believed to be already in sight, and, after ascending two or three high hills in the vicinity and obtaining a distant view of a broken line of trees in the direction in which this stream was believed to be, we turned in towards the river and encamped after travelling only eleven miles. A few deer were frightened from the coarse, rank grass as we entered it near the river, but, as usual, they escaped our marksmen. Captain Gunnison, whom I accompanied, went in search of the mouth of the river, which we found in a bend of the Arkansas immediately south of the camp, and of a ford by which to cross the latter stream. In this, however, we were unsuccessful, and it was not until the following day that Captain Gunnison found one, on a northern bend of the river, half a mile west of our camp. The river at this point was 300 yards wide, varying in depth from one to three feet, with a strong current and sandy bed. The 31st of July was passed in camp, and on the following morning the banks of the river were cut down, and Captain Morris's wagons, with large wheels and broad tires, crossed successfully. The remainder of the wagons were not so favorably constructed for crossing fords, and Captain Gunnison, deeming it unsafe to attempt to cross them with their loads, built a raft of logs at a point on the river where it was fifty yards in width, a short distance above the ford. It was only by the greatest labor and difficulty that a rope could be carried across the stream, the current of which was very rapid at this point, but was accomplished, after one or two failures, by ascending the stream some distance and stationing men at short intervals along the rope, who entered the water in succession; the leading man pushing rapidly for the opposite shore, which he was barely able to reach and secure the rope by the aid of a man stationed there to assist him. One of the men—the second—in his desire and determination to succeed in crossing successfully, had lashed the rope with his handkerchief to his arm, from which he narrowly escaped a serious accident as his companions dropped the rope, the current sweeping him under with such force as to deprive him of all power in his bound arm; but he was rescued by the leading man returning to his assistance. The raft once in successful operation, lightened the wagons of half their loads or more, which were safely landed on the opposite bank at sundown, and the wagons thus laden were crossed at the ford before the twilight rendered it unsafe. The Arkansas could be easily bridged at the point where this raft was operated, the banks being several feet above high-water in times of freshets, and approach-

ing unusually near each other. Opposite to our camp of July 30th, and to the east of the stream which here enters the Arkansas from the south, are three hills, two conical and one oblong, rising some 250 feet above the river, and 100 above the general level, distinguishing landmarks for the stranger. The bluffs to the northwest of that camp rise still higher above the adjacent hills. Our average ascent per mile for the last thirty-four miles has been twenty feet and seven inches.

August 1.—We were gratified this evening by a clear and beautiful view of the Spanish Peaks and of the Greenhorn mountains, with others just rising above the horizon to the right and left. From the summit of the bluffs on the north bank of the river, James's Peak is distinctly seen; and upon all the high ranges the snow is visible, accounting for the high water in the streams which rise in them.

CHAPTER III.

From mouth of the Apishpa to Roubideau's Pass.—August 2 to August 25, 1853.

August 2.—Our route, following the creek, lay up a plain valley for five miles, ascending more rapidly than that of the Arkansas; then for $8\frac{1}{2}$ miles about the same, with a far wider and better grassed plain than on that river. There are no bottom lands on this stream, which flows in a deep, narrow passage, with precipitate banks, cut in the argillaceous soil of the plain. Such water channels, with steep earthy banks, are styled arroyos by the New Mexicans, in contradistinction to cañones, which are walled with rocks. At a few yards distance in the plain, one would not here expect to find water, even though acquainted with the character of the country, much less a cool mountain stream. The banks, twenty feet in height, are green with grass, the arroyo at top being twenty-five or thirty feet in width; but we only found one point during the day's march at which we could descend to the water, which is at a point where the plain is underlaid by a stratum of shale. This creek, in this part of its course, hugs the base of a line of hills sloping down from the east; the valley at our camp being about a mile in width, sweeping up gently to the west and southwest for several miles, where it appears terminated by elevated hills. Thermometer in the shade during the warmest part of the day, 104° Fahrenheit.

August 3.—The survey was continued along the valley of the creek, rising gradually for $2\frac{1}{2}$ miles over a gentle swell extending in towards the stream to a nearly level prairie, from two to three miles in width, extending for nine miles in a course S. 23° W. We encamped at the mouth of a small cañon on the creek at the foot of the hills terminating this plain. The party being without a guide, it was found necessary very often to make distant excursions to the summits of the most elevated bluffs and hills, from which extensive views could be obtained,

and the courses of the streams and main depressions of the country followed by the eye. These bluffs and hills passed to-day, as were also the banks of dry ravines and creeks, were sometimes composed of a red sandstone and of strata of shale, and at others of a sandstone of a yellowish shade, from the disintegrations of which the soil of the hills and valley is formed, being light and friable, in which the felloes of the wagon wheels sink deep, and cast up clouds of dust, from the pungency of which we judged the cement of the sandstone to be carbonate of lime.

August 4.—Captain Gunnison, with a small escort, proceeded to examine the cañon this morning. He found the water at its mouth running over a sandstone ledge for 500 feet, with falls over the sharp edges of $1\frac{1}{2}$ feet, occurring at pretty regular distances of about 100 feet. "This," he remarks, "is the first sound which has given me notice of a waterfall since leaving the mountains in New York." Above this he entered a gorge, in which the current is sluggish, running in a deep gully, which he followed for a mile, coming to a high perpendicular escarpment of rocks on the right, on which are numerous hieroglyphics or Indian writings, "which appear to have been made at various times, but are mostly of a recent date." A mile and a half from this inscribed rock, large masses of fallen rock blocked up the way, or bench, six feet in width on one side of the creek, the bed of which is fifty feet below, with nearly perpendicular banks; the passage on the opposite bank was even worse than this a few yards above, the creek washing under the bluff, preventing the passage of horse or footman. The rocks are soft sandstone, easily cut. He then ascended to the second table, or inclined bench, which he found covered with broken fragments of prismatic stones with sharp edges; the crevices and open parts of the rocks were filled with gigantic cacti, some of which were five feet in height, with lobes in whorls around the main stem, the branches themselves standing off like radii from the centre of a circle. They had flowered, and the corolla having fallen, had left the top like a small cup. Ascending eighty feet above this table, "we came to some pines of a stunted growth, but some of them a foot in diameter. They are of the three-leaved or pitch-pine species of the east. Dwarf cedar also grows in these rocky precipices." Near this point a cañon comes in from the south, extending several miles to some high lands. Above this the cañon of the main creek widens, and could be followed by wagons, but would require working at various points. In following along the cañon, or near it, several rocky gullies were passed, and were followed by cañones perpendicular in their course to that of the creek, with sides nearly one hundred feet in height. The main course of one of them was slightly north of west, towards the Greenhorn mountains, for six miles; then diminishing in size, spread out into several smaller ones. Following this cañon, Captain Gunnison came upon the trail of the wagons, and soon after arrived at camp. In the mean time the remainder of the party, with the wagon trains, finding it impossible to follow the course of the creek, in consequence of the side cañones and deep chasms, with abrupt and often vertical walls, of fifty and a hundred feet in height, had followed up one of them by a long up-hill march, turning ravines first in one direction, and then in another,

until we at length came to a practicable pass over the first cañon, where we resumed our course for the creek, but were almost immediately intercepted by another no less formidable cañon, up which we followed until we were fortunate enough to find water remaining in pools from a recent shower, and also a not difficult crossing to the cañon. We encamped here, having travelled but fifteen miles; but as we were without a guide, and had not been able to get water for our animals during the march, it was necessary to halt, not knowing where we should again meet with it. We have all day passed limited but luxuriant fields of grass in the cañones; grass is also finely scattered over the hills. The rocks of the hills and cañones are red sandstone. We have been forced, in searching for a passage, nearly to the summit of the divide between the waters of the creek at our morning camp, and of the Arkansas river; and it is becoming more than doubtful if we are not following some other than the Huerfano river. I rode forward several miles before dismounting to ascertain something of the nature of the country, and the proper direction for the following march, and returned to camp through large herds of antelope.

August 5.—We pursued our course to-day, from the observation made after our arrival in camp yesterday, without difficulty. Passing the head of several dry cañones, and branches of them to our left, we descended, about three miles from camp, into a broad valley, in which are standing two yellow sandstone buttes on a base of soft shale, some hundred feet in height above the surrounding country. I ascended one of these with considerable difficulty to its narrow summit, and obtained an extensive view of the adjacent country. From one side of this butte the water descends in a broad valley to the south, and from the others it runs off to the west and north, to branches of the Arkansas; and we were evidently on the divide between these streams where their side valleys meet, and their lateral and perpendicular cañones necessarily terminate. In every direction were bluffs and knobs, and ledges of rocks whose sides and tops were covered with the short, crooked, wide-spreading cedar of the country, with here and there a stunted pine. Grass was everywhere abundant, and game in every hollow and valley, and, save the light, argillaceous soil and want of water, our course was evidently easy for the day. The mountains before us looked grand and formidable, our proximity and elevation for the first time giving us a fair and full view of them from their summits, streaked with drifts of snow, to their base. The summit of this butte, however, so swarmed with winged ants that I was driven from it in haste, literally covered with them, and it seemed their especial delight to get into my eyes, either on foot or by the wing. A few fossils were hastily gathered from it. A few yards from its base a fine field of flowers tempted my curiosity, and searching for the finest cluster, I rode to it, and stooped from my horse to gather it, when the warning rattle of a large snake coiled under it caused me to withdraw my hand from danger in time, and selecting other flowers, I left him undisturbed in his flowery retreat. A few wild horses coursed around us, and excited the spirits of our horsemen, but it was not deemed prudent to break down good horses in their pursuit for the chances of capturing wild ones, and they were left unmolested to pursue their course, and enjoy their natural freedom.

The timber on the Arkansas was visible during some part of the morning march, and it was evident that the route we had pursued was not the proper one for a road after crossing that river, as this point can be easily reached, if necessary, by a nearly direct course from that crossing. In our search for water Captain Morris and myself ascended a small butte, and discovered some pools with large herds of antelope and a few deer feeding near them, a short distance to the west; and through an opening in the hills a few miles to our right and front, were seen the green leaves of the cotton-wood. Leaving the party to encamp at the pools, we proceeded at once to the cotton-woods, and found, as we anticipated, a fine stream, larger than that we had been attempting to explore; and it was at once evident, from the position and course of this, and the great southern bend of the former, that it could not be the Huerfano. During this ride we were drenched with a heavy shower, the third which we, who travelled by the Santa Fe road to Walnut creek, have actually encountered on this long journey, although we have been every day in sight of them, and often surrounded by thunder-showers within a stone's throw. The dews, which are said generally to be uncommon west of Walnut creek, have been as heavy and constant with us this year west as east of that creek. This, I think it not improbable, may be accounted for by the almost entire absence this season, on this route, of the prevalent southeasterly winds of the day, which are changed to westerly winds at night, for we have seldom enjoyed a pleasant breeze at any time on this march to this point; and I remarked in crossing from Fort Leavenworth to Santa Fe in 1849, that the dews were regulated almost entirely by the prevalence or absence of winds at night. Since leaving the Arkansas river we have seen nothing of flies and mosquitoes, which were there a severe daily and nightly torment to men and animals. Captain Gunnison, with a small party, left camp early in the morning to continue the exploration of the cañon of the main creek; but after riding in a nearly southern course over a country intersected by cañones, ravines and rocky cliffs, rejoined us at a late hour in the evening, not having succeeded in reaching the Apishpa, which we afterwards learned was the name of the stream we had been following. It rises to the south of the Spanish Peaks, and is not unfrequently dry; indeed no water entered the Arkansas from it a few days after we passed it.

August 6.—After travelling two miles in the direction of the Spanish Peaks, we were obliged to cut timber and fill up a small branch over which we crossed, and bearing thence to the right, struck a wagon trail leading from the Raton Pass to the Pueblo on the Arkansas river, and Fort Laramie on the Platte. This we followed to the Cuchara, which is forty feet wide and two deep at the ford which we crossed; and encamping two miles above this ford, Captain Gunnison ascended a neighboring butte, and thus describes the view: "Pike's Peak to the north, the Spanish Peaks to the south, the Sierra Mojada to the west, and the plains from the Arkansas—undulating with hills along the route we have come, but sweeping up in a gentle rise where we should have come—with the valleys of the Cuchara and Huerfano, make the finest prospect it has ever fallen to my lot to have seen." Accompanied by five men, I started at an early hour of the morning in search of the

Greenhorn settlement, on a stream of the same name, rising in a range of mountains, to the east of the Wet river valley, to obtain information of the country, and, if possible, procure a guide well acquainted with it and with the mountain passes we were about to explore. Our course from camp was W.N.W., in a direct line for the Wet mountains, crossing the Cuchara at the point at which we had visited it the previous evening. The banks were here vertical walls of clay, twenty feet in height, resting on a stratum of shale. We descended through a break in the bank, and following the bed of the stream for some distance, ascended the opposite bank through a similar opening. The borders of the river are here entirely destitute of grass. A few miles below us, plainly in sight, the river enters a cañon; the hills about it, and an unusual extent of rolling country, being covered with a thick growth of low cedar. On the table-land beyond this river we passed innumerable prairie-dog towns, herds of deer and antelope, and several bands of beautiful wild horses, which came circling round us in all the pride of their native freedom, at a distance of fifty or eighty yards, and at the report of a rifle dashing wildly away over prairie, hill, and valley, exciting our admiration. On this table-land we also passed basins of rain-water some hundred yards in diameter, which in dry seasons are themselves doubtless dry. Ten miles from the Cuchara we descended from the table-land to the valley of a stream evidently rising in the position laid down on some maps for the Huerfano, and on whose southern bank we had an hour before had a fine view of an isolated butte in its bottom—a feature of this valley marked and unmistakable. It is from this butte, from its isolation known as the Huerfano or Orphan butte, that this river derives its name. This stream we crossed as we had the Cuchara; its volume of water being less than that of the latter stream, and its clay banks, overlying the shale of the bed, of less height. The Huerfano between this point and the head of its cañon, seen a few miles distant on our right, and which is said to be the longest in this part of the country, has but little timber on its banks. The Cuchara enters the Huerfano in this long cañon, and the river for eighteen miles between the mouth of its cañon and the Arkansas, it is said, has a large border of cotton-wood. We next came to the Apache creek, whose sources in the Wet mountains had been visible during our morning ride. It is a small mountain stream, with water at this time only in pools. Willow, plum, thorn, and cherry bushes, with a few cotton-wood trees, grow densely thick on its borders, and we were detained an hour in making a passage through them. Beyond this creek we entered upon a wide open valley of weeds, prickly-pears, and sand, and I changed my course a little more to the north, hoping to strike the trail from Taos to the Greenhorn near the base of the mountain, which we reached after a ride of four miles, and found the trail as anticipated. Following this trail we rose over a hill and descended into a rough narrow ravine, which we followed in a northeast direction for a mile and a half, and then passed over a high ridge—a spur of the Wet mountains—covered with oak bushes, to another ravine, on the sides of which we were gladdened by the sight of a herd of cattle and horses feeding, and were soon in the camp of a trader from New Mexico returning from Fort Laramie. From

him we learned that the two streams and ravines are called the Granaros by the Spaniards. Passing over another sharp ridge, we descended in two miles to the fine little valley of the Greenhorn, a stream of two feet in width and three or four inches in depth, which is now entirely diverted from its natural channel and employed in irrigating the lands of the six New Mexican families who reside at and constitute the present population of the place. They plant a few acres of corn and of wheat, of beans and of water-melons—in all, an area equal to that of a small eastern farmer, who cultivates his own fields. Two hundred fanegas of wheat and fifty of corn, with the requisite amount of beans and melons, constitute the largest total crop of this valley. They have a few cattle and horses—the latter very poor. The houses are built of adobe or sun-dried brick, without windows or other openings than a single door, in entering which a man of six feet in stature must bow very low. In front of each house is enclosed a small space of ground, twenty yards in width, by poles planted in the earth and lashed to horizontal strips by rawhide thongs. These picketed yards are intended as a protection against Indians—the Utahs having killed some of their cattle last year, destroyed their grain, and stolen their horses. Corrals are attached to the backs of their houses, built in all respects like the front enclosures. With one exception all the houses of this settlement are joined, and a tall man can reach to the roof, on which the whole population, not absent in the fields, assembled on the approach of my party, not knowing whether to expect friends or foes. I enjoyed the hospitality of the smaller mansion, being invited to a seat on the only article of furniture in the room, a board against the wall, spread with a blanket and furnished with a pillow. On the earthen floor, at the sides of the room, were two or three narrow beds on wool mattresses. I soon found the guide I wanted, and engaged his services hence to Fort Massachusetts, in the San Luis valley of New Mexico. Mossalino is, by birth, of the Spanish New Mexican race, of about forty-five years of age; having spent it entire in the wild life of a mountaineer—by turns a hunter, a trapper, a trader, a voyageur, a fighter, a farmer, and a guide—he is familiar with the country westward to the Pacific. Last year he lived at this place with his Pawnee squaw; but his losses by the Utahs were considerable, and he removed to the pueblo of the Arkansas, where he is, with his family, the sole occupant of the place. He had this year planted a little corn there, but the high water of the river destroyed it, and he has no crop now growing. "I have lived," said he, "nine years on meat alone, at one time, in these mountains, without tasting bread or salt. I can now live well enough for me with coffee and the little meat I can kill." He is reputed a fine hunter. "I never see a grizzly bear but I give him a shot. I try to hit in the right spot; but if I miss it, I have to run. We will have," alluding to our trip, "a fine chance for fun;" and his dark liquid eyes flashed as he looked towards the mountains, and visions of his grizzly friends appeared to his imagination. But few men of experience are bold enough to attempt to shoot these animals unless accompanied by a friend well armed. The mistress of the house very courteously inquired where I would have my bed prepared, which I preferred leaving to her own convenience. I

should, however, have been a little surprised, had this been my first visit to a New Mexican residence, at the place selected—in the yard, just in front of the door, under the broad, bright, blue canopy of heaven, brilliant with stars. I enjoyed the matronly grace and dignity of the mistress as she brought forth the pallet and spread the necessary blankets to exclude the chilly night winds from the mountains. There, too, were spread the beds for the family, the open air being preferred to the house during pleasant weather. I could, of course, procure no supplies at this place at this season of the year.

August 7.—I returned this morning by a route somewhat to the west of that followed yesterday; and after passing the Geanaros, crossed the Huerfano at the butte, and soon after reached camp, which had remained on the Cuchara.

August 8.—We crossed immediately over to the Huerfano Butte by the route which I had followed the previous day. This butte is one hundred and fifty feet in height, as determined by Mr. Homans, standing in the river bottom quite detached from the adjacent hills. Its diameter at the base is equal to twice its altitude, sloping up to its summit which is about twenty-five by forty feet across. Its base is strewn around with prismatical blocks of granite rocks, of from one to six feet across, and its surface is also covered with these prisms, which are very dark—containing iron, perhaps, as a coloring matter. A narrow way, leading over the summit from the southeast, is nearly destitute of these rocks, on either side of which they are arranged in regular order, presenting a trap-like appearance. Latitude of this butte, $57^{\circ} 45' 03''$. Captain Gunnison remarks in his journal, that our line of travel since leaving the Arkansas should not be followed; “but, striking up a valley or plain ten miles from the mouth of the Apishpa, in a course for the Spanish Peaks, cross the Cuchara near our camp of August 5th, and continue over to the Huerfano, which gives a direct line of travel on a fine plain. But if we undertake to ascend the Apishpa, or the Huerfano, by following their valleys, we meet with cañones on the former, as we have described—and on the latter, we are informed, eighteen miles above its junction with the Arkansas. And the whole country having been under our eye as we travelled on the higher land to the south of this indicated route, we can say that no obstruction of any magnitude exists, thus far, to the successful construction of a railroad.”

August 9.—The river here is eighteen feet wide, by one deep, with a rapid current. The soil is light, and would produce, if irrigated, fine crops. Stone for bridges and building purposes may be readily had. We moved up the river for several miles on its southern bank, and then crossed to the north side, and a mile above recrossed by the ford on the Taos trail to the southern shore, but only to recross again and again, five or six times, the river here coming through a narrow passage formed by the Greenhorn mountains, or Sierra Mojada, on the north, and spurs from the Sierra Blanca on the south, of some six hundred feet in width in its narrowest part, but still good for a wagon or a railroad, with a little labor. The Taos trail of which I have spoken leaves the river at this gorge, leading directly to El Sangre de Cristo Pass. Captain Gunnison finding a better route, however, kept up the river,

encamping on its northern bank, where the hills are covered by small cedars and pines. Day's march, 14.54 miles.

August 10.—We crossed the Huerfano this morning, and pursued a fine valley between two spurs from the main chain, luxuriant with grass, from one-half to one mile in width, to the base of the mountain five miles to the south; and then turned east by the same valley depression into an adjacent valley, and encamped at its head, as it began to rain, after a march of seven miles. Narrow ridges of sand and limestone of considerable height, covered with wide branching cedars, suitable only for fuel, and a few dwarfed pines, extend from the base of the mountain north to the Huerfano, along the summits of which a road could easily be constructed, diminishing the ascent to the pass. Ours was to-day literally a pathway of flowers, among which the helianthus, a verbena, a lupine, and the blue flowering flox, were brilliant and showy. Magpies flew around us, but escaped our shots uninjured. Bears were seen on the Huerfano, and our hunters supplied us abundantly with venison.

August 11.—We left the valley of our camp by ascending a giant mountain spur, along the top of which we followed to the south for some distance, ascending as we approached the main mountain, and then descending into the next eastern ravine or valley, through which flows a little rill, entering the Huerfano at the gorge which we passed two days ago. This descent was difficult, and so sideling that we were obliged to hold the wagons by hand-ropes to prevent their being overturned. By following the rivulet from the river this difficulty would be avoided. We ascended it for some distance through waving fields of grass quite up to our saddle-girths; and, cutting a road for a short distance through a forest of quaking-asp as we turned to our left, encamped, in a shower of rain, amidst the luxuriant fields of blue grass (of the mountain men) and flowers. Quaking-asp covers the mountains around us, interspersed with small pines. Fire, however, swept over these mountains two years ago, destroying much of the timber. Sandstone, an impure limestone, and porphyritic rocks, are among the most common of this part of the mountain. Distance marched, 5.12 miles.

August 12.—A working party was engaged during yesterday afternoon in opening a road through the forest to the summit of the pass, and much of to-day has been spent in the same manner and in working on the opposite side-hill, along which it is necessary to descend from the pass. The teams, too, were engaged all day in making the ascent as the road advanced, and at dark the most of them had reached the summit, and a few had descended some distance to El Sangre de Cristo creek; and all were obliged to encamp where night overtook them, on a line of two or three miles, on the summit and either side of the pass. The examination of the various depressions in the mountains also went on to-day, to ascertain their elevations and practicability for roads. The scenery around us is very fine—the views from various points extending far back over the plains, buttes, ridges, and streams, on which we have for so many days laboriously pursued our march. The bold, rocky mountain peaks tower loftily above us—whitened here and there with lines of snow—around which, at mid-day, dark masses

of clouds gather and the lightning plays, while torrents of rain pour down their sides with irresistible fury. The valleys of the mountains are small, but unsurpassed in luxuriant grass; the mountain sides are plentifully supplied with aspen and small pine, and all around us, and under our feet, covered with exquisitely beautiful flowers. Here, too, the geologist finds an interesting field, and sportsmen's spirits are excited by grouse and pheasants, deer and grizzly bear, in every valley and glen, and the streams are alive with the finest mountain trout.

August 13.—The labor of crossing the ridge was completed this morning, and just in advance of the 1 o'clock shower we encamped in but near the head of the southern descent of this pass, on the Sangra de Cristo, which is a small stream of clear, cold water, in a beautiful little park or valley. The labor of crossing this ridge has been very considerable, which is partly owing, however, to the rarified atmosphere at so great an elevation. Both men and animals were soon exhausted and obliged constantly to stop and rest, where at a lower altitude no rest would have been required. Our teams were all doubled, without being then able to do the ordinary work of a single one, and the strongest men sat down out of breath after a few moments' exertion. Astronomical observations gave us for the latitude of this camp, which is $2\frac{1}{2}$ miles from the summit passed by the wagons, $37^{\circ} 36' 56''$ N.

From the Arkansas river, at the mouth of the Apishpa, it is eighty miles by the route we travelled to the Huerfano butte; but this distance is at least one-fourth greater than is necessary in the construction of a railroad between these points. Taking the shorter distance our ascent was 28 feet 10 inches, in whole numbers, to the mile, the elevation of the butte being 6,099 feet above the sea. We ascended the Huerfano river $14\frac{1}{2}$ miles above this point, ascending nearly 52 feet 10 inches per mile. The ascent during the first day's march from the Huerfano river to the base of the Sierra Blanca, 7.59 miles, was 603 feet, or 79 feet 5 inches per mile. On the following day we advanced 5.12 miles, ascending in that distance 1,289 feet, or over 251 feet per mile; and from thence to the summit of El Sangra de Cristo Pass, seven-tenths of a mile, the ascent was 647 feet, developing a line entirely impracticable for a railroad. But the Huerfano river west of the gorge through which we passed on the 9th instant, drains a large circular amphitheatre, surrounded on the north, west, and south, and partly on the east, by elevated mountain ranges, with large, irregular spurs extending into this valley, and sending down numerous tributaries to the river. Twelve miles above this gorge stands the Black Butte, an immense mass of rocks with irregular points shooting up 100 and 200 feet. Here comes in a fine stream from the northwest, two miles beyond which another enters from the west from near Williams's Pass. At this point the Huerfano, whose general course from the gorge is $N. 70^{\circ} W.$, bends towards Roubideau's Pass on a curve for some three miles, where it receives the waters of Gunnison's creek, a small stream from the south, but which towards its source descends more from the east. This little creek continues the curve, until it reaches the point whence it issues from the mountain at the foot of the declining ridge, near which, but on the opposite side, our wagons passed, at the head of a small valley, on leaving the Huerfano. Following this stream above this point, it is,

by chain, five and one-fourth miles to the summit, the water descending on an inclined plane without falls, with an equable, swift current. Four miles and a half from the summit the creek flows through a narrow passage in the rocks, which slope up to the top at a small angle from the vertical, the width at bottom being one hundred and fifty feet, affording abundant room for the stream and a road. Above this gorge or cañon there is a small park, such as are found on the heads of many of the streams in this part of the country, abounding in deer, elk, and bear, and affording luxuriant pasturage for thousands of head of cattle: indeed, few more inviting spots for grazing can anywhere be found. Two miles and a half from the summit is Turret Rock, a pillow-like cone of stone, divided in the centre from the apex, with one face a plane, against the base of which the stream strikes and is deflected a little to the left. Above this, numerous small streams join the main one from the southeast, and that from the summit descends at the foot of the grassy slopes which extend up to the base of the crowning peaks of the Sierra Blanca. A railroad or any judiciously chosen wagon road would cross the summit-level near the base of these peaks, and, taking advantage of the winding slopes, pass down the right of the creek to Turret Rock, to where the park becomes a gorge, and thence be confined to the little valley, from one hundred and fifty to three hundred feet in width, where it could be constructed along the foot of the hills with great ease, and issue with the stream from the mountain upon a broader valley, and, swinging around the base of the hills that set off from the great mountain masses reaching to within a short distance of the Huerfano river, pass through the gorge of that stream, and taking choice of the great plains, to and along the Arkansas and Kansas rivers to the Missouri. The supposed distance (for it was not measured) from our last camp, of August 9, on the Huerfano, to the summit of the Sangre de Cristo Pass, by the circuit just indicated, is from twenty-four to twenty-six miles, and the ascent to be overcome, two thousand three hundred and fifty-four feet—an average of ninety-eight feet and one inch to the mile for twenty-four miles, or of ninety feet six inches per mile for the longer distance. On the 13th of August the day was bright and clear, and the mean of five hourly barometrical observations gave us an altitude for this pass above the sea, of nine thousand two hundred and nineteen feet, which I have used in the estimated elevation to be overcome. "A single grade," says Captain Gunnison, from whose notes I have derived the data for the description of this pass, "could easily be carried from the summit to the gorge of the Huerfano river; but two, one along Gunnison's creek and one on the river, would probably be preferable. Spruce-pine in abundance is at hand on the mountain sides, to supply ties for hundreds of miles of railroad, especially if that which the great fire of 1851 swept over and left standing, killed and blackened, be not left to decay." The small stream called El Sangre de Cristo rises near the summit of the pass, and runs in a general southwestern direction to the valley of San Luis. The valley of this stream is narrow, the stream being lined with thickets of willow bushes, and, winding from side to side, impinges against the base of the hills, forcing us frequently to cross it, or, where it was practicable, to pass over the foot of the hills. The labor of preparing

the road for twelve miles was considerable, employing a large force, of which Captain Morris took charge, for four days. We descended from the summit of the pass during the first mile and three-fourths, 178 feet, or about 101 feet per mile; and 549 in the next 5.34 miles, or nearly 103 feet per mile. Six miles from this point we left the Sangre de Cristo, and rose to a plain extending along the base of the mountain spurs, which we followed for 4.57 miles, encamping on Utah creek, a short distance below Fort Massachusetts, having descended during the march of 10.57 miles, one hundred and twenty-seven feet, about twelve feet per mile. By descending from the summit of the pass along the side of the mountains on the right of the Sangre de Cristo, a railroad can be constructed throwing a larger proportion of the descent upon the lower part, where it should curve around a mass of low hills in a bend of the mountain, to the plain just indicated, which subsides gently into the valley of San Luis in the direction of the Coochetopa Pass. The entire descent from the summit of Sangre de Cristo Pass to our present camp, is 854 feet in a distance of seventeen miles. A meridian altitude of the sun, gave us for Fort Massachusetts a latitude of $37^{\circ} 31' 58''$.9.

After completing the examination of the Sangre de Cristo Pass, Captain Gunnison made an examination of the mountains to the south of the Spanish Peaks, by ascending Gold Branch from its junction with El Sangre de Cristo, to near its head. It is a very crooked stream, coming into the Sangre de Cristo from north 55° east for three miles, then east for one mile, thence winding from the southeast near the mountains beyond Indian and Culebra creeks, and near one of the head branches of the Cuchara. Becoming satisfied, after a long ride, of the exaggeration of the guide, who had represented this route as "without a hill," the party ascended a high peak and looked down upon the extended plains, over which, for a month, we had wound our way. The view was majestically beautiful, with the Huerfano, Cuchara and Apishpa at their feet, and towering mountains to the north and south, with the valley of San Luis to the west. Descending again to the stream they had left, and finding that about ten miles from its head they were, by barometer, higher than on the Sangre de Cristo Pass, and that the gorge was very winding and narrow, they turned back from their southern course for two miles, and then rode up hill for two hours, much of the way steep and stony, and arrived at the summit of the ridge, "where one could look almost vertically down on the heads of creeks of the Cuchara—one of which winds under Bald mountain, considerably to the south of the Spanish Peaks, where there is a not inviting depression, entirely impracticable for a road." The party passed over fine grassed slopes, and through groves of branching pine and aspen. In descending they came upon a fresh trail, "which had been made by a party of hunters from Taos, who had crossed by the Culebra Pass to the head of the Cuchara, and obtained pack-loads of venison. These men travel a hundred miles, kill the game and pack it on asses, taking from ten to twelve days to procure the load, and four to return to market. They use no salt, and only cover the meat to keep it from the flies. At night they spread out the quarters and saddles on the ground, and lie down among them to protect them from the dogs and wolves. And notwithstanding the daily

occurrence of showers about the highest peaks of the mountains, the dryness of the atmosphere is such that the meat is well preserved."

At a late hour, after a fourteen hours' ride, the party arrived at Mr. Williams's herd-grounds on the Sangre de Cristo, Captain Gunnison being quite ill. They dined with the master of the rancho on milk and tole, or parched corn-meal pudding, and slept under his awning on buffalo-robos. Captain Gunnison was quite restored by the kind attentions of Mr. Taplin and his host, from a severe attack of inflammatory rheumatism, which had been greatly aggravated by sleeping out at night with the gentlemen of his party, in exploring the Sangre de Cristo Pass. The information gained in regard to the snow which falls in El Sangre de Cristo Pass and valley of San Luis, is conflicting. Massalino, our guide through the pass, states that he crossed it in February last, a winter of unprecedented severity and great fall of snow; that he was seven or eight days in making the crossing, which is usually made in two—the dry snow being ten feet deep in the ravines, while the ridges were nearly bare. Antoine Leroux, on the contrary, represents it generally as unusually free from snow for a mountain pass, which can be crossed with facility during the severest storms.

The officers of the army stationed at Fort Massachusetts, which is situated just under the Sierra Blanca, in a sheltered valley on Utah creek, about seventeen miles from the summit of the pass, represent the snow, which is usually very dry, to have been in the valley about them, during the past winter, about two feet in depth. Once during our stay in this vicinity, during a thunder-storm on the lower peaks, those more elevated were covered with a beautiful mantle of white. There are no evidences of snow-slides or avalanches about the pass.

Our recent experience in exploring a wild mountainous country without guides, was such as to show the necessity of profiting by the practical lessons in geography gained in the school of the trapper and hunter, by that useful class of mountaineers who have spent so many years of their lives in encountering the hardships and imminent dangers hourly incident to their occupation in these fields of savage barbarity, short-lived gratitude and native grandeur, which are annually stained by the sacrifice of some of their number, as victims to unbridled ferocity. Accompanied by Lieutenant Baker, I accordingly started on the 15th instant from our camp at the head of El Sangre de Cristo, for Taos, in New Mexico, the headquarters of many of the most reliable and experienced of these mountain men. Leaving camp, we passed rapidly down the Sangre de Cristo for ten miles, and entering the broad and extensive valley of San Luis, hemmed in on either side by high mountains, and traversed by the Rio Grande del Norte and its mountain tributaries, skirted with bushes and a little timber, soon reached the Trenchara which comes in from the mountains to our left, and is joined a few miles to our right by the Sangre de Cristo, whence it flows on to the Rio Grande. A ride of twenty miles further brought us to the Culebra, or Snake creek. There is a small settlement five miles to the east of the point where we crossed this stream, near the mountain; but without visiting it we continued our journey, and arrived a little after dark, after a ride of sixty-five miles, at the Costilla, a stream similar to the last, on which a new settlement is opened

and a few fields are already covered with crops of corn, wheat, oats, and the other usual crops of a New Mexican farm. But the settlement contained no grass, and our Indian bred mules, not knowing the taste of corn, disdained it, much to our regret, for we deemed so long a ride inhuman enough to our animals, without consigning them to a night of abstinence, with a fifty-mile ride before us for the following day. We therefore negotiated for the corner of a wheat-field, the kernel being still soft, and were gratified with the avidity which our Comanches exhibited in feeding on this grain. During the day's ride we had occasionally seen the smokes from the signal-fires of the Indians in the mountains; but they did not molest us, although we subsequently learned that a party of New Mexicans had been robbed by them, near where we saw their smokes just as we were passing them. The night was lovely and beautiful, succeeded by a bright, clear day. Resuming our way southward in the early morning, at 10 o'clock we passed settlements on streams near the base of the mountains, and at noon arrived at the Rio Colorado, or Red River of the Rio Grand del Norte, where there is a considerable settlement, surrounded by fields of grain. At 3 o'clock we crossed this stream a short distance from the village, and ascended the low, stony, mountain range, which here extends across the broad valley of the Rio Grande, separating the valley of San Luis from that of Taos.

The Rio Grande passes this low range in one of the most formidable cañones existing in this part of the country. Our pathway was thickly shaded by a forest of pines; and the landscape views of the valleys and near and distant mountains, during our afternoon's ride, were among the finest I have ever seen. Fifteen miles from the Rio Colorado we crossed the Arroyo Hondo, or Deep arroyo, from one hundred and fifty to two hundred feet in depth, with fine streams carried in irrigating trenches along its sides to the cultivated fields of the valley, which, from the crest in all directions, appeared by twilight covered with fields of grain; and, to shorten our evening ride, we followed on the banks of the irrigating ditches for some distance, until we reached the road leading to Taos, where we arrived at 10 o'clock at night. The valley of Taos is large, and, for New Mexico, extensively cultivated, containing several small villages, of which the principal is San Fernando de Taos, and many farms. It is on all sides surrounded by high mountains, the Rio Grande entering it through a gigantic cañon, and also leaving it through one. The water of the river is but little if at all used for irrigation, the mountain streams being large and more favorably situated. In our ride of over a hundred miles from El Sangre de Cristo to this place, we saw no grass in the valleys worth naming; the vegetation being confined almost exclusively to artemisia and a few varieties of cacti, but chiefly the prickly pear—the pines of the mountains at times extending well down to the plains. In the high small valleys of the mountains the grass is luxuriant and the flowers beautiful. Here, too, showers are of daily occurrence, whilst in the broad valley but little rain falls and nothing can be cultivated except by irrigation. Procuring what information we could of the country westward over which we were to pass, and the services of a guide, we returned in thirty hours to our camp, (which in our absence had been moved but

fifteen miles,) by nearly the same route we had followed in leaving it, arriving at noon on the 19th of August. On the following day we were joined by the experienced and well-known guide, Antoine Leroux. Here some half-dozen men came to ask for their discharge, refusing to perform further duty. One who had refused to guard the animals, while grazing in the early part of the day, was discharged, forfeiting arrearages of pay for a violation of his contract. Two others preferred their discharge on the same terms, which was granted; the others returning to their duty.

August 23.—We were detained in making necessary repairs, and in obtaining supplies at Fort Massachusetts, until this morning, when we took leave of the officers of the post, from whom we had received much courteous hospitality; and, following down Utah creek for three miles and a half, crossed it, and passed along the base of the gravelly hills which lie directly at the foot of the Sierra Blanca, southwest and opposite the sharpest peak of which we encamped, at White Mountain spring, seven miles from Utah creek; and, in a direct line over the gravel hills, not more than that from Fort Massachusetts. These gravel hills are a confused set of elevations from fifty to one hundred feet in height, resulting from the washing away of a former deposit and the crumbling of the higher mountain masses. The mountain torrents have washed among them deep channels, and occasional dykes, like vertical walls laid up in regular masses many feet thick, are left exposed. These hills are covered with branching cedars and pines, seldom exceeding twenty feet in height. A few wild hops were observed growing luxuriantly at the crossing of Utah creek.

August 24.—Following the base of the Sierra Blanca on our right, with the broad valley of San Luis on our left, we encamped, after travelling fourteen miles, on a small stream from the mountain, which soon sinks in the plain. The grass along our path was scattered, and we experienced considerable difficulty in driving over the thick masses of sage which cover almost the entire surface of this immense valley. We were here nearly opposite to Roubideau's or Musca Pass. Captain Gunnison immediately proceeded to examine it. It was found impracticable to ascend it with horses, in consequence of one of those great mountain torrents to which all mountain countries are subject having swept down it, depositing trees and rocks in every direction, and tearing the bed of the creek, over which two light wagons crossing from the Greenhorn settlement to Taos had descended but a few days before, into holes and gullies ten and twelve feet in depth. For two hours the party toiled up the cañon, sometimes on one side of the creek (which is known as Musca or Fly creek) and then on the other, to the summit, through the upper opening of which they could look down upon the San Luis valley. The course of this ravine from the summit is due west for two and a half miles; then north, 80° west, into the valley. It is 100 feet wide at bottom, with points of the rocky sides jutting into it, making the bed quite crooked. The sides are about 500 feet high, rocky and precipitous, but can be ascended by a footman from the stream at the bottom of the ravine as easily as most lofty mountains can be climbed. The rocks of this pass are chiefly a coarse altered mica slate. The elevation of our present camp above the sea is 7,638 feet,

and the difference of level between it and the base of the Sierra Blanca 6.25 miles distant, 518 feet. From this point to the foot of the pass where it opens into the valley of San Luis, and thence to its summit there is, unfortunately, a want of clearness in the record of the estimated distances from point to point where observations were made for differences of level. I have therefore taken the largest possible distances which could intervene between these points, presenting the pass in its most favorable aspect. By the direct path which we followed, the greatest distance which could intervene between the foot hills of the mountain and the narrow mouth of the pass is 1.60 mile—the ascent being 450 feet, or a little over 281 feet per mile. But as these foot hills are open rolling slopes, the pass could be approached by a much longer path from the south, distributing this elevation over several miles, bringing the grade for a railroad within 100 feet to the mile. But above this point this pass is entirely impracticable for a railroad and but little better for a wagon-road, the ascent being in the next mile and a quarter 373 feet, and in the following seven-tenths of a mile 377 feet, while in the succeeding three-fourths of a mile, to the summit of the pass, it is 416 feet; the whole difference of level from the mouth of the ravine to its summit, 2.70 miles, being 1,166 feet, the summit of the pass being 9,772 feet above the sea. No apparent obstacle presents itself from the summit to descending with facility from this pass to the Huerfano river to the north and east; but the western descent having proved so difficult, no further examination of it was made. *Our guide informs us* that to the west of our trail, along the banks of the Rio del Norte to where it enters a plain through a cañon from the San Juan mountains, bearing west from our present camp, and thence above on its tributaries, the valley of San Luis, which in this part of it is known to many as the valley of San Juan, is rich and fertile, covered with extensive meadows of grass, and abounding in game and wild horses. The narrow line of timber, thirty-five miles distant upon the Rio del Norte, is plainly seen from our trail; but it is represented to be difficult to cross the valley with wagons on account of the marshes along the river and the miry banks of the sunken creeks, and we have therefore followed the base of the Sierra Blanca, which extends from the Sangre de Cristo to Gunnison's Pass. To the north of this range, but partially connected with it, a broken range of mountains extends towards the Arkansas river, called the Sierra Mojada or Wet mountain, from the constant rains which fall upon it. Opposite to the first-named mountain, on the west of the San Luis valley, the Indian name of the mountain is Sahwatch, but it is more generally known by the Spanish name of San Juan. The San Luis valley is from 40 to 70 miles in width, and still more in length, and so level that trees are seen in any direction growing on the streams, as far as the eye can discern them.

CHAPTER IV.

Roubideau's Pass to Blue river.—August 25 to September 20, 1853.

August 25.—The examination of Roubideau's Pass being completed this morning, the main body of the party proceeded up the valley, under the command of Lieutenant Baker, while Captain Gunnison, Captain Morris, and myself, after leaving this pass, rode to Williams's Pass, the approach to which from the San Luis valley is through a grove of pitch-pine, behind most gigantic sand-hills, rising above the plain to half the height (apparently) of the adjacent mountain, and shaped by the winds into beautiful and fanciful forms with waving outlines, for within certain limits this sand drifts about like snow. These immense hills are from eight to ten miles in length, lying along the base of the mountains, and four or five in width, and therefore constitute a great barrier to the western approach to Williams's Pass, directly before which they stand. The stream which flows from it is turned immediately southward, and soon sinks in the sand plain. These hills are so steep and smooth on the side towards this creek, that the smallest pebbles started at their summits roll uninterruptedly into the creek, leaving their paths distinctly marked from the summits to the bases. High up on the sides are seen, at half a dozen points, single bushes of artemisia—the only vegetation seen upon them, and the only change discoverable since they were visited by Captain Pike, fifty years ago, when they were entirely destitute of vegetation, and “appeared exactly like the sea in a storm, except in color.”

The course of Williams's Pass as we entered it is N. 58° E., but it soon bends to the left to N. 27° E. We passed up it only about three-fourths of a mile. Its width is about two hundred and fifty yards, rising gradually as far as we could see. Its walls of rock rise on either side to a height of some hundreds of feet, and are nearly vertical. Our guides represent it as continuing for fourteen miles, both in character and direction, as here described; beyond that it is more abrupt, terminating at its summit less favorably for a road than Roubideau's Pass. It is followed by a large Indian trail. Captain Gunnison did not deem it necessary to pursue the exploration further, and we left this pass, having only made our entrance and exit at its western portal. Turning the southern base of the sand-hills, over the lowest of which we rode for a short distance, our horses half burying their hoofs only on the windward slopes, but sinking to their knees on the opposite, we for some distance followed the bed of the stream from the pass, now sunk in the sand, and then struck off across the sandy plain, which here extends far into the valley, and is very uneven, the clumps of artemisia fixing in place large heaps of sand, while the intermediate spaces are swept out by the wind. As we rose a sand-knoll a few miles from camp, we were made aware of its position on Sand creek, by a light cloud of dust raised by the furious charge of frightened horses dashing over the plain; and before we reached it, at dark, we came up with Lieutenant Baker, who had succeeded in recovering all his stampeded horses. Distance 10 miles.

August 26.—Our route lay over the sandy plain to the north of Sand creek, which flows around the north base of the sand-hills, sinking in the plain near our camp. The sand was so heavy that we were six hours and a half in making ten miles—the sand being succeeded, on the last two miles, by a light, friable soil, and heavy growth of artemisia. We encamped on Chatillon's creek, in which we could only obtain water by digging in its sandy bed. A few scattered cotton-woods are the only trees upon these streams, on which willow bushes also flourish. The mountain sides and ravines are dark with low branching cedar and pine; but they are generally of too small a size to be of any use except for fuel.

August 27.—In our course to-day we approached nearer the base of the mountains on the eastern line of the valley, the soil being still sandy but much less so than for the last two days. The sage, however, being no less luxuriant, forced us constantly to wind about to avoid the thickest patches. A few small spots of prairie-grass were passed, and marsh grass grew luxuriantly for a few hundred yards on either side of two small creeks which we crossed, one of which, Trois Tetons, deriving its name from the peaks whence it descends, was so miry that it turned us a mile directly towards the mountains before we could effect a crossing. To our left we could see fine prairie-grass fields, directly in the course to Coochetopa Pass, for which we were travelling around the valley; but the guide warned us of marshes, and the attempt was not made to cross them. Thirteen miles from camp we reached a fine meadow of bot-tom-grass a mile in width, extending from the base of the mountains far out into the plain, through the centre of which winds a fine stream of mountain water, named, after our guide, Leroux creek. A few grouse and sand-hill cranes were frightened from their retreat as we came to camp. Deer also were seen here and on the mountain bases a few miles distant. Our hunter supplies us with venison; but while pursuing a wounded buck, an hour ago, was driven in by a bear, which disputed the passage to the prey. The sharp edges and needle forms of the summits of the Sierra Blanca, rising 3,000 feet above the valley, attract much admiration at our camp to-night; and the promising opening in the Sierra San Juan, to the southwest, which allured Colonel Fremont to the disaster of 1848-'49, attracts its full share of attention and comment, some of the gentlemen of our party having participated in that misfortune. The pea-vine and barley-grass grow here, thick scattered on favorite spots; but the surface of the ground, over large spaces, is often covered with effloresced salts.

August 29.—Our course bore strongly to the west to-day in nearly a direct line for the entrance to the Coochetopa Pass—keeping, however, somewhat to the north to secure a good crossing at Homans's creek, on which we are encamped; there being large marshes further to the south, and the dams of the beaver, which are numerous, flowing the water back to some extent. Our march was only six miles to this fine little stream, with a meadow of grass on each side, of a mile in width. Two varieties of currants, a black and a beautiful yellow, grow in and around our camp in great abundance, and are thought very delicious by the party.

August 30.—Leaving camp we reached Sahwatch spring and

butte, by a very direct course across the valley, in ten miles and a half. This spring of pure cold water bursts from the base of the granitic butte which is immediately west of it, but detached from the Sahwatch mountains, to which it properly pertains. Captain Gunnison observed, on the 31st of August, large volumes of air at intervals escaping with the water of this spring. The latitude of this point, by noon observation, is $38^{\circ} 07' 46''$. This butte is not high, but its isolation makes it a prominent feature, standing as it does at the puerta or gate of the Coochetopa Pass. It is formed of coarse, gray granite rocks. The spring sends out a fine little stream, winding south and east along grassy fields until it joins the Sahwatch creek, which we reached five miles from the butte in the broad opening leading to the Coochetopa Pass. This stream, which is said to sink before reaching the Rio Grande, flows past our camp over a pebbly bed. It is one foot in depth and eighteen in width, with a rapid current. Its valley at this point is five or seven miles in width, growing narrow towards the west; and there are several isolated buttes standing in it, but none of them of considerable height. A few cotton-wood trees and a margin of willow bushes line the stream. The soil passed over to-day was unusually light and dusty, our horses sinking hoof-deep in it over large spaces.

We here leave the immense valley of San Luis, which is one of the finest in New Mexico, although it contains so large a proportion of worthless land—worthless because destitute of water to such an extent where irrigation alone can produce a crop, and because of the ingredients of the soil in those parts where salts effloresce upon the surface. Its lower portion is adapted to the cultivation of grain, as we have seen at the Costilla and Rio Colorado; and, if its upper part should prove too cold for cereals, its fine fields of grass on and above the Rio Grande del Norte must make it valuable for grazing. Elevation above the sea 7,567 feet.

August 31.—Five miles from camp the valley narrowed to a few hundred yards in width, and continued so for most of the day's travel of twelve miles. At our camp this evening it is half a mile wide, covered with fine grass, fine bottoms of which we passed several times during the day. We passed, also, a fine grove of cotton-wood half a mile in length, in which deer were bounding about in every direction, even passing between our wagons, which were separated by but a few yards. When ten miles from our morning camp the sand-hills in front of Williams's Pass lay plainly in sight, directly down the valley. We then turned to our left, taking a course for a short distance south of west, on which we are encamped. The hills and mountains enclosing this thus far beautiful valley, vary in height from two or three hundred to twelve or fifteen hundred feet, covered with a scanty growth of small pine. No mountain pass ever opened more favorably for a railroad than this. The grouse at camp are abundant and fine, as are also the trout in the creek, several having been caught this evening weighing each two pounds.

On the morning of the 29th instant Captain Gunnison and Mr. Homans, accompanied by a guide and four or five men, left the main body of the party and continued up the San Luis valley for fourteen

miles to its head, where a small park, into which several small streams flow and unite, forming a single creek, is nearly separated from the main valley by low hills extending into the plain. To this park, which is ten miles in width by fourteen in length, as well as to the creek flowing from it, Captain Gunnison gave the name of his assistant, Mr. Homans, who located them. In this park the party crossed a narrow strip of alkaline earth, sparsely covered with greasewood, to the most luxuriant fields of grass seen on the trip. This grass covers an area of ten miles by four. Captain Gunnison says, "this is the prettiest, best watered and grassed valley, with wood convenient for fuel, which I have seen in this section. Much hay could be cut, and fine grazing farms opened; and it is also probable that wheat and flax, and perhaps other grains, could be raised." From this park the party proceeded over a pathway of coarse, angular gravel, formed by the crumbling of the quartzose rocks of the hills, by an inclined plane, to the summit of the pass—the object of its present examination—which here divides the waters of the Arkansas river from those of the Rio Grande del Norte. At 1.45 p. m., August 30th, on this summit-level, the aneroid barometrical record is 22.26, thermometer 81° Fahrenheit; and at 2.40 p. m. 22.23, thermometer 73°; the mean of which referred to our camp of August 27th, 28th, and 29th, the altitude of which is well determined, gives for the altitude of this pass above the sea 8,603 feet. Six miles west from the summit, at 4.30 p. m., the aneroid record is 22.50, thermometer 72°; giving an average descent of fifty-six feet per mile for six miles. Three miles west from this point, at 9 p. m. August 30th, and 6 a. m. August 31st, the records are 22.70, thermometer 50°, and 22.60, thermometer 37°, respectively; giving an average descent of between sixty-seven and sixty-eight feet per mile for three miles, to the centre of Homans's park, from which a railroad can be carried in any direction over the valley of San Luis.

The eastern descent for three-fourths of a mile was by a steeper path than that by which the party had ascended to the summit, to a spring branch of the Pucha creek, an affluent of the Arkansas, where they encamped in latitude, by astronomical observation, 38° 25' 04". Being without tents, the party found their limited supply of blankets too cool, and rose early, the grass being covered with a white frost—the thermometer standing at 32°, aneroid 22.23; and at 10 o'clock a. m. at this point, thermometer 80°, aneroid 22.35; giving a descent from the summit of the pass of 85 feet, or 113 feet to the mile. One mile and a half from camp Captain Gunnison came to the south branch of the Pucha creek, which is a bold mountain stream; aneroid at 7 a. m. at this point reading 22.50, thermometer 42°; and at 12 m. at the same point 22.64, thermometer 33°; giving an average descent of over 223 feet per mile. But notwithstanding this, the character of the ground is such—broad, open and rolling—that it was deemed practicable by Captain Gunnison to so extend the distance in descending, as to bring the grade within that upon which railroads operate successfully. He descended without difficulty from this point through a cañon four miles in length to the beautiful plains of the Arkansas, ten miles in width, which lie above its cañon, bearing N. 61½ E., magnetic. The aneroid record at this point at 9 a. m., August 30th, is 23.17, ther-

mometer 66°, giving for the four miles an average descent of 185½ feet per mile. Half a mile below this cañon the north or main branch of the Puncta, descending from high, snowy peaks to the north and west, is joined by that of his path, and thence gradually approaches the Arkansas. Heavy Indian trails attest the frequent use they make of this pass in going to the South Park, and to the Wet Mountain valley, and Hardscrabble, now deserted, and back to the Rio del Norte and Coochetopa regions. And Captain Gunnison gives it as his opinion upon the ground, before any computations were made for grades, that "it affords an excellent wagon and railroad route; the former by Hardscrabble creek, passing around the cañon, or up the Huerfano river; and the latter following the Arkansas river through its cañon." As a testimonial of respect to the memory of the officer who explored it, I have given his name to this pass. On the night of the 30th of August the party returned and slept in Homans's park, and rejoined the main body of the party late this evening, during a slight fall of rain.

September 1.—On the crest of the mountains at day-light—some six or eight hundred feet above us—were a fine band of mountain sheep, some of them large, majestic fellows; but they did not tempt the spirit of the sportsmen among us. We continued on the southern course, on which we encamped last evening, for about two miles, and then turned west, following the Sahwatch creek for six miles, where we crossed it for the last time, and left the main Indian trail which still follows that creek, which rises considerably to the south. This main trail is said to lead through thick forests of timber, through which it would require much labor to open a wagon road to Carnero Pass, equal if not superior to that of our route. We pursued for three miles a fine branch of the Sahwatch, coming in from the north, when we left it, and, turning west, followed a branch of this creek, and after a march of fifteen miles, encamped where a low opening in the mountains to our left afforded a small supply of grass, and enabled us to enter and encamp with our train. The valley of the Sahwatch to-day continued narrow, as at our camp last evening, and the travelling in it very fine, at this dry season. The valley of the next branch was still narrower, ranging from 130 yards to 150 feet, and the travelling equally fine; and in the succeeding valley, often narrowed until the huge, fallen rocks from either side had passed each other and lay scattered over the bottom, the road was still good, although we had constantly to wind around these rocks, and to cross and re-cross the creek, here, as almost always under similar circumstances, with soft, springy banks. The pines are confined to the mountain tops and sides, and but few are of respectable size. Surrounding our camp they are small but numerous, extending from our camp-fires quite to the mountain tops. The rocks of the cliffs on all these creeks were porphyritic and pudding-stone, and igneous rocks of various kinds. The precipitate escarpments of the narrow ravines are of the former stone, very porous, and of a red cast, not unlike, but a shade lighter than the common red sandstone, in formations of from twenty to sixty and eighty feet in thickness. The crests of these bluffs are covered with earth a few feet in thickness, some terminating in larger or smaller plains of table-land, while others are rounded off into

points and ridges. In the dry bed of a stream near camp we passed over a sedimentary stratum of coarse sandstone, much water-worn.

September 2.—Captain Morris and myself went forward with working parties, to make practicable crossings for the wagons at the various points where, from the winding of the streams and narrowness of the pass, it should be necessary, and to cut out the timber which at various points quite filled the pass as it covered the ridges, which at this point divide the waters of the continent: those of the eastern slope flowing by the channels up which we have travelled for several days, to the Rio Grande del Norte, and thence to the Gulf of Mexico; while those from the western slope flow into the Rio Grande, or Grand river, one of the main branches of the Colorado of the West, reaching the Pacific through the Gulf of California.

We found little difficulty on the banks of the creek, but were detained some hours from the dense growth of quaking-asp, from the size of saplings to a foot in diameter, among which, fallen in every direction, was an equally large growth of dead aspens. At 11 o'clock, however, we were progressing rapidly towards the summit of the pass, which we soon reached, and, as we enjoyed the prospect before us, a slight thunder-shower was not a disagreeable accompaniment. The elevation of this pass is not enough to give an extensive view, but the numerous small, grassy valleys, and pine and aspen groves of the mountain sides to the west, afforded us a pleasant prospect, the more so as it gave hope of an easy prosecution of our future labors, at least for a time. After cutting away trees for a quarter of a mile down the western slope, we entered an open prairie, at a spring which sends out a fine little creek, which we followed for a mile, without obstruction and encamped, at half-past 1 o'clock p. m., in a fine field of grass, where two or three mountain rills, coming from as many small valleys, unite. Distance, five miles and a quarter. Latitude, by observation $38^{\circ} 12' 34''.7$.

The width of this pass at the summit does not exceed six hundred yards, but the slopes to the low peaks rising above it are not abrupt. The ascent from the valley of San Luis, by which we reached the summit, was very gradual, increasing with considerable uniformity until we approached it within a short distance, where the ravine of the stream was narrow and thickly timbered; and we left it with the wagons, making an abrupt ascent to the right to the level of the summit "which we could have reached by an easier grade," Captain Gunnison says in his notes, "by keeping to the left of our track, where the ravine winds gently round to the summit-level." The approximate elevation above the sea of our camp at the Puerta, as we left the valley of San Luis, was 7,567 feet. To our next camp, twelve miles and twenty-seven hundredths above the Puerta, on the Sahwach creek, we ascended slightly over thirty-nine feet to the mile; and in the next fifteen miles to our camp, four miles east of the summit, we ascended 913 feet, or nearly sixty-one feet to the mile; our altitude at this camp being 8,960 feet, while the indicated height of the summit itself is 10,032 feet, giving an ascent of 279 feet 9 inches per mile for 3.83 miles; and of our camp on Pass creek, one mile and thirty-three hundredths west of the summit, 9,540 feet—a descent of 492 feet in that

distance, or, in whole numbers, 370 feet per mile. Captain Gunnison describes the system of barometric levelling which he employed on several sections of the route explored, as follows: "The instruments are kept one hour's distance apart, and record simultaneous readings at the different points of the route. The barometers being first read in camp for comparison, say at 7 o'clock a. m., the party which goes in advance moves forward at once for one hour. At 8 o'clock the barometers are read for altitudes, and the odometers for distances, and the necessary bearings by compass are taken. A small flag is then numbered and planted at this point, when the advance party again moves forward, and at 9 o'clock performs like operations; while the rear readings are made in camp at 8 o'clock, and at 9 at station No. 1, and so on at 10, &c." By this method of levelling we ascended from our camp east of the summit, 154 feet 4 inches per mile for the first mile and sixty-two hundredths; 215 feet 9 inches per mile for the next mile and thirty-nine hundredths; 396 feet 6 inches per mile for the following fifty-eight hundredths of a mile; and 292 feet on the last twenty-four hundredths of a mile at the summit, or nearly 1,200 feet to the mile. Observations taken for the purpose of ascertaining what extent of deep cutting could be easily effected, gave a descent of 94 feet in the first 350 feet on the eastern slope; and, allowing fifty yards for the length of the summit, an equal distance gave a descent on the western slope of forty-seven feet. But in constructing a railroad, the level of our camps and path would be disregarded wherever it could be best effected by ascending the hill-sides along the pass, distributing the elevation to be overcome over a longer and more uniform grade. But the ravine character of the pass is such, narrow and direct, (with sides broken by numerous lateral ravines,) rising to no considerable height above the stream, that the elevation to be thus gained would be thrown entirely upon the last few miles preceding our camp, 3.83 miles below the summit, and could not probably exceed 200 feet. If, therefore, this pass be deemed desirable for a railroad, it will be necessary, after having gained this elevation at this camp, to pass the summit with a grade of 124 feet to the mile, which will require a tunnel, including a deep approach from the west, of not less than two miles in length, entering the hill three-fourths of a mile below the summit on the east, and a short distance above our camp, 1.33 mile west of the summit—diminishing the elevation to be overcome by 490 feet. Below this camp the natural grade again becomes practicable for a railroad; for a wagon-road this pass is already practicable. In the Sahwatch mountains, to the north of this pass, another pass exists, leading from one of the numerous little branches which we passed after leaving the Sahwatch spring, to the head of the Coochetopa creek, but it is not favorably represented. Captain Gunnison concludes his notes upon this pass by the remark, "that it occupied five hours to cut the road and make the passage of this ridge—the men working hard; and Captain Morris deserves great credit for the manner of executing the labor and selecting the route."

September 3.—We proceeded down the valley of Pass creek in a westerly course, the hills on each side being cut by small rills, deep

back towards their summits, which will render a winding route and much cutting and filling necessary in constructing a railroad, for which the southern side of the creek is the most favorable. Four miles from camp we passed a broad valley extending several miles to the left towards the Sierra San Juan, whose northern slopes are still covered with large fields of snow. Opposite this valley that of Pass creek widens considerably, and we passed easily down it for six miles further to where another valley sweeps off to the south, through which a fine creek descends, and, uniting with that of our path, enters a broken cañon. The valley from this point extends to the south towards the snowy peaks of the Sierra San Juan, near which the Sahwatch creek is said to rise, flowing north and east along the base of the mountain to the left of this and the preceding valleys, looking south, where its waters approach nearer those flowing into the Pacific than at any other point. The Carnero Pass leads from that creek over this ridge, and its summit does not appear more elevated than that of the Coochetopa, and its western descent much more favorable for a road. Our guide, Leroux, represented its approach from the east, however, as more abrupt than that of the Coochetopa Pass, and did not think it practicable for our wagons to pass through the rocks and timber which obstruct it, without more labor than our limited time and the season of the year would warrant us in stopping to bestow upon them; and for the same reasons, no delay was made to examine it. The descent from our morning camp for the first 2.24 miles was (in whole numbers) 108 feet to the mile; 68 feet per mile for the next 2.15 miles; 93 feet per mile for the following 2.05 miles, and 42 feet per mile for the succeeding 3.47 miles.

Captain Gunnison says, "the disposition of the mountains indicate that a line can be carried from the Coochetopa Pass southwesterly for some distance, passing behind the hills which divide the two southern valleys described above, and descending the most western one, securing a better grade than by following Pass creek." This creek here inclines more to the north, and enters a small cañon which sends out several side branches, and we were forced, in turning it, to cross a ridge to the N. N. E. to another branch of the Coochetopa creek. This ridge was rough and thickly covered with several varieties of artemisia—the sage so large and stiff that our animals were very reluctant to pass through it. Distance marched 20 miles.

September 5.—Following for three miles the narrow valley of the little creek on which we had encamped, either side of which is lined with ledges of sandstone, through which numerous small rivulets have cut deep channels, it is joined by other valleys and spreads out a mile or two in width, and is, whether wide or narrow, covered with abundant grass. On our right we passed a very large, elevated, and remarkably round butte, standing quite detached from the mountain beyond it. Eight miles brought us to the Coochetopa creek, a fine, rapid little stream of twenty feet in width, which we were repeatedly obliged to cross and recross as the valley narrowed in to gorges, and the stream impinged against its banks, while to avoid this at other points we passed over the artemisia bluffs. A few cotton-woods were scattered along the creek, but it was generally lined only with willow bushes. At one point where

we crossed it, ledges of coarse and crumbling feldspathic granite were observed; but the rocks were generally sandstone, the light-colored argillaceous frequently overlying the red ferruginous. Conglomerate rocks, but slightly cemented, also prevailed, and a few trap-rocks were seen.

Captain Gunnison ascended a hill one mile W. N. W. from our morning camp, from which he had a fine view of the snow-clad range of mountains from which the Puncta and Coochetopa creeks descend. This mountain extends round by the north to northwest (magnetic,) where Grand river passes between it and Elk mountain. From this point also he had a view of a snowy peak of the mountains at the head of the Arkansas river, distant in a course N. N. W. perhaps one hundred miles. From this hill he passed over the broken, barren and slightly elevated country along Pass creek, which receives many small cañones from the left, over which it would require considerable labor to construct a road; "but it could be carried over this elevation by rising below gradually for some distance." Numerous elk-horns and buffalo-skulls lay scattered whitening on the hills, attesting the former range of the latter animals to these pastures, where the small variety of artemisia with a camomile odor, of which they are said to be more fond in winter than of any of the grasses, flourishes. Reaching the mouth of Pass creek, we encamped in a meadow of half a mile in diameter, having travelled 15.88 miles. Several times during the day we experienced very sensibly the sudden changes of temperature to which high altitudes in mountain regions are subject from a passing storm or a change of wind—our thick coats being at one moment necessary to our comfort, and the next oppressive. At this season of the year, rain-storms are here always accompanied by thunder and follow the mountain ranges, or gather about their summits, which act, by their icy coldness, as natural condensers. And while I am writing this evening it is snowing on the higher peaks in sight, and a slight shower of rain, accompanied by violent thunder, is falling on the lower ranges. At this camp our altitude was 7,681 feet above the sea—a descent of 1,134 feet from the head of the cañon on Pass creek, sixteen miles distant, or of seventy-one feet per mile.

September 6.—Seven miles from camp the valley of the Coochetopa, which we experienced the same difficulty in following to-day as yesterday, and which was here and there lined with bluffs of coarse pebbles and boulders, slightly cemented and crumbling, opened into that of Grand river, on the opposite side of which are high ledges of red sandstone—the base of the Elk mountains. This valley for eight miles after we entered it, is from one-half to one mile and a quarter wide, covered abundantly with grass, the stream being lined with willow and cottonwood. The bottom is very level, and is evidently annually overflowed at the season of the melting of the mountain snows, the drift of the present season lying scattered in the grass to the base of the hills. Elk mountain towers high above us to the west, the hills immediately along the valley being high and more or less of a table character, or what the mountain men, of Spanish descent, term mesas—elevated level spaces of land, terminated on one or more sides by precipices and lower levels. Grand river is at present a fine, clear stream of cold water,

one hundred feet wide and three feet deep, flowing rapidly over a paving-stone bed. Our guide states that its main branch rises in the Elk mountains to the northwest. This is joined by a large branch from the north which rises in the range of mountains to the west of the headwaters of the Arkansas river, and drains the western slope of that range and of the Sahwatch mountains. Following the eastern slope of Elk mountain to its termination, Grand river passes to the south and west of it, where it joins the Nah-un-kah-rea, or Blue river of the Indians and mountain men, which rises in the Middle Park, and is erroneously called Grand river on some of the most correct maps.

We encamped in the valley on the west bank of the river, having marched but 14.75 miles, with an average descent of over seventy feet per mile. This fine little valley is terminated a short distance below our camp, by the close proximity of the hills on either side, and a deep cañon presents its giant mouth to receive the river.

September 7.—We recrossed the river at our camp, and proceeded down its southern bank 1.80 mile to the head of the cañon, where a small creek enters, which we crossed, and immediately began the ascent of the hills to pass around the deep ravines which enter the cañon in deep chasms. The hills were very rocky, but we found little difficulty in ascending and passing them with our wagons, except from the everlasting sage, which was large and rank, and the only vegetation on them, although we approached quite close to the base of the tables or mesas, which are elevated from 300 to 400 feet above our path, and are separated by deep ravines from a few hundred feet to a quarter of a mile in width. The perpendicular rocks at the head of the cañon are some eighty feet in height, the cañon itself increasing to twice that altitude where a creek enters it from the northwest half a mile below its head. The course of the river in the cañon, for the first mile, is south-southwest (magnetic) and south. It then turns abruptly west, and continues on broken courses towards the southwestern point of Elk mountain. The rocks are granitic, containing large masses of crystallized quartz, glistening brightly in the sun. After making 3.25 miles over the hills, passing the heads of ravines, we came upon a precipitous descent, the first cañon having terminated, and an open grassy valley succeeding to the hills for two miles. We had ascended, in this short distance, 735 feet above the head of the cañon, or 715 feet above our morning camp. We had, therefore, to make, in a few hundred yards, a descent nearly equal to this ascent, on a natural grade of about one foot in five, full of igneous rocks of all sizes, from fragments and projecting masses, to mighty ledges. The loose surface stones removed, we attached ropes to the first wagon, which, to prevent accidents, was held by a number of men. It arrived safely at the bottom of the hill, 547 feet below, and half a mile distant; and we dispensed with ropes, and descended with the remainder of the wagons, separately by a few yards, and soon reached and again crossed the river. This valley was succeeded by another cañon, and we ascended the opposite bank of the river for a similar purpose for which we had labored in the early part of the day. For five miles the ascent was easy, but here we were obliged to cross a deep ravine, and for this purpose were forced close to the base of the mountain to find a practicable descent, which,

at best, was very precipitous, as was also the ascent, although not exceeding a hundred yards in length. A mile further on, we again descended to the river, where a narrow strip of grass afforded a night's pasture for our jaded animals, which had been eleven hours in making fourteen miles. One of our wagons had broken an axletree in the passage of the first hill in the morning, and did not arrive at camp until late in the evening. On each side of the river to-day, and, as we can see, for some days ahead, the banks rise rapidly towards the precipitous sides of the mesas, which extend back from fifteen to thirty miles to the mountains. These elevated tables are in classes, each class preserving the same level, though on opposite sides of the river, and consisting of the same formations—all of them terminated at the top by a capping of greater or less thickness of igneous rocks, overlaid by a few feet of soil, on which, occasionally, small groves of trees may be seen. They were formed, doubtless, by the upheaval of large plains at the same time; and the immense cracks and crevices of those convulsions have been enlarged, in time, by the elements, and now form the cañones, gorges, ravines, gullies, and passes, which in every direction surround us. While the current of the river is rapid, and the descent very considerable, these tables seem to preserve the same absolute level, and consequently become more elevated above the river as it descends. They are judged to be, to-day, 1,200 feet above it, and not less than 1,500 twenty miles west of us. Sage alone flourished along our path.

Captain Gunnison rode into the cañones several times during the day. He says of the first, "that it would require blasting one-third of the distance for the construction of a road, and solid masonry, with many arches for culverts on the whole line—a stupendous work for an engineer. The second is less formidable, the rocks being more friable, and the curves of larger radius, while the cliffs are but 100 feet in height." The river, at high water, he judged to cover the bottoms in places to the depth of six and eight feet; and from a neighboring hill, he esteemed the country "the roughest, most hilly, and most 'cut up,' he had ever seen. Hills with flat tops, hills with rounded tops, and hills with knife edges and points, and deep chasms, are on every side." Gray and brown headed ducks are numerous on the river; the cock of the plains and blue grouse are common, and also deer, antelope, and elk. The average descent of the river from camp to camp to-day, was less than ten feet per mile.

September 8.—Last night was clear and cold, ice of some thickness forming in our water-vessels; and the thermometer half an hour before sunrise this morning indicated 23° of Fahrenheit, but the sensation of cold is much less than at a much higher temperature in a moist climate. We were obliged to cross the river twice at this camp to pass around a bluff from a spur of Elk mountain, and to avoid ravines on the south, which enter the river at a gorge a short distance below us. Leroux had gone in advance, leaving a man who had been over the road with him the previous day to point it out to us, but he wandered off in search of mountain sheep, and our pilots, after crossing a spur, descended to the river again, where we lost much time in searching for a ford, the river being narrow and too deep for our wagons; and we were eventually obliged to return to the hills, and follow them for a short

distance, when we again crossed to the southern bank of the river, and proceeded immediately from it towards the base of the high tables on that side. We ascended rapidly, having, however, but one sharp ravine to cross, the opposite bank of which we ascended only by dint of hard labor, and descending into another ravine, where we found a small spring of cool water, encamped, with abundant grass on the hills for our animals, having travelled but four miles, our camp being 346 feet above that of the morning, although 200 feet below the crest of the ravine. A large smoke ascending from our last camp, from the grass taking fire after we left it, a larger counter-smoke was seen during the day directly on our route ahead, made doubtless by the Utah Indians in the heart of whose country we have been travelling for several weeks, and whom we expect daily to meet, as we are approaching their summer hunting-grounds—the elk, which they follow both north and south in the winter, migrating here at this season. Antelope are also abundant, and are taken by the Utahs by building a pen, or rather two sides of a triangle, and driving a large district of country, narrowing in until they themselves form the third side, when they seize the game; and a whipping betides the unfortunate *women*, sa s our guide, if one happens to escape where they are stationed.

As the train left the river, Captain Gunnison ascended a spur on the north side, whence “a small part of the Arkansas mountains could be seen through the gorge of the river, N. 80° E.; the river itself passing him between square-capped hills, which characterize the spurs on either side, S. 75° W., for perhaps twenty miles. From this position, the reason was apparent why the guides pronounced the further progress of the wagons along the river impracticable.” “The stream is imbedded in narrow and sinuous cañones, the dark top outline of which resembles a huge snake in motion, as the wavy atmosphere conveys the light to the eye. And the little spurs appear merged into one great connecting ridge, from the mountains at the head of the Rio del Norte to the great Elk mountains on the north. These spurs have their lowest depressions at the bed of Grand river, a chasm in the porphyritic and crystalline rocks opened for its passage. The red sandstone that has at one time overlaid it, has been washed away. The side creeks from the mountains have cut deep valleys, with perpendicular sides, in the softer rocks; and there are left standing many hills of sandstone, which are protected from decay by what appears to have been lava, cooled under water after spreading over the sediment, which is hardened into argillaceous sandstone in some places, and sand cemented with a ferruginous cement in others. In some parts the capping is removed over great areas, and the stone is found in the bottoms of the streams rounded into pebbles. To look down over the tangent plane to the cañon below, it seems easy to construct a railroad; but immense amounts of cutting, filling, and masonry would be required. There is no timber to speak of nearer than the mountains, and that difficult of access for such a work. Cotton-wood in clumps on the rivers, and dwarf cedar and pine scattered on the cliffs and hills, will furnish fuel for wagoners.”

September 9.—For the second time our guide returned to camp last night ill at ease, and it was evident that his two morning's examination

of the route ahead had not only proved less successful than he desired, but had quite surprised his memory. But we were too close upon his trail to admit of longer delay in informing us that we had a serious obstacle before us in the passage of the Rio de la Lagune, or Lake Fork, coming into Grand river from the south, through almost one continuous cañon from the mountain to the river, and that he had failed to find an easy crossing. This morning, therefore, large working parties of soldiers and employes started forward, under their respective commanders, to prepare the crossing of the creek; and at 2 o'clock p. m. we received orders to move on with the train. Ascending from the ravine on which we had encamped, we were forced high up on the mesas, to avoid numerous deep ravines, which we succeeded in turning successfully, when a short, steep ascent around the rocky wall of the table to our left, brought us, four miles from our morning camp, to the top of the difficult passage—a rapid descent of 4,055 feet in length; and 935 in perpendicular height above the stream, covered with stones of all sizes, from pebbles to tons in weight, with small ledges of rocks cropping out at various points. Some of the stones had been removed in the proposed road; but the wagons, with locked wheels, thumped, jarred, and grated over the greater portion, especially those too large and deeply imbedded in the soil to be removed, until their noise quite equalled that of the foaming torrent creek below. At one point, as they passed obliquely over a ridge, it was necessary to attach ropes to the wagons, and employ a number of men to prevent their overturning. Two hours were thus employed in descending with our eighteen wagons, and in twice crossing the creek, in the bed of which we had to descend for a quarter of a mile, before we could gain a permanent footing on the west side. The creek is sixty feet wide by from one to two deep, with an impetuous current falling with a loud noise over a bed of rocks and large stones. Just above its mouth two fine streams, half a mile apart, enter Grand river from Elk mountain. Day's march five miles, through a heavy growth of sage.

September 10.—After considerable labor in removing surface stones and digging down a few yards of the opposite hill, too sideling for our wagons, we doubled our teams, and with ten mules, but not without severe labor—detaining us, however, but six hours—pulled up the load of six to the crest of the western bank of Lake Fork, ascending 480 feet in forty-one hundredths of a mile. By the line followed by our wagons, it is 1.50 mile from crest to crest of the banks of this creek, ~~but~~ in a right line it is only 2,639 feet, or about half a mile, while the perpendicular descent from the east, as already given, is 935 feet. The most practicable means by which this immense ravine can be passed by a road, will be by ascending one of its banks by a heavy grade into the mountains, crossing it by a bridge, and descending the opposite bank—a stupendous labor, for it will be necessary to cut through miles of rocks and to cross large side-ravines. But it becomes narrower below the crossing, and proportionally steeper; and Captain Gunnison, after examining it, thought it, perhaps, not impossible, but very difficult to bridge it.

Leaving Lake Fork we continued along under high bluffs, over very rocky hills with deep intervening gullies, which forced us southward

into a valley gorge, which we reached by a steep ascent, and encamped, after a march of 4.69 miles, under a vertical wall of igneous rocks 100 feet in height, at a beautiful spring of cold water in a fine grassy meadow, through which a creek descends to the river, distant two miles. This little valley is part of a depression some four miles in diameter, like a basin in the high table-land among the mesas, which on all sides enclose it to the eye, although Grand river passes through it, and small streams enter it through deep, wide gorges in all directions. The agreeable and exhilarating effect of the pure mountain air of these elevated regions, ever a fruitful theme of eloquence among trappers and voyageurs, exhibits itself among our men in almost constant boisterous mirth. But violent physical exertion soon puts them out of breath; and our animals, in climbing the hills, unless often halted to breathe, soon become exhausted, and stop from the weight of their loads, but after a few moments' rest move on with renewed vigor and strength.

September 12.—Crossing the creek, we followed the ravine valley of our camp southward to the top of the mesa, and turning westward, passed for two miles along its summit, and descended with difficulty to a creek two hundred feet below it, only to ascend again, by an equally abrupt path, to the same level, and again immediately descended, by a similar path, to another creek, difficult to cross only because of the dense thicket of willow bushes which line its banks, and again ascended to nearly the same level as before, and then wound more gradually down a long descent to a larger creek, coming through a deep gorge to the south, from snow-peaks, plainly in sight, of the Sierra de la Plata. We left this creek by a more gentle ascent than we had climbed for a week before, through luxuriant fields of grass, in which, indeed, we had travelled during most of the morning, in rear of the mesa adjacent to Grand river, and passing one or two small ponds of water on the way, descended for five miles to the first branch of Cebolla or Onion creek, the last two miles through a level artemisia field, in which we encamped, on a small grassy space near the creek, having travelled 13.18 miles. While Captain Morris and myself were out in search of a suitable camp, a few Tah-bah-was-chi Utahs exhibited themselves on their war steeds, near enough to call out to us. We advanced to meet them, and a crowd of men, women, and children soon gathered at our camp.

September 13.—Captain Gunnison, this morning, made presents to the Indians; first providing the chief with the articles which he was to distribute to his people, and then a package for himself. They were very importunate for powder and lead, everything else appearing of little value to them. We were anxious to purchase horses, but they would sell them only for arms and ammunition.

We crossed the creek a short distance above our camp, where a practicable ravine afforded us a descent, the bank being forty feet high and very steep, and passing down it ascended the other bank by a similar ravine, opposite our camp, to the rolling sage plain which we crossed to the main branch of Cebolla creek, which we forded, and encamped, after a ride of only 3.75 miles, on a grass field near by, at the base of a connecting mountain range, which here crosses the valley of Grand river from the Elk towards the Sierra de la Plata—it being ne-

cessary to find a path for our wagons before attempting the passage. Captain Morris and myself, therefore, with Leroux as guide, and a party of men, rode forward by one of the two routes followed by Indians and hunters in passing this mountain, and reached the summit in two hours; the scenery becoming more beautiful as we ascended, especially through the gorge of Onion creek to the south, where vertical columns of rocks stood out high and clear against the sky, being part of the Sierra de la Plata—a range of mountains to the west of the Sawatch and Sierra San Juan—whose sharp summits are broken into a thousand points and angular forms, and its sides streaked with banks of snow. Our route far behind us lay clear and distinct at our feet to the mountains about the Coochatopa Pass; and the course of Grand river, with the Elk mountain to the north extending round to the northwest with a level summit for many miles, terminating with a vertical descent of a few hundred feet, and then apparently subsiding into a plain. At our feet to the west lay the Uncompahgra river, rising in the Sierra de la Plata, and flowing northwest through a valley of considerable width, beyond which a range of high land was overlooked by more distant mountains, among which the Salt and Abajo peaks were pointed out to us. The former is directly upon the noted Spanish trail leading from California to Abiquiu, New Mexico, and is a favorite resort for the Utah and Navajo Indians for trade; while the latter is near the junction of Grand and Green rivers, considerably below the fords for this trail, or, as Leroux says, below any ford on Grand river known to the New Mexicans, and hence its name. But we had little time to enjoy this majestic scenery, and hastened to examine the descent of the mountain, which we found very difficult, and at various places, as on the ascent, thickly covered with scrubby oak bushes and aspens. The soil is light, but covered with luxuriant grass. We thought it possible to pass this route with wagons; but the other route, followed by the Indians from our camp to the Uncompahgra, lay directly below us while ascending the mountain, and appeared much preferable to the one we had examined; and a small party, sent out to examine it a short distance, reported it passable.

September 14.—It was 3.80 miles by this route to the top of the steep ascent of the ridge, and three hours were occupied in its ascent; our barometers giving a difference of level of fourteen hundred feet. The top of the mountain was broad, and near the summit we fortunately found a small basin of water, in our circuitous path to avoid ravines, at which our animals were watered; but it was too stagnant for the men. From the western slope the valley of the Uncompahgra could be seen in the distance; and, striking the dry head of Cedar creek, we commenced our descent to it. This creek was too narrow and ravine-like to allow us to descend its bed, and we accordingly circled round on the hillsides, sometimes in grass fields, at others in dense masses of sage, from which we escaped only to encounter the stiff scrubby branches of oak bushes, and at length, through a mass of them, to make a precipitous descent to the creek, which was itself lined with them. Just before sundown we reached a point where Leroux had, under a rock in a deep thickly-bushed ravine, discovered a little cool and refreshing water, with which our animals were watered from buck-

ets, and ourselves supplied for the night, which now overtook us; and we encamped a mile below on a very little coarse grass, having travelled thirteen miles. Two miles west of this camp our elevation above the sea was 6,962 feet, while it was 8,755 feet at the top of the sharp ascent nine miles east of camp. The average ascent per mile to this point, for the 3.80 miles from our morning camp, is a few inches over 368 feet, and the average descent for the succeeding eleven miles is 163 feet per mile. Some additional distance can be gained by a winding path in the ascent of this ridge, but not sufficient to make it practicable for a railroad, which, if at all, can only be carried on this part of Grand river immediately along its banks.

September 15.—We were still forced to cross Cedar creek several times, each passage requiring considerable labor in cutting down the banks, before it became wide enough for our wagons to pass freely down it, which it did two miles below camp, where we found water in pools. To this point the cacti and sage were troublesome, but were scarcely seen again until we reached the borders of the Uncompahgra; the hills and valley alike, on each side of our route, being a light colored, friable, and clayey soil, almost destitute of vegetation. The valley of the Uncompahgra, efflorescing with salts in many places, is several miles in width, and the stream is lined with cotton-wood trees, willow, and buffalo-berry bushes, and, by crossing it where it was thirty feet wide by one deep, we found an abundance of grass and encamped, having marched 12.30 miles, descending 87.7 feet to the mile for the last ten miles. This river rises, as I have already stated, in the Sierra de la Plata, which appears to set off from the Sierra San Juan, and lie nearly parallel with our path, and from fifty to sixty miles distant. Near us are two or three Indian lodges, the occupants of which were greatly frightened at our sudden appearance. Their young men being absent on the hills hunting, were too timid to return and warn their lodges of our approach, for they had seen us, as we had them, long before reaching these lodges. Those of the women who could, fled to the thickets with their children; but two were too old to run, and were soon assured of their safety. They, however, experienced considerable difficulty in calling the young women from their hiding-places, until their men returned and they no longer feared treachery. The two old women bear unmistakable evidence of having seen the snows of a hundred winters pass away. They are of small stature, and bent forward with years; wearing their coarse hair, still as abundant as in their youth, after the manner of the women of their nation: cut short across the forehead, and passing below the ears, across the nape of the neck, and a little thinned on the edges, it stands off hideously ugly, but gray only in a few locks. Their features are dried and shrunken to a mummy-like appearance, with bleared eyes; and sunken lips covering teeth worn to the gums. The joints of some of their fingers are stiff and distorted, and all are enlarged to ugliness. These poor objects of humanity are clothed in deer-skins, and, on learning that their lives were not in danger, sang and jumped with joy at their escape from what they had supposed inevitable death. The most domestic scene witnessed was that of a mother who visited our camp with her four little children—the five riding the same horse, and

all as much at home as mothers and children in a nursery. One sat in front of the mother, and one was swung on her back on a frame covered with skins, and two rode behind her, leaving no place unoccupied from the horse's tail to his neck. Presents were made to these people by Captain Gunnison.

September 16.—We travelled 18.25 miles down the Uncompahgra to-day, crossing the stream four miles below our morning camp, and again a few miles before encamping this evening, a short distance above its junction with Grand river; the descent from camp to camp slightly exceeding forty-one feet to the mile. The country is in all respects like that passed yesterday—cotton-wood, willow, and grass in the narrow bottom, and near it heavy sage; but the great mass of the valley land is nearly destitute of vegetation—light, clayey, and arid to such an extent that it is disagreeable to ride over it, as it sends up clouds of dust at every step. We met several small parties of Indians during the day, all of whom followed us to camp; and others continued to arrive until a late hour at night, filling the air as they approached with yells and calls, which were answered by their friends in or near camp—consisting of inquiries and directions as to how and where they were to pass—until we were heartily tired of them. The most of them were sent out of camp, but they built their fires only a few yards from ours, and their noise was little abated by the change, and our safety but little increased. They had, much to his regret, recognised our guide; but he neither showed fear nor want of confidence in them, although he had once shot one of their chiefs, who was attempting to rob him of his horse; and he shared his fire, pipe, and blankets with the chiefs who remained all night with him.

September 17.—Si-ree-chi-wap, the principal chief of the band, who is now so old that he exercises but little authority directly—intrusting it to his son, who accompanies him—arrived during the night, and, followed by his sub-chiefs and warriors, this morning repaired to Captain Gunnison's tent to talk and smoke. The Captain informed them that "the President had sent him to look for a good road by which his people, who live towards the rising sun, can visit those who live upon the great water where it sets; that he was their friend, and had authorized him to make them a few presents in his name." The son of Si-rec-chi-wap replied: "This is your land, and you can go over it at any time. There are bad Indians over the mountains, who kill white men, but the Utahs are good, and glad to see the Americans." Presents were then distributed, pipes smoked, and the party moved on, accompanied for several miles by the chiefs. We crossed the point of land lying between* the Uncompahgra and Grand river, reaching the latter at Roubideau's old trading fort, now entirely fallen to ruins. The river is much larger than where we left it a week ago; and its water has here a greenish shade, while there it was colorless. The Uncompahgra, however, is remarkable for this color of its water, and for a pea-green moss, two or three inches long, covering the stones in its bed, even when the stream is shallow and very rapid. A mile below the fort we crossed the river at an excellent ford; the bottom being a mile in width, and covered with abundant grass.

The cañon which we have been so many days passing around, termi-

nates several miles above the junction of the Uncompahgra, where Grand river receives a large affluent from Elk mountain, known as Smith's fork. The high ridge, varying from 500 to 1,500 feet in height above our path, back of which we passed from Lake Fork in avoiding this cañon, and which is itself cut with deep cañones by the Cebolita and other streams, terminates, towards the valley of the Uncompahgra, in buttes and clay hills, of which there are two ridges; the first and lowest, of gray, and the second of red clay, bordering the river. Alkali is seen in these hills, as it is also in the plain, and is doubtless the chief cause of the barrenness of the soil. From our camp below the mouth of the Coochetopa creek, to the junction of Smith's Fork with Grand river, there is nothing deserving the name of valley. Now and then there is a small open bottom, from a few yards to a mile or two in length, but at the season of high waters the river sweeps over these spaces, and the stream is not followed even by an Indian trail.

The difference of elevation between the head of the cañon and our camp, a few miles below its termination, on the Uncompahgra, separated from Grand river by a level bottom only, is 2,077 feet; and as the distance between these points by the river does not exceed seventy miles—of which, perhaps, sixty preserves its cañon character—the average descent will vary but slightly from thirty feet to the mile. But from the continuance, for so great a distance, of vertical rocky walls along the river, upon which the road must be carried, and which can be cut only by blasting, and, from the deep side-chasms to be passed, as described by Captain Gunnison on the 7th instant, only by the heaviest masonry, it is evident that a railroad, although possible, can only be constructed in the vicinity of this section of Grand river, at an enormous expense—for the accurate estimate of which, situated as the work is at so great a distance from civilization, where not only laborers, but their subsistence, must be transported by land carriage nearly 1,000 miles, and where scarcely a stick of timber has been seen for the last 100 miles on the route, nor will be for the succeeding 150 miles, suitable for a string-piece for a small temporary bridge, or even a railroad tie, it is not too much to say, no data exists, nor will until such a labor shall be undertaken.

Ascending from the river bottom, our route passed, parallel with it, over a district of pulverulent clay, the surface occasionally incrustated with salt, with small broken crystals of gypsum scattered freely about. This soil is formed from the wash of the impure clay-slate bluffs on our right, our animals sinking in it to their fetlocks. These bluffs rise one above another until they attain an altitude of 1,000 feet, their summits presenting the appearance, as we descended Grand river, of an unbroken plain; but as we pass in front of them they are seen to be cut into deep ravines by the small streams which descend from them during rains. In a few miles, however, we passed from this soil to a hard one, covered with small fragments of black vesicular volcanic rocks scattered over the surface. The men sent forward to select a camp, failed to find access to the river; and having travelled 20.33 miles at dark, we encamped without water, and on so limited a supply of grass, scattered over the hills, that the most of our animals were tied up to secure their presence in the morning. Our elevation was perhaps 150

feet above the river, and during the afternoon we had repeatedly to cross deep ravines entering the river in cañones, in trap-rock or in sandstone and clay-slate, where they overlie the trap. The land rises from our camp to the river, distant half a mile; and beyond it is soon elevated into a mountain: the stream flowing, consequently, in an immense chasm along the mountain side, made, doubtless, by volcanic action. Much "cutting and filling" would be required in constructing a road near this cañon, which the Utahs call Una-weep, or Red cañon. It extends from a short distance below Roubideau's old fort to near the junction of Grand river with the Blue or Nah-un-kah-rea of the Indians. The Utahs also give the name of Una-weep to a small stream which enters Grand river from the south, in this cañon.

September 18.—At break of day we moved forward for 8.45 miles, over a country like that of yesterday, but less broken, and encamped on a small stream from the west end of Elk mountain, which is on our right, our course being northwest. This little stream the Indians who visit us call Kah-nah. The grass, though not abundant, is sufficient for our stock. Descent from the Uncompahgra twenty-nine feet per mile, in round numbers.

September 19.—Four miles and a quarter from camp we came to a small creek, running between clay banks twelve feet in depth, which detained us an hour in crossing. The cañon of Grand river disappears at this point on this bank, and the bottom is covered with a small field of cotton-wood; but we saw no grass either on the creek or river, which is again soon walled in by rocks of sandstone, numerous bluffs of which we passed. The light friable soil of the last two days continued to the Nah-un-kah-rea river, which we reached in a march of 12.32 miles. The eastern bank of this stream, for miles above and below where we struck it, is perpendicular, and from forty to eighty feet in height—the top of clay and the base of shale. A small gully afforded us the means of cutting a very steep path for our wagons to the river, which we crossed a few hundred yards below, at a point where it was but a little over two feet deep and a hundred yards wide, with a very rapid current—the volume of water being twice that of Grand river. The opposite bank, although but six feet high, the moment it was cut down and moistened by the water thrown up by the leading horses, became so miry that we were occupied three hours in crossing, and encamped near the ford—the grass being coarse, and gritty from a recent overflow. This river enters this valley through a cañon or immense gorge, which separates the Elk mountains on its east from the Roan or Book mountains to the west, and, bending from its southern course, unites with Grand river just below us. Roan mountain, which derives its name from the color of its sides of red, gray, white and blue clay, in horizontal strata, destitute of vegetation and washed into many deep gorges and fanciful forms, sweeps round to the west, following a course some miles from the river. The west end of Elk mountain is terminated with a similar formation; and that to the southwest of Grand river, before its junction with the Blue, resembles it, although more rocky, and some of its bluffs are scantily supplied with small cedars and pines. The valley, twenty miles in diameter, enclosed by these mountains, is quite level and very barren, except scattered fields of the greasewood

and sage varieties of artemisia—the margins of Grand and Blue rivers affording but a meagre supply of grass, cotton-wood and willow.

The latter stream at the season of melting snows is greatly swollen, and at every step we see evidences of the great volumes of water which at such times roll forward in its channel or spread out over its bottom, in the deep channels, now dry, and island now part of the main land, covered with huge trees cast up and left by the angry stream. Average descent during the day, nineteen feet per mile.

CHAPTER V.

Blue river to eastern foot of Wahsatch Pass.—September 20 to October 13, 1853.

September 20.—Captain Gunnison, for the first time, succeeded in purchasing horses from the Indians with the public goods which had been brought for that purpose.

The horses were small, but hardy, and we were much in want of them. Our camp was moved down the river but 9.10 miles, as the Indians informed us that we could not reach grass beyond that point before night—an artifice to retain good customers; for there was better grass two hours' march ahead, and our animals fared badly on the gritty blue-grass at our camp. Latitude, $39^{\circ} 07' 24''$; descent, 4 feet 4 inches per mile.

September 21.—The clay soil yesterday and this morning was often very smooth and dry, and so hard that our shod horses scarcely left a mark on it. Seven miles below camp the river again enters a cañon, near which we filled our canteens for the night, and continued on for 7.30 miles over the same greasewood plain to Salt creek, which we found a mere rivulet of miserably brackish water, the sands of the bed being covered with incrustations of salt, which also effloresces widely over the plain. Near this creek the plain is washed into little valleys, leaving small knolls and ridges standing, which give it a rolling appearance; and our men find much labor in cutting down the banks of gullies for the passage of our wagons. Bunch-grass is scattered over the hills towards the river, and our animals drink the creek water freely. Many trails lead up this creek, and the Indians inform us that they are used in visiting their neighboring band, the Uintas. Latitude, $39^{\circ} 13' 12''$; average descent per mile during the day, 9 feet 7 inches.

September 22.—Captain Gunnison found a bed of coal on a ridge bearing north-northwest from Salt creek cañon, and a mile from it, which he describes as being "100 feet long by 20 broad, and about one foot thick. It is exposed to the weather, but appears to be a good bituminous specimen." Evidences of coal, by the burrows of animals and blackened clay banks, are frequent. Latitude by noon observation, $39^{\circ} 14' 14''$.

We left Salt creek without a guide—Leroux having gone forward some four days since to examine the route, and show those who ac-

company him the best road to the Spanish trail, and not yet returned. We determined, therefore, to keep up the broad, rolling valley between Roan mountain on our right, and the cañon bluffs of the river on the left. The day was very hot and oppressive, and the soil friable, with the usual amount of sage and an increase of cacti; with numerous gullies to cut and fill. We found no point at which we could approach the river until too late an hour in the afternoon to reach it with our train, for it was impossible to travel at night with wagons without a road. We encamped, therefore, without grass, near the dry bed of what proved to be a small intermitting creek of bitter water. Streams of this kind during the day time in the dry season contain no water, but small rivulets break out and flow during the night, but again disappear as the sun becomes hot. So many of our animals gave out, that several of the wagons did not reach camp during the night.

We were here about four miles from the river, which, by following the ravine cut through the cañon wall by the creek, was easily reached on horseback, and only obstructed for wagons by a dry channel cut deep in the clay, at a narrow bottom of fine grass two or three miles in length, with shady groves of cotton-wood on the banks of the stream. The red sandstone cañon walls are nearly vertical, and two hundred feet high; beyond which smaller ledges rise above each other, terrace-like, for some miles towards Salt mountain, which bears south from our camp, some twenty miles beyond the river. The cañon narrows to the width of the river below the groves of cotton-wood. In a ravine by which Captain Gunnison approached the river, four miles below Salt creek, and nearly opposite the mouth of the San Miguel, he says, "sandstone and clayey deposits alternate one above the other, one layer of which is altered by heat, and much of the argillaceous rock is black with the appearance of coal having burnt under it. Coal is found in the cañon near our camp, and can be gathered in place, and there can be no doubt of this being a part of the Green river coal basin formation; at least the formation has the same appearance there as here, and the water from the red sandstone and clay deposits similar crystallizations."

We observe the greatest contrast between the heat of the days and nights in these mountain valleys; the thermometer from noon to 3 o'clock p. m. ranging, for the last several days, from 87° to 92° Fahrenheit, and at night falling below the freezing-point. Yet we find a cactus here which flourishes generally in Texas and warm climates.

The barrenness of these valleys is greatly influenced by the alkaline and saline ingredients of the soil, while their dryness is easily understood by observing the distribution of the aqueous vapors. The moment a cloud begins to form, it rushes towards a mountain chain, is poured in torrents upon its highest peaks, and rushes down its rocky sides into the chasms and gutters in which the beds of streams lie in the valleys, too deep and confined to irrigate the adjacent lands to any distance. The higher mountains are also protected by the clouds to a great extent from the powerful rays of the sun, which scorch the valleys; and hence, in inaccessible places to man, grass and herbage flourish. It is not intended to say that no rain falls upon the valleys and plains, but only a very small proportion is deposited there during

the warm season, when the rain comes in showers of sudden formation; but in the colder parts of the year more is diffused over the general surface. We have seen rain falling in showers usually in the afternoon, on the mountain-tops, almost every day since we first came in sight of the Rocky mountains, two months since; whilst in this valley for two weeks we have been scorched at midday by a tropical sun, and in the whole distance scarcely moistened, except once or twice, near the summits of passes, by rain.

The formation of the valleys is against a system of artificial irrigation; their absorbing power being so great that the mountain streams, during the summer, seldom reach far into the plains. It is therefore only at the foot of the mountains which are not too elevated and cold for vegetation to flourish, where the small streams descend, that irrigation can be employed. No part of the route thus far from San Luis valley, therefore, offers a spot of any considerable extent suitable for settlement. Sufficient grass flourishes in the mountain valleys of Grand river, east of the junction of the Blue, for grazing purposes; but it is a significant fact, bearing upon the climate, that elk frequent them only in the summer, migrating both to the north and south in autumn, where they remain during the winter and again return in the summer.

Leroux, with three companions, left us at this camp to return to New Mexico, having completed his engagement as guide. He expects to travel much at night, and trusts to his knowledge of the country and tact for passing safely through the Indian bands along his route. Day's march, 21.74 miles; ascent, 9 feet 9 inches per mile.

September 26.—Having passed three days in camp, keeping our animals at the river to graze, we this morning resumed our march and determined to continue our course back of the river hills. We were not without hope that the fine rain of the previous night (falling freely for two or three hours) would furnish a supply of water in pools or in creeks from the mountains. At break of day, therefore, I started, accompanied by one man, armed, as I observed after riding some time, only with a spade and hatchet, to find water, if possible, and grass for a camp; and, if successful, a smoke was to guide the party to the point selected. The first two or three creeks passed within a short distance, poured down small muddy streams; but as the sun rose hot and drying, a few hours drained off the surface water, and the beds of creeks soon contained but a few holes of water, and by 10 o'clock even these were fast disappearing. As soon as I had ridden far enough for the day's march, I began my search for grass and water—indispensable items for the camp of a party of exploration, with jaded and weak animals, and months of labor before them. So fruitless was the search, however, that it was not deemed possible to find water; but an extensive view from an elevated position convinced me of the error of deviating from this course, and I therefore made the concerted signal of a camp, trusting to the fortune of a more diligent search—in which threatening showers promised to aid us, and eventually swelled the rain-water creek on which we encamped to the size of a respectable stream, on which and the adjacent hills we found a little bunch-grass. The train arrived, after a march of 16.28 miles, a little before sundown, having passed during the day but one or two small hills and a few gul-

lies. As night closed in, clouds gathered around us; and as I write occasional flashes of lightning and steady-falling rain threaten us with a comfortless night. Average descent during the day, about two feet per mile.

September 27.—It continued to rain most of the night, and increased in violence until 10 o'clock in the morning, when it ceased, and we moved slowly forward over a very slippery and miry soil—all the beds of creeks, recently dry, pouring down torrents of water, and water filling every little depression on the surface of the ground; yet the earth was not moistened more than two inches deep, the wagon-wheels turning the dry earth up onto the brick soft clay of the surface. At 12 o'clock a passing shower sent down such a torrent from the mountain, that, although the leading wagons had crossed it without difficulty, the others were unable to follow for some hours; and we therefore encamped just west of this stream, on a hill finely dotted with bunch-grass, after a march of 5.66 miles. Our route here lies but two or three miles from the base of Roan mountain, and is much more direct from Salt creek than by following the river to the Spanish trail, and thence crossing to the ford on Green river, and is less interrupted by deep gullies; but in wet weather it would be impossible to follow us with heavy loads, and in the dry season no water can be found on this path between Grand and Green rivers.

Captain Gunnison indicates the choice of localities for a railroad track as lying still nearer the base of the mountain, where, however, "much cutting and filling would be required, and many large culverts necessary." The thunder-showers of the morning covered Salt mountain with snow, the effects of which we feel as the wind sweeps round from that quarter; and we can get no wood, and only sage enough to cook our coffee. Ascent, 71 feet per mile.

September 28.—We delayed our march until 8 o'clock, to derive as much benefit from the sun and morning drainage as possible, and it was difficult, even at that hour, to make any progress—mules miring and wagons stalling even on the descent of the hills, which were destitute of a turf or sward, the whole surface to a considerable depth being of the character of stiff brick-yard clay; but after going two or three miles, the soil became more slaty and gravelly on the ridges, and eventually over the whole surface. We descended a steep bluff in the morning, and passed over two gentle swells during the day, the last of which was the divide between the waters of Grand and Green rivers, and encamped, after a march of 16.71 miles, in which we descended 12 feet 10 inches per mile, just at sundown, on the remnants of a rain-water creek, and a thin supply of grass on the hills. Deep narrow gullies cut in the clay soil, with perpendicular sides, obstructed our progress more than usual to-day, as they were from four to sixteen feet deep, and from one to twelve feet wide.

The mountain on Grand river is very broken, and during the day presented many beautiful rocks standing high above the adjacent ledges and ridges. From one position a majestic shaft stood out clear against the sky; and chimney rocks were almost hourly presented as we rode along, with piles occasionally resembling ruins of immense churches

and dwellings, and one or two on eminences, resembling the ruins of mighty cities of adobe buildings.

September 29.—For a mile, in the morning, we continued our course of yesterday, W. S. W., and then changed to S. W. for seven miles, when we came upon the noted Spanish trail which leads from Salt mountain. We then turned W. N. W., following this trail, and encamped, after a march of 14.07 miles, in which we descended 12 feet 3 inches per mile, at a rain-water pool, a neighboring ravine furnishing a limited supply of grass; but for once, sage was even more scarce than grass, the country being entirely destitute of wood.

From an elevated bluff near camp, Captain Gunnison describes the view as disheartening in the extreme. "Except three or four small cotton-wood trees in the ravine near us, there is not a tree to be seen by the unassisted eye on any part of the horizon. The plain lying between us and the Wahsatch range, a hundred miles to the west, is a series of rocky, parallel chasms, and fantastic sandstone ridges. On the north, Roan mountain, ten miles from us, presents bare masses of sandstone, and on the higher ridges, twenty miles back, a few scattering cedars may be distinguished by the glass; Salt mountain, to the east, is covered half down its sides with snow; and to the south, mass after mass of coarse conglomerate is broken in fragments, or piled in turret-shaped heaps, colored by ferruginous cement from a deep black to a brilliant red, whilst in some rocks there are argillaceous layers, varying to gray or glistening with white. The surface around us is whitened with fields of alkali, precisely resembling fields of snow. The soft clayey earth in many places glistens with selenite, and gypsum appears in masses along the sharp sides of the bluffs, while fragments of obsidian are scattered over the ground."

September 30.—Our course for six miles this morning was the same as that of last evening, following the direction of the hills and dry beds of creeks. We then passed through the range of hills on our right, and again resumed our course along the base of Roan mountain; these hills presenting precisely the appearance of immense beds and fields of ashes, being more saline and friable even than those of previous days, and even more destitute of vegetation, the undulating descent being relieved near the Akanaquint or Green river by scattered tufts of grass. Groves of cotton-wood lined the stream, and a narrow bottom afforded grass for our animals for the night, after a march of 14 miles. The distance from Grand river to this ford by a very direct course is 70 miles and from Bitter creek 67 miles by our route, which, except during rains, is entirely without water. By following Grand river, however, some miles below Bitter creek, until the Spanish trail is reached, and, following it, crossing a more broken and gullied country, a spring is said to be passed; but its locality is not known to me.

The greatest difficulty to be overcome in the construction of a railroad on this part of the route would be in obtaining a firm bed for the superstructure in wet weather; and for this purpose it would be necessary to macadamize the road very extensively. Average descent, 12½ feet per mile.

Many Akanaquint or Green river Utahs were on the opposite bank as we encamped, and soon crossed it to beg tobacco, and, if possible,

to trade; dressed deer-skins being the only article they offer for this purpose.

Our latitude at this camp was $38^{\circ} 57' 26''$, and our elevation above the sea 3,873 feet; average descent from camp to camp, $42\frac{1}{2}$ feet per mile.

October 1.—We crossed the river by an excellent ford, which we had observed the Indians crossing, from a few yards below our camp (on the Spanish trail) to an island opposite, and from its upper end to the shore. The river is 300 yards wide, with a pebbly bottom, as we forded it, but with quicksands on either side of our path. The water, rising just above the axletrees of our common wagons, flows with a strong current, and is colored by the red sandstone of the country through which it passes, having here the same red muddy character which the Colorado has far below, where it enters the Gulf of California. A fine field of blue-grass in a grove of cotton-wood just above the ford, and the lateness of the hour, determined us to encamp for the benefit of our animals; but a recent overflow had left a fine deposit of sand on the grass, which made it unpalatable to them.

Indians thronged our camp for several hours. They are the merriest of their race I have ever seen, except the Yumas—constantly laughing and talking, and appearing grateful for the trifling presents they receive. A wrinkled, hard-faced old savage, with whom I shared my luncheon of bread and bacon, quite laughed aloud with joy at his good fortune. They confirmed the report we had before heard of a war between the Mormons and Wah-ka-ra's (Walker's) band of Utahs, and his absence in New Mexico to dispose of a herd of cattle which he had stolen from them.

The Roan mountain, along which we have travelled for more than a week, extends quite to Green river, and forms one side of the cañon through which it descends a few miles to the north of our present camp. Three miles to the north, if our recent guide is not mistaken, White river cuts the opposite side of this cañon, passing, itself in a cañon, through the southern point of Little mountain, which lies chiefly between White and Green rivers, and forms the western side of the cañon of the latter stream. But in reality Little mountain, which is united to the Wahsatch range on the west, is merely a continuation of the Roan, whose character and appearance at a distance I have described at Blue river. Here, however, we are but a mile or two from its base, and its stratified rocks, nearly horizontal, are distinctly visible, extending on each side of the river on the same level. The mountain itself, as we see it here, is but a few hundred feet high, generally level on its summit; yet there are a few peaks and ridges rising above this common level, but their character is the same as the lower mountain, which has the appearance on the side towards us of recently-broken earth, as though the valley had just been sunken or the mountain thrust up, leaving its sides almost vertical—indeed, quite so with the higher strata, the talus having only accumulated at the base. This mountain wall, however, is very irregular; deep ravines and gorges extend back into it, giving it, with its regular strata presented to us, where no sign of vegetation exists, the appearance of an unfinished fortification, on a scale which is pleasing to the imagination, and contrasts the works of men strongly with those of nature. These walls

may be in height from 300 to 500 feet; and its strata, in color, are red, blue, gray, and white. Desolate as is the country over which we have just passed, and around us, the view is still one of the most beautiful and pleasing I remember to have seen. As we approached the river yesterday, the ridges on either of its banks to the west appeared broken into a thousand forms—columns, shafts, temples, buildings, and ruined cities could be seen, or imagined, from the high points along our route. Fifty miles apparently below us on the river the high snow-peaks of the Sierra Abajo are visible.

Efforts were made to obtain a guide from among the Indians, but no one could be induced by a display of the trinkets, cloths, paints, and blankets they so much covet, to accompany us even to the Wahsatoh Pass.

October 2.—Our course this morning, for two hours, was a little south of east, gradually leaving the river. It then gently changed to north-west—our march being 16.76 miles, following the Spanish trail, generally over the same friable soil so often noted; but towards the latter part of the day along the borders of a creek in which we found a little standing water, over sandstone hills, the upper strata of which were red, and the lower resembling the yellow argillaceous sandstone of the Arkansas river near Bent's fort: a few slate ledges also crop out. We passed but very little grass, and but few cotton-wood trees were seen along the dry streams, sage covering the bottoms. At our camp to-night, on the hills, we have bunch-grass, and a fine cool spring of water, called Akanaquint by the Utahs. Average ascent per mile, thirty-five feet.

October 3.—Travelling sometimes in the bed of the creek, (dry above the spring,) and at others over the rocky, friable soil of the hills, we made but slow progress this morning—about four miles in as many hours—on the Spanish trail. Its course then bore off more strongly to the west, over very rocky, broken hills—and we left it, taking a north-west and a north-northwest course by compass, leaving these rocky hills to the left, and skirting along others to the right, as rocky but perhaps less broken and cut up transversely with cañones. Following for some miles the bed of a dry creek which lies at the base of one of these innumerable bluffs, we eventually came upon the divide between the waters of White and Green rivers, and then, for four miles, descended the bed of another dry creek, running, as before, at the base of immense bluffs of sandstone, and very winding in its course, so that we travelled west, north and east, alternately, and once or twice a little south—encamping, just as the sun went down, after a march of 15.77 miles, on a little bunch-grass, where a small supply of saltish water leaks from the strata into the bed of the stream. These bluff ridges were apparently formed by the upheaval of the strata of sandstone, giving a long gradual ascent on one side, while they are broken off on the other nearly perpendicularly; and they succeed each other like rows of bricks laid in a receding manner, with the front ends tilted up and the opposite covered with earth. In a few instances the strata of red, yellow, gray, and white sandstone were observed bent; but they were generally in right lines, with a dip to the east-northeast. We passed occasional masses of conglomerate, and on the hills scattering

cedars and some fine fields of bunch-grass. The day was oppressively hot as we moved along the bluffs, the sun's rays being reflected with great force until he ceased to shine above the horizon. Ascent per mile, for 4.6 miles, 119 feet, and for 1.14 mile to where we left the Spanish trail, 165.7 feet per mile; but this last distance can be greatly increased. From this point, for 6.08 miles, the grade is upon the summit-level between Green and White rivers, succeeded by a descent for 3.96 miles, of 111.3 feet per mile.

October 4.—We followed the dry bed of the creek in which we had encamped for five miles, turning northwest as we approached White river, which we crossed nine miles from camp. This is a small stream, of cool muddy water, eight inches in depth by twenty-five feet in width, with a moderate current. Coarse dry cane-grass covered the bottom, where we came to the river among a grove of cotton-wood and willows; and dense fields of sage formed the border between these and the nearly barren hills. We encamped a mile above the crossing, on the thin bunch-grass of the hills. Average descent per mile, 16.4 feet.

October 5.—Our course for five miles lay along the base of the mountain, with inclined benches intervening some four miles in width, cut transversely by dry mountain streams. White river winds very much among high hills, frequently impinging against their bases, and at various points passing through narrow cañones, rendering it quite impracticable to follow near it. Turning more westerly, we descended a dry creek for two miles and came upon Clover creek, a small branch of White river from the northwest winding between high hills and bluffs, and encamped after a march of 8.72 miles—being timid about leaving the grass, which was here more than usually abundant. The soil today was less friable than heretofore; and the artemisia, except for a half mile just below camp, did not interfere with our progress. The night was cool and the morning chilly, making fires desirable; but before noon the sun was very hot. Average ascent, 41.85 feet to the mile.

October 6.—Our northwest course was continued for four miles and a half, when we left the branch on which we had encamped, turning to the left up a narrow valley, which we followed for some three miles, and then took an Indian trail leading W. S. W., crossing a low ridge to another creek, which the trail descended for a couple of miles, and then ascended a hill towards White river, until we overlooked that stream just at our feet. But the descent was so steep that we were forced to turn from our southwest course directly north; and were then occupied two hours in descending the half mile of bluff to the river bank, crossing the stream and encamping on the opposite hill, having travelled by an unnecessarily serpentine path 11.11 miles. The bunch-grass was thin on the hills and ravines, and the river-bottom only afforded willow-bushes and dry cane-grass. Buffalo-berries grow in great abundance at our camp, and are esteemed very edible by the party, and are a fine relish when stewed. Latitude by noon observation, $39^{\circ} 27' 00''$.4. Average ascent, 23 feet per mile.

The Little mountain, sometimes from the regular appearance and variegated color of its strata, like the Roan, called the Book mountain, lay during to-day's march plainly in view from Green river north and

west, to where it apparently joins the first range of the Wahsatch—a low mountain, resembling the former in all respects, which extends around to the west and southwest, White river coming from a low depression in it nearly north of our present camp. Latitude $39^{\circ} 26' 48''$.

October 7.—The thermometer at sunrise indicated 31° , and at noon in the shade 82° Fahrenheit. Passing from the bluff on which we encamped last night over rolling barren hills, we entered a small valley coming from the southwest, in which we again came upon the trail we were forced by the hills to leave yesterday, and followed it during the day in a very direct course, passing small pools of water occasionally, and fields of bunch and grama grasses. Our camp, after a march of 13.26 miles without reaching the summit of the hills drained by White river, is at one of these pools in the bed of a creek, and the valley and hills promise favorably for our animals to-night. Ascent, 38 feet per mile.

October 8.—Two miles from camp we passed the divide between the waters of the White and San Rafael rivers; and in eleven miles reached and crossed the latter stream, which at present, without the appearance of being swollen, is twice the size of the former, its waters deriving a milky appearance from the clay of its banks. There is not a tree at the point where we crossed this stream; a narrow bottom is covered with dry grass and willow bushes, intermixed with the buffalo-berry bush thickly covered with fruit. Two miles and a half from the San Rafael we came upon a branch of that river of half its size, with dry grass covering bottom-lands a half mile in width, with the usual bushes and a few cotton-wood trees on the margin of the creek. Captain Gunnison, who was in advance as we approached camp, observed an Indian ascending the opposite side of the valley, and, discharging his pistol, made signs for him to approach, which he did after some hesitation, galloping at a rapid rate with his rifle held ready for action, fearing we were Mormons, with whom he informed us his people were at war, and boasted of their feats of prowess. At this camp the cochineal insect was observed on the prickly pear. Day's march, 13.17 miles. At sunrise the following morning the thermometer stood at 26° , and ice formed in basins of water a quarter of an inch thick; but before noon the thermometer was again above summer heat. Average descent, 22 feet to the mile.

October 10.—Two miles from camp, in a nearly southern course, we came again upon the Spanish trail, which we left a week ago to avoid the rocky hills which lay in front of us, passing to the right by a route which, from a want of knowledge of what route exactly to pursue to secure the best road and a supply of grass and water, may have been extended too far. We struck lower down on White river than it would be necessary to do if the march from Akanaquint spring to that river could be made in one day, or if water could be found at some intermediate point. The distance from the spring to the river, at a point near the northwest end of the Rock hills, could probably not exceed twenty-five miles. The Spanish trail itself, however, if it can be followed with wagons, is much shorter than the route here indicated; and I see no reason to apprehend any insurmountable obstacle from the appearance of the country, much of which was in view as we passed around

it. But the distance from the Akanaquint spring to the San Rafael by this trail may reach thirty miles; and although there was water on it at a point ten miles from the spring when we passed it, I did not see it, and am not informed as to its permanence. But, as the country is very broken and generally arid, only actual exploration can determine its practicability, which, however, I cannot think more difficult than the route we have followed, and it would certainly not be one-half the distance. The San Rafael also deserves an examination; for if it is practicable to ascend it, a better route might possibly be found to Grand river, from the confluence of the former with Green river, than the one we followed. The soil became more gravelly and firm to-day, while the hills are less difficult of ascent on their bluff sides; but they are equally barren—a few small cedars on the summit of the Wahsatch range, dry grass, willow and berry bushes, with a few cottonwood trees along the streams, and a few small bunches of sage, being the only vegetation seen on a march of 11.40 miles. The third branch of the San Rafael, called Garambulla by the Indians, of the size of the second, we reached six miles from the morning camp and crossed at our present one. The few Utah Indians who live here seem to subsist almost entirely on the buffalo-berry, the bushes growing on the banks of the creeks in abundance. These berries, which are of the size of currants, grow in great profusion upon the smallest bushes, and are rattled off into skins spread under the bushes. The juice, which is very considerable, is expressed by the hands, and the residue eaten. These Indians are, however, many of them mounted, and we succeeded in purchasing horses from them. Ascent, 25.61 feet per mile.

October 11.—The Spanish trail, though but seldom used of late years, is still very distinct where the soil washes but slightly. On some such spaces to-day we counted from fourteen to twenty parallel trails, of the ordinary size of Indian trails or horse-paths, on a way of barely fifty feet in width. Specimens of coal were brought in from the hills near camp, but were inferior in quality. A small variety of artemisia—and we have often seen it on the route—grows here in small quantities, of which our mules are quite as fond as of grass. We encamped on Big Rock creek, after a march of 13.46 miles. It is a small creek, destitute of timber. Ascent, 17 feet per mile.

October 12.—Thermometer at sunrise 21°, and 72° Fahrenheit only during the day. The broken valley between the Rock hills, which occupy nearly the whole space between the Wahsatch mountains and Green river, is two miles in width at our last camp, six miles from which we descended a steep bluff, and crossed a small creek as it enters a cañon in the Rock hills. Four miles from this cañon, we reached the foot of a small valley, on the eastern border of which a creek descends from the south from a spur of the Wahsatch range, which sets off to the southeast from the Wahsatch Pass. A series of sandstone spurs, rising one above another, sets down from this range to the south, joining the Rock hills to the east, whilst numerous small lateral valleys branch off to the west towards the gorges, among sandstone peaks and tables overlying clay, which form the eastern range of the Wahsatch mountains. These bluish clay cliffs, from two hundred

to three hundred feet high, are capped with red and argillaceous sandstone a hundred feet thick, and thence sweep gently up to the summits of the mountains. The soil of the valleys varies from ashy friability, whitened more or less with effloresced salt, to hard clay sprinkled with pebbles. We encamped, having marched 15.65 miles, at Oak Spring, which furnished us with an abundance of cool water; and a few acres of dry grass was found on a small stream near by, to which Captain Gunnison gave the name of the commander of his escort, Morris.

Tewip Narrienta, or Powerful Earth, one of our Utah acquaintances of four days' standing, came up with us to-day, having overcome his fear of the Mormons so far as to determine him to accompany us three or four days as a guide. Many of our mules came into camp quite broken down, and, although appearing in good condition, are so weak and leg-weary from months' of incessant labor, that it is with great difficulty they can haul our light wagons even a few miles a day. Average ascent, 53 feet to the mile.

CHAPTER VI.

Eastern foot of Wahsatch Pass to most western point of explorations, near Sevier lake, and back to Cedar Springs, after the death of Capt. Gunnison.—October 13th to October 28th, 1853.

October 13.—Passing a low break in a ridge of hills to the south of our camp, after a ride of a mile, we reached the Akanaquint, a small mountain brook of two feet in width, running over a stony bed, well skirted with bushes but without grass. We turned up this creek nearly due west, following its narrow gorge, averaging in width from 100 to 200 yards, walled in on either side by high hills of nearly perpendicular sandstones, often water-worn into holes, from which, our Indian guide informed us, the stream received its name. He also told us that a circle in red, high up on a sheltered rock on the face of one of the hills, where some rude human figures are seen, also sketched in red lines, was called Akanaquint. These rude figures, in the place in which they are seen, were a great wonder to him, and he had often attempted to describe them to us the previous day, telling us that they had been made by an American captain—all chief men of parties are captains with these Indians—who had passed here on his way to California, which the Indians know by the name of Monterey; and, in pointing them out to us, he seemed to think he was showing a remarkable sight. This gorge is cut into deep gullies by streams which pour down from the mountains during storms, which gave us some labor to cross; and a small stream coming in from the south also detained us a short time. But, after following it for two miles and a half, the Spanish trail branches; the southern branch, following the stream, passes over a higher elevation and soon rejoins the northern branch, which, though longer, crosses the mountain at a lower depression. We followed this branch, the

hills becoming less high above us, more open and smooth, and covered with dry grass and bushes, and, by a quite gentle and uniform ascent over a fine road, reached the summit of the Wabsatch Pass, the eastern rim of the Great Basin, three miles from the Akanaquint creek. The hills in the immediate vicinity of the summit scarcely rise above the pass, while the country, both to the north and south, as far as the eye can reach, is exceedingly rough. A large range, through which no pass is known to exist, bears off from this pass southeast towards the Sierra Abajo. To the west, but little can be seen over the intervening peaks, except the summits of the mountains, 30 miles distant, on the western border of the valley of the Sevier river.

For two hundred yards the descent of the opposite slope is steep, but was passed with the same ease as the ascent; and we thence followed a small ravine of dry grass, varying in width from one hundred to three hundred yards, from the summit to our camp. Salt creek issues from springs in this ravine half a mile from the summit of the pass, and flows into the Sevier (Nicollet) river. It derives its name from the crystallized salt found in the red-clay bluffs of the mountain, its waters being cool and fresh. A few grouse started up as we rode forward, and a large number of sand-hill cranes circled high above the mountains, uttering their peculiar note—pleasant sights to travellers over barren wastes, enlivened by animate nature only here and there, by a pigmy rabbit or a hungry raven. The hills, ravines, and peaks differ materially to the west of the summit from those to the east. Here although vegetation is entirely withered by frost, it covers the whole face of the country and gives it a pleasant, cheerful aspect; whilst there it is dreary and desolate indeed, relieved only at intervals by scattered sage, the grass of the river bottoms, and more rarely of the hill-tops. A keen northwest wind whistled about us during the day, sharpened by a few drops of rain, icy cold; but our camp-fires tonight burn brightly and pleasantly, the wind having subsided, while our animals have, for the first time for days, entirely ceased their disagreeable cry to feast on the abundant grass.

The narrow sandstone ridge, passed just above our morning camp, can easily be cut for the passage of a railroad. Its summit is 129 feet above that camp, which is distant, in a direct line, sixty hundredths of a mile, which, however, can be considerably increased by taking advantage of the natural formation of the approach. On Akanaquint creek, one mile and eight hundredths above this point, we had ascended but 44 feet. In the next mile and sixty-six hundredths, the ascent is 232 feet, or 140 feet to the mile; and 253 feet in the following one and thirty-four hundredths miles, or 189 feet per mile, while it is 186 feet per mile for the next mile and seventy-four hundredths. From this point to the summit of the pass, it is twenty-two hundredths of a mile; the ascent being 49 feet, or 223 feet per mile. The altitude of this pass is 7,820 feet above the sea.

From the summit, the descent westward is 218 feet per mile for the first mile and nine-tenths; and 137 feet per mile for the next mile and seven-tenths; and 202 feet per mile for the following ninety-seven hundredths of a mile to our camp.

The defile character of this pass is such, that it must be approached

by the line we followed without material extension, by which, however, a heavy uniform grade of 125 feet per mile can be carried, after reaching the Akanquint creek, to within one-third of a mile of the summit, where a short tunnel, with deep approaches, will be required—the whole not exceeding three-fourths of a mile in length—diminishing the elevation to be overcome by from 175 to 200 feet, and giving a grade of 131 feet per mile for 3.6 miles west of the summit, and thence to the vicinity of our camp, or even less than this, by keeping on the side of the ravine above Salt creek. Latitude, by noon observations, a few hundred yards east of the summit, $38^{\circ} 45' 36''.5$.

Salt creek, our Indian guide says, (as well as we can understand him, and the appearance of the mountain confirms his statement,) enters a large cañon two miles below our camp, in a very direct course to the Sevier river. Through this cañon, he says, there is a horse-trail, but that it is impossible for wagons to pass through it without removing the rocks. The stream, to where it enters this gorge, continues its easy descent.

October 14.—Leaving the little valley of Salt creek, while a dense cloud enveloped the mountain, which, however, was soon dissipated by the sun, we passed over a small hill to the left; and almost immediately struck a fine little stream, which we ascended for half a mile, and then crossing another divide to the southwest, reached the Swam-bah, an ice-cold creek, two or three feet wide, falling over a rocky bed. This stream rises to the south in one of the highest ranges in the vicinity, on which are large banks of snow; and flows in a narrow ravine, in a nearly direct line for ten or fifteen miles, as seen from the summit of a high peak ascended during the day. It is densely lined, throughout its entire length, with willow-bushes, interspersed with aspens and a few spruce and pines. The Spanish trail, leading for a short distance up this creek, the guide represented to be much more practicable than any other for wagons; and we therefore followed it for two miles and three-quarters, to where the trail leaves it. The labor on this short space was very considerable, occupying a large party the whole day in cutting willows and digging down the banks to allow us repeatedly to cross and recross the creek, and to pass along the narrow ravine; two wagons being overturned after the road was deemed practicable. Our progress was five miles during the day, encamping at sundown at the mouth of a beautiful ravine of abundant grass, with fine groves of aspen on the hill-sides for our camp-fires; and the loveliness of our camp, in this mountain vale, is increased by a clear sky and bright moon. Barometers give us an elevation of 679 feet above our morning camp.

October 15.—Rising rapidly for half a mile, the little ravine in which we had encamped terminated, and we ascended its eastern slope by a steep path through a small aspen grove; and then following the ridge, rising still more rapidly for the next half mile, we passed over its summit which divides the waters of the two little creeks of our last and present camps, the Swam-bah and Un-got-tah-bi-kin—an elevation considerably higher than that of the Wahsatch gap. We then descended into the valley of the last-named creek, which we followed during the remainder of the day, encamping just before sundown

at the junction of this with another small creek from the southeast. Here the valley opens to the width of half a mile, and the surrounding hills are much lower than those over which we have been passing. The hills and valleys in every direction sustain the character of those of the last two days, in beauty and in the luxuriance of the grass, and absence of large trees. The labor of preparing the road, though considerable in removing scrubby oaks, pines, cedars and rocks, was much less than that of the preceding day; but we only made eight and a fourth miles from early morning to late evening, having passed a high mountain and descended 1,100 feet below the level of our morning camp.

Colonel Burwell and Mr. Ross, from the party emigrating to California and driving stock for that market, who have continued to follow our route during the summer, from a week to ten days behind us, came into our camp just after dark, with their horses quite broken down from hard riding, having left their party at Green river and taken six days to make the distance which has occupied us for two weeks. Having exhausted their supply of provisions, they have come to us for relief, and will return to-morrow to meet their friends with the small amount we are able to furnish them. I have already noticed their loss of fine horses by a stampede, as we were starting out. A similar misfortune overtook them above Fort Atkinson, on the Arkansas river, attended with the loss of several of their riding animals. Some of their sheep fell sore-footed while on that part of the route, also, and were unable to travel; and recently, near Green river, they were forty hours without water, and a few of their cattle, coming to water in a miry pool, crowded over each other with such violence that some of them were never recovered from the mire. The Indians on the Uncompahgra had threatened to fight them if they persisted in crossing their country, but, finding they could not intimidate them, did not attempt to execute the threat. On Green river the Indians assisted in crossing the sheep, but had slyly pierced three or four with arrows as they were feeding among the bushes, although they had been presented with half a dozen. They represent their cattle and sheep to be in superior condition, and in passing through the lower settlements in this Territory they were so represented—a fact which bears directly upon the grass on this route.

Timber upon the mountains, near our camp, alone is wanting to make the evening scenery in the clear full moon as delightful as mountain travellers can desire.

October 17.—Our Utah guide, Tewip Narrienta, left us this morning to return to his squaw and papoose, for whom he expressed much fear lest in his absence they might suffer for want of food; but, as they were subsisting when he left them on the still abundant en-carpe, or buffalo-berries gathered by the squaw, there was no doubt that his anxiety was attributable to our proximity to the Mormon settlements. He repeatedly warned us against these people. His services for the few days that he was with us were valuable; for he was one of the best guides I have ever seen, and was as good a judge of natural wagon-roads as any one, and was of course familiar with his own hunting-grounds.

Crossing the creek near our camp in the morning, we ascended a

low depression in a high ridge to the northwest, and descended by a good road for two or three miles, to a narrow ravine. Near the head of this ravine, the Spanish trail turns to the west up another small ravine, and passes over two series of hills, divided by large depressions and creeks, and then crosses the Sevier river, as we are informed, below the junction of its main forks; thence it ascends the San Pasqual, and passes over the west range of the Wahsatch mountains to the vicinity of Little Salt lake "on a route," Captain Gunnison says, "entirely unsuitable for a railroad." We continued to follow the Indian trail down the first ravine, which was very narrow and rocky with a deep channel winding from side to side, which had constantly to be cut to allow the wagons to pass, and for which rocks, small cedars, and pines had also to be removed.

White, red, and blue clays, and coarse sandstone, formed the sides of the ravine; and it was apparent that, in passing from the district of igneous rocks, we were descending from the fine grazing regions of the mountains to the arid districts of the plains. Eight and a half miles from camp we again crossed Salt creek, which has united with the other small branches we have passed on this slope of the mountain, and is here a fine stream, twenty feet in width, with a strong current. "I have reconnoitred," says Captain Gunnison, "much of this mountain and hilly region while the party has been engaged in its passage. From a high ridge which I ascended on the 14th instant, the valleys of the San Pasqual and Sevier rivers were plainly marked out, and to the northwest a broad opening in the mountains, the passage of the Sevier river, presented itself. On all sides were mountains, peaks, and ridges, abrupt bluffs and white cliffs capping the summits; and the deep cañon, which has driven us over a mountain much higher than the summit of the pass itself, lay three miles to the north. Through this a railroad track might be made, but, owing to the cutting of rock, at a very great expense."

The cañon which we thus passed around, by a circuit of twenty miles, cannot exceed sixteen miles in length; but its walls must be often broken by the entrance of lateral streams, and are not generally perpendicular. The altitude of our camp of the 13th instant, two miles above the head of this cañon, is 6,975 feet, to which seventy-five feet should be added to connect at that point with the estimated grade for a road, which will require an average descent of ninety-five feet per mile for the eighteen miles intervening between that camp and our present position, 1,706 feet below it. A pleasant sight to us, in crossing this creek, was a few wagon-tracks, after months of toiling without a road, and frequently without trails even, in an unexplored and wild country. These wagons had been here, as we subsequently learned, to procure salt, which is shoveled from the red clay hills, where it is found in the mountains, and is itself red. Following the creek for 2.65 miles, with a descent of ninety-one feet per mile, we entered the broad valley of the Sevier river, leaving the high mountains we have crossed to the west, a beautiful high peak of which, capped with white sandstone or clay, the Indians call Moot-se-ne-ah. To the south, perhaps fifty miles, the valley is terminated by a high cross range, from each end of which a main branch of the Sevier river descends—the eastern

being known as the Se-ki-ber, the Indian name of the mountain; on the west a range of the Wahsatch mountains, Un kuk-oo-ap, extends to the north, until broken by the passage of the river, beyond which, in a low range, it still extends to the north; to the east of this range, and north of our present camp, a fine valley sets off from that of the river, and is watered by several fine mountain streams, tributaries of the Sevier, on which there are considerable Mormon settlements. The width of the Sevier river valley is from four to seven miles, and its length from fifty to sixty, without a tree, and with but little vegetation of any kind, even the sage-bushes being thin and scattered. As we entered it, we bore down the river to the north in search of grass; which is very limited, even in the river bottom, and is confined almost exclusively to its western bank. We encamped, however, on its eastern bank, on a small field of dry scattered grass, after a march of 14.27 miles, descending twenty-seven feet per mile for the last 3.13 miles from the foot of the mountain to the river. The altitude of this camp is 5,019 feet.

The river winds from side to side of an immense ditch, with banks cut perpendicularly in the clay soil from six to ten feet above the surface of the water. This channel, which may be a hundred yards wide, encloses also the bottom lands and all the grass of this immense valley. The stream is thirty-five yards wide by one deep, with a moderate current; and it winds so constantly in this narrow passage that it is very difficult, standing on its banks, to follow its course with the eye. The bottom lands are but a few inches above the surface of the water, and are annually overflowed. In entering this valley, Captain Gunnison, with two or three men, rode forward in advance of his party, "and enjoyed the scene extremely. On reaching this plain a stage is attained," he says, "which I have so long desired to accomplish: the great mountains have been passed and a new wagon-road open across the continent—a work which was almost unanimously pronounced impossible by the men who know the mountains and this route over them.

"The result is, a new mail and military road to Taos, in New Mexico, by way of Fort Massachusetts; which, with a little work on Gunnison's creek and a hill near Taos, will be very direct and easy, with excellent feed and water all the way.

"2d. A road for the southern States to California, and for emigrants who are late in starting from the States.

"3d. A military road to, and command of, the Utah country, passing into the centre of the territory of that people at Grand river, from whence radiate trails to all points of the compass.

"4th. It is demonstrated that, for a railroad route, it is far inferior to the Middle Central, by Medicine Bow river, and Laramie plains. It passes some thousand feet higher, and also lower, and is much longer from Saint Louis.

"To the energy, zeal, and ability of Lieutenant Beckwith and Brevet Captain Morris, in superintending the working parties and conducting the train, the expedition is greatly indebted. That a road for nearly seven hundred miles should be made over an untrodden track, (except in some places by pack-mules and footmen,) through a wilderness all the way, and across five mountain ranges, (the Sierra Blanca, San

Juan, Uncompahgra, Sandstone, and Wahsatch,) and a dry desert of seventy miles between Grand and Green rivers, without deserting one of our nineteen wagons, and leaving but one animal from sickness and one from straying, and this in two and a half months, must be my excuse for speaking highly of all the assistants on this survey."

October 18.—Through the negligence of the men in charge of the mules, they were allowed to wander entirely away from camp, and some of them were found thirteen miles back on the road near our previous camp. It was half-past 12 o'clock, therefore, before we started on our course down the Sevier river, following the wagon-track for eight miles, in the course of which we crossed a small creek coming in from towards the Moot-se-ne-ah peak, which stands out high and clear against the eastern sky. The wagon-track here leading to the northeast, we left it, following the course of the river, and encamped a short distance from it in a fine field of grass on San Pete creek, which flows from the valley containing the settlements to which I have before alluded. Captain Gunnison, who had been out during the day in search of a settlement, returned to camp without having succeeded in his object. Our progress was 11.82 miles; the thermometer at sunrise standing at 28°, and in the shade at noon at 81° Fahrenheit.

October 19.—After proceeding a mile and a half, we came upon another wagon-trail more beaten than the previous one, leading from the San Pete valley directly down the river. Six miles from camp we crossed a small stream with miry banks, the bed of which was lined with a plant emitting a strong pole-cat odor. Four miles from this creek the valley of the Sevier river is terminated by the close proximity of the hills on either side, leaving but little bottom land, and no natural road-way except on the hills, where one can easily be carried. Passing along the hills near the river, among sage and scattered cedar-bushes, we again come to its banks nineteen miles from our last camp, where we have abundant grass on the right bank of the stream, but it has a strong taste of salt.

October 20.—Two miles and a half from camp we came upon the road leading from the Great Salt lake to California, by the way of Fillmore and Parawan, (Mormon settlements,) the Vegas de Santa Clara, and Walker's Pass, and encamped perhaps a mile above Fremont's point of crossing in 1844. This was a very pleasant autumnal day, for we had not to record a change of temperature from sunrise to mid-day of from forty to sixty degrees, to which we have become so accustomed in these valleys.

Captain Gunnison left us at our camp of yesterday morning, and proceeded up the valley of San Pete, or the northeastern extension of the valley of the Sevier river, to the settlement at Manti city, eighteen miles from that camp. He found the settlers, a hundred families, all gathered into a village for mutual protection against the Utah Indians, who have killed several of the citizens, destroyed their mills, and driven off some of their stock; but this has been accomplished by no means with impunity. A strong guard was posted at this settlement at night. Having procured some necessary supplies and guides (two brothers, G. G. and Wm. Potter) to accompany him to the Sevier lake, Captain Gunnison rejoined us this evening at a late hour.

October 21.—The thermometer at sunrise stood at 14° . The country from our camp to the cañon of the river being broken, and the guides never having passed through it, we crossed the river and followed the California road, passing a low range of hills within a short distance into a small valley in the Un-kuk-oo-ap mountains—the Indian name of the mountains lying in the bend of the Sevier river. This valley, from a small pond which stands several miles to the south of the road, is called Lake valley. To the south of this pond there is said to be an easy pass descending by a creek to the Sevier river. This, if practicable, would lessen the distance considerably from the point where we first came upon the river westward to this point. Sage grows luxuriantly in this mountain valley, which we followed for ten miles, and passed easily over the mountain lying west of it to the valley of the Sevier lake. This range is finely covered with grass quite down to the sage plains, and is dotted with a growth of small cedar and oak, and is a fine pastoral district. The Sevier valley below the cañon opens broad to the west and south. We encamped, after a march of 24.18 miles, at Cedar springs, 10.21 miles from the settlement of Fillmore, which is situated on Chalk creek, at the base of the mountains, on a scarcely perceptible slope that descends into the Sevier valley. On the following morning Captain Gunnison visited Fillmore, and returned to camp in the evening.

October 23.—Yesterday morning, at sunrise, the thermometer stood at 14° ; this morning it stood at 15° , and the cold northwest wind which prevailed during the day gave us a foretaste of winter. Between eleven and twelve o'clock we moved in a northwest direction across the valley towards the Sevier river, our guides thinking it possible that we might find water after travelling seven or eight miles; there being at that point, in the spring, a small mountain stream. We, however, found no water and continued on towards the river until eight o'clock, when, the night being dark and very cold, we halted and tied up our animals without water or grass; but their hardship was relieved by a small allowance of corn to each, which Captain Morris had fortunately procured for his animals at Fillmore.

October 24.—As early as we could see, the thermometer standing at 12° , we moved forward, and at ten o'clock reached the Sevier river at a point well supplied with dry grass; which our animals required after a march of 25.43 miles, on which we were engaged for twenty-two hours, over large rank sage-bushes and a friable soil, occasionally sandy. Indeed, this whole valley, some fifty or sixty miles in diameter, is one vast artemisia plain surrounded by grassy mountains. Geese and ducks were numerous on the river, and a large herd of antelope were seen yesterday—the first for many weeks. Latitude, $39^{\circ} 20' 57''$; altitude, 4,692 feet above the sea.

October 25.—Captain Gunnison, with Mr. R. H. Kern, Mr. F. Creutzfeldt, and Mr. Wm. Potter, (guide,) with John Bellows, and a corporal and six men from the escort, left camp at a late hour this morning to explore the vicinity of Sevier lake, supposed to be distant some fifteen or eighteen miles. From Captain Gunnison's journal I extract the description of the country and operations of the party during the day; written after they had encamped for the night: "I came down the

river southwest for nine miles, and then, bearing more west for two miles, concluded to encamp, as the water below might prove too salt. The route was through heavy artemisia for five miles, when we came upon more open plains to the nine-mile point, where we met with sloughs alive with geese, ducks, brant, pelicans, and gulls. A few hawks were careering in the high wind, and the black-eared and black-tailed rabbits were very frequent in the large artemisia.

"The mountains wore all day their white night-mantle of snow, and we had squalls from the north, with snow falling on the high mountains on all sides of us. Towards sunset it brightened up a little; and our hunters brought in four ducks of as many different varieties." The remainder of the surveying party left under my charge, with the escort under Captain Morris, crossed the river at an excellent ford at the point of our encampment, immediately after the departure of Captain Gunnison, and, agreeably to his request, proceeded up the river in a northeast direction, encamping at a late hour on the river bottom where it is unusually wide. The river at this point makes a long bend in the plain to the south, passing through drifting sand-hills partially covered with artemisia. We had passed southward to avoid these hills in crossing from Cedar spring to the river, and to-day we passed to the west of the largest of them, yet our route was very heavy and the labor severe on our animals. The day, too, was cold and blustering, with occasional slight squalls of snow in the plains, while in the mountains it fell during the greater part of the day. Those of us who were mounted halted frequently, the wagons coming on very slowly; and built fires of sage, which, being resinous, burnt very freely, with a large flame for the moment, giving out abundant heat. With the setting sun the wind went down, and the night was clear and cold; and at a late hour the pure mountain snows reflected beautifully the clear light of the waning moon, while all around was quietness and repose. The gap by which the Sevier river passes the Un-kuk-oo-ap mountains, is called a cañon; but at this distance, six miles directly in front of us to the northeast, it appears like anything but a cañon passage, although the river may wind from side to side, striking against the foot of the mountains, preventing an easy passage for wagons in its natural state. A large Indian trail, however, passes directly up the river into it. This range of mountains, as seen from our present and last camps, seems to terminate a few miles to the north, leaving a broad open passage of several miles between it and the succeeding range to the west, in which the waters of the Sevier and Great Salt lakes are divided only by gentle slopes. Distance, 14.27 miles.

October 26.—The morning was clear and cold, and Mount Nebo, seen through the Sevier river gap, with its pure mantle of snow, half enveloped in floating misty clouds, mildly reflecting the rays of the rising sun, presented one of the most beautiful mountain scenes I have ever witnessed. Our animals were kept out to graze until a late hour. At 11 o'clock, however, a party was despatched to ascertain the practicability of the passage around the mountain and thence north to the Great Salt lake; and, without moving camp again until the return of Captain Gunnison, it was intended to examine the passage of the Sevier river the following day. But the first party had scarcely pro-

ceeded a hundred yards from camp, when it was met by a man, weak and exhausted, reeling breathless into camp, barely able to communicate, by a few broken sentences, as he sank into a seat, the painful intelligence that Captain Gunnison's party had been surprised in their camp by a large party of Indians, and, he thought, all but himself massacred. Orders were instantly given by Captain Morris, and promptly obeyed by all the men remaining with him of his escort, to replenish their ammunition; and having brought up and saddled their horses, in thirty minutes they were moving rapidly towards the scene of that fatal disaster, hoping to rescue all who might yet survive and perform the last mournful duties of humanity to those who were known to have fallen.

The man who first reached camp was the corporal of the escort, who had made his escape on his horse, and had ridden him until he could go no further, leaving him at our camp of the previous day, whence he ran on foot fourteen miles—twenty-five in all—arriving, without arms, in the condition I have described, an expression of wild excitement flashing from his eyes. Another of the escort reached camp on horseback, before Captain Morris's departure; and two others were met by him in the course of the afternoon, making their way towards camp. The horses of Dr. Schiel, who had accompanied Captain Morris, and of several of his men, gave out during their rapid march, and their riders were left straggling behind; but eventually all arrived safely in camp—some of them from their own folly in a poor plight.

Before Captain Morris's departure the train animals were driven in, with the intention at first of removing the train to a more secure place, with the two young gentlemen, Homans and Snyder, and the teamster force, some of whom were unarmed, to guard it. But it was subsequently determined to break up the camp altogether, and move towards a common point, where it was hoped Captain Morris and myself could meet on the following or succeeding day, and take such measures for future operations as circumstances might require, with better means within our reach.

Crossing the river at the camp, we took the shortest line to escape from the heavy sand, which proved far heavier than that of the previous day, and 7.44 miles in a southeast course, beyond a border of small cedars a mile wide, among which the sand was so drifted that it was only by innumerable windings and contortions of teams and wagons that we at last escaped from it, and reached the plain of grass a mile or two wide, which here lies on the gradual slope of the mountain. Here we encamped. In crossing the sand-hills numerous fresh Indian tracks were seen, notwithstanding the prevalence of a high wind; but the night passed quietly, and at sunrise we travelled along the base of the mountain, hoping to escape a continuation of the sand of the previous day, in which we were only partially successful, however, as it continued heavy for ten miles. We then passed a spur of the mountain and changed our course from south to southeast, and struck the trail we had made in going from Cedar spring to the Sevier river, six miles from the spring, at which we found a large camp of Mormons, on their way to settle at Parawan, near Little Salt lake. Here we encamped and turned our animals out to graze on the hills; the 20.93 miles of to-day.

being the severest day's labor performed by them, although the day was cool, during the whole course of our long summer journeying. The last of our animals were not out of harness when Captain Morris arrived, confirming our worst fears for the fate of our late comrade.

Captain Gunnison had encamped early in the afternoon, while the wind and storm were yet fresh, and doubtless feeling the security which men come to indulge after passing long periods of time surrounded by savages without actually encountering them. The abundant grass and fuel of a little nook in the river bottom, sheltered by the high second bank of the river on one side, and thick willows, distant scarcely thirty yards, on two of the others, with the river in front, offering a tempting place of comfort and utility, which was perhaps accepted without even a thought of danger. It was known to the party that a band of Indians was near them, for we had seen their fires daily since entering the valley; but an unusual feeling of security against them was felt, as Captain Gunnison had learned that a recent quarrel, resulting in several deaths, which they had had with the emigrants had terminated and that notwithstanding this difficulty they had remained at peace with the neighboring settlers, which had been confirmed and guaranteed for the future in a "talk" held with some of the Indians of this band, by an agent of the governor of the Territory, during our stay near Fillmore. This information, Captain Gunnison told me before leaving, relieved him of any apprehension he might otherwise have felt regarding this band, and which was the reason for having asked for so small an escort to accompany him, which his guide, an experienced citizen of the Territory, deemed sufficient.

The usual precaution of a camp guard had been taken, each of the party (including the commander) in turn having performed that duty during the night. At the break of day all arose and at once engaged in the usual duties of a camp preparatory to an early start, to reach that day the most distant point of exploration for the present season. The sun had not yet risen, most of the party being at breakfast, when the surrounding quietness and silence of this vast plain was broken by the discharge of a volley of rifles and a shower of arrows through that devoted camp, mingled with the savage yells of a large band of Pah-Utah Indians almost in the midst of the camp; for, under cover of the thick bushes, they had approached undiscovered to within twenty-five yards of the camp-fires. The surprise was complete. At the first discharge, the call to "seize your arms" had little effect. All was confusion. Captain Gunnison, stepping from his tent, called to his savage murderers that he was their friend; but this had no effect. They rushed into camp, and only those escaped who succeeded in mounting on horseback, and even then they were pursued for many miles. The horse of one fell near camp, tumbling his rider under a bush, where he lay for six or seven hours, while the Indians were passing him on every side, until finally he could no longer hear them near him or in the camp, when he left, and was met soon afterwards by Capt. Morris's party which reached the fatal spot just before night. Two Indians were seen near camp by Lieutenant Baker and Mr. Potter, brother of the guide, but they were not able to come up with them before darkness enabled them to

escape. The bodies of the slain were not all found at dark, and hope still lingered as a bright fire was built to assure any survivor of safety. But the long weary night, rendered hideous by the howling of wolves, wore away, as this little band of armed men, barely larger than that which had already been sacrificed, lay near the fatal spot, and day dawned only to discover the mutilated remains of their recent comrades, none of them being scalped—a barbarity which some of the tribes on this part of the continent seldom indulge. Some of their arms were, however, cut off at the elbow, and their entrails cut open; and, the wolves having had access to them during the day and to those exposed during the night, their bodies were in such a condition that it was not deemed possible to bring them away—not even that of Captain Gunnison, who had fallen pierced with fifteen arrows.

CHAPTER VII.

Cedar Springs to Great Salt Lake city.—October 23 to November 8, 1853.

October 28.—We moved our camp to Pioneer creek, three miles southeast of Cedar spring, to obtain better grazing for our stock. Messrs. Snow and Richards, from Great Salt Lake city, travelling on a mission to the lower settlements in the Territory, called at our camp.

October 29.—A party of the citizens of Fillmore, headed by their president, Mr. Anson Call, and accompanied by Mr. Richards from Great Salt Lake city, came to our camp to request Captain Morris to furnish the particulars of the disaster of the 26th instant, to be forwarded by express to the governor of the Territory of Utah, which express could also take despatches for the War Department to Great Salt Lake city, in time for the mail of the 1st of November—which would be the last that could be depended upon to reach the States before the next spring—provided these despatches could be furnished within two or three hours. Hasty notes were accordingly written, without time to take copies for future reference, and reached Great Salt Lake city just in time for the mail.

President Call and Mr. Richards, taking an interest in the survey, tendered us all the aid within their power, and the former voluntarily took upon himself the task of recovering from the Indians the papers and instruments they had captured; for which I furnished presents to reward the exertions of the friendly Indians who were to be employed.

These efforts of Mr. Call proved very successful, and we had the pleasure, a few days subsequent to our arrival at Great Salt Lake city, of receiving at the hands of the agents of the governor of the Territory, Brigham Young, all the notes, most of the instruments, and several of the arms lost—the latter much injured, but the former in good condition. Several mules and horses were also recovered. Governor Young, immediately on the receipt of the intelligence of the massacre, despatched agents to the scene of the tragedy to bury the dead,

and, if possible, remove the remains of Captain Gunnison and others, and recover the property captured in the camp. In the last particular, however, as I have stated, he had been anticipated.

October 30.—Kenosh, the chief of the band of murderers, arrived at Fillmore, having been sent for by Mr. Call, accompanied by fifteen or twenty of his people. He brought with him one of the public horses lost by Captain Gunnison's escort, "which," he said, "he had taken from the fellow who came to him with the intelligence of their successful operation, and hastened to return it, meeting Mr. Call's messenger on the way; that he deeply regretted the tragedy; that it was done without authority by the young men—boys, as he called them—of the tribe, who had no chief with them, or it would not have happened." He subsequently informed the governor's agent that there were thirty of his people in the party, two of whom were its instigators, seeking revenge for the death of their father, who, they said, had been killed by emigrants but a few days before.

Some of our men were in Fillmore on the arrival of Kenosh, and gave some trouble to the authorities—Captain Morris receiving a note from them, deprecating the indignation of our men against these Indians, and hoping we would restrain it within killing limits.

It will be observed that we have been forced much further north in our course west from the Cochetopa Pass than had been anticipated when the instructions were issued fixing the vicinity of the Vegas de Santa Clara as the western limit of the survey. The pass in the Wahsatch mountains was also found considerably to the north of its anticipated locality, and the broken and mountainous character (given by our recent guides, and confirmed by observations from the summit of the Wahsatch mountains) of the country intervening between this pass and the Little Salt lake and Vegas de Santa Clara was such that Captain Gunnison deemed it impracticable for a railroad, but, if practicable, by no means desirable, as, in his opinion, it would necessarily increase the distance from the Wahsatch Pass to any known pass in the Sierra Nevada beyond what it would be by passing down the Sevier river and north of the lake of that name. He determined therefore to descend this river to the vicinity of the Sevier lake—a point considerably to the north of the Vegas de Santa Clara, but in nearly the same longitude; and thence turn northward, on a return route by the way of Lake Utah. In our course down the Sevier or Nicollet river, as has been seen, we crossed it on its northern bend, and thence passed over the range of mountains which it partially encloses to the broad open plain of the Sevier lake, and again crossed to the right bank of the river. No other than the most ordinary obstructions exist to the construction of a railroad from the foot of the Wahsatch Pass to the western point of our explorations, passing the Un-kuk-oo-ap mountains through the gorge of the Sevier river; for, although we did not pass through this cañon, as it is called, we could see entirely through it at either end as we passed it. It is apparently without walls, but the mountains rise abruptly from the river bank. Twenty miles perhaps to the west of this point mountains are again seen, apparently in detached broken masses. To the north, as before stated, no obstruction could be seen to an easy passage to the Great Salt lake.

October 31.—We re-crossed the Sevier river, encamping half a mile north of our camp of the 20th instant. Distance, 28.24 miles.

November 1.—Following the road in a general course a little to the east of north, at a short distance from the river, a broken range of hills intervening for three or four miles, we came opposite the upper end of the Sevier River cañon, which appears no more difficult of passage from this than the opposite end. Nine miles from camp we passed a small creek, spreading out in some places into little sheets of water, covered with ducks and lined with grass. It breaks through the high hills to our left in its course to the river. We travelled up its valley, along the course of the mountains on our right, for ten or twelve miles; and, by an almost imperceptible change of level, came upon the slope towards Salt creek, which we reached, after a ride of 24.85 miles, at the small settlement of Nephi. Seventy men with their families constitute this settlement, which, on account of Indian depredations, is concentrated at present in a little village—each settler bringing in with him, not only his ricks of corn and hay, but his little log house. Salt creek, which runs into Utah lake, descends from a cañon of the mountain just to the east of the village, directly at the southern base of a high peak called Mount Nebo. The creek takes its name from salt springs on its banks.

November 3.—Passing northward down Salt creek at the base of the mountains, we crossed Willow creek eight miles from Nephi, and three or four fine springs eleven and a half miles from that place, one of which sends out a fine bold stream of cold water. Just below these springs Salt creek finds a passage through the small ridge to the left, and the road ascends a low divide, from which we had the first view of Utah lake; a little distance from which we came upon Summit creek, nineteen miles from Nephi, where a small settlement has been broken up by the Indian difficulties. Three miles from this we passed another fine creek, with cultivated fields to the left of the road, and encamped at Payson, a fine little village on a stream called Peteetnete, 25.18 miles from our morning camp.

November 4.—Five miles and a half from Payson we crossed the Spanish Fork, where it was twenty feet wide and two feet deep; a mile and a quarter from which we passed through Palmyra, a fine settlement irrigated by the waters of this stream. The road was very tortuous, winding around fields, irrigating ditches, and spring places in the level valley of Utah lake, which was just on our left. Thirteen miles from Payson we passed through Springville, on Hobble creek—an older and finer settlement than we had before seen, with some good adobe houses, a few of which were of two stories. The road then followed close along the base of the mountain for 6.37 miles, to the settlement of Provo, on the Timpanagos river. This river, at the present low stage of water, runs in several small stony channels, so divided that it is not easy to give its dimensions; but its current is deep and rapid, with at least double the volume of the Spanish fork. The cañon of this stream is two or three miles northeast of this settlement. It is narrow at the bottom, but appears favorable for the construction of a road hence to Kamas prairie.

The western range of the Wahsatch mountains, (at the western base of which we have been travelling for several days,) standing on the eastern border of the Great Basin, is continuous, extending north and south over five degrees of latitude, from the vicinity of Little Salt lake to north of Bear river, broken only by the passage of the Sevier, Timpanagos, Weber, and Bear rivers. Its altitude, at 3,000 feet above the general level of the country, is quite uniform; but it occasionally falls down to 2,000, and at a few points rises to 4,000 and 4,500 feet. Its western slope is very steep—often inaccessible—presenting generally a formidable barrier to the entrance of a railroad into the Basin from the east. Many small streams descend from it; and as far as its disintegrations have been deposited at its base upon the alkaline plains of the Basin, it forms a rich soil. This line of deposit is narrow, and not continuous, but varying in width, where it is found from two or three miles to ten or twelve at a few points, as opposite Utah and Great Salt lakes, where it occupies the entire space from the mountain to the lake shores. It is to this narrow belt of land that the Mormon settlements are almost exclusively confined, the isolated settlements being upon similar deposits in small valleys at the base of other mountains, the small mountain streams upon which, of course, these deposits are the richest, and chiefly exist, being used for irrigation. Respectable crops of wheat and oats are produced, and barley has been cultivated to some extent; but corn does not flourish well. The grass of this district and of the higher mountain valleys is excellent; and potatoes and other roots are produced in abundance, and of a superior quality.

Supplies were freely furnished to us by the authorities of the settlements through which we passed, at reasonable rates.

November 5.—Leaving the Timpanagos river, we ascended a high bluff to a table extending along the base of the mountain. The road for eight miles was very fine, and the view of Utah lake the best we have had, reminding us of those of western New York. It is twenty-five miles in length, north and south, by twelve in width, with fine, irrigable lands on the east, and pasture lands on the west; the whole enclosed by high mountains, with low passages to the south and north, through the latter of which its outlet, the river Jordan of the Mormons, descends to Great Salt lake.

Coming opposite the ravine from which Battle creek descends, we again passed to the lower level, passing through the village of Pleasant Grove to that of Lake city, on the American fork, which is a few miles nearly east from the foot of the lake. Altitude, 4,596 feet above the sea.

November 6.—We passed Lehi settlement on Dry creek, and, eight miles from Lake city, ascended a small ridge, along the side of which, towards the river Jordan, the road is cut in gravel banks, passing from the valley of Utah lake to that of Great Salt lake.

For the description of this valley I beg to refer you to the survey and able report of Captain Howard Stansbury, of the corps of topographical engineers, made in the years 1849 and 1850.

On the 8th of November our party arrived in Great Salt Lake city, and on the 12th the animals were sent to graze for the winter, in

charge of a strong guard, in Cedar valley, a few miles west of Utah lake.

The season of the year was so much advanced, and the condition of our animals—especially of the American grain-fed horses, upon which the escort was mounted—was such, after our long summer's labor, that it was Captain Gunnison's intention, had he survived, to have terminated his field operations for the present season by the examination he was engaged upon at his death, and by a reconnoissance, more or less minute, of the cañon of the Timpanagos river. He would then have taken up quarters for the winter, and have prepared and submitted a report of the explorations of the summer. Not only will the expediency of this course be manifest, but its necessity will be evident, from the fact that the train animals for subsistence transportation were unfit to leave this valley without a rest of several weeks on fine pasturage; and that several snow-storms had already occurred in the Wahsatch mountains directly on our course east; and that it is impossible to cross these mountains, where there is no road, with wagons, while they are covered with a heavy fall of snow. To avoid the loss of time, therefore, in recruiting the animals, and the risk of crossing the mountains with our train in winter, Captain Gunnison had determined upon the course I have indicated.

The severe labor performed immediately after the disaster resulted in the loss of several of the escort horses, and further reduced the condition of all our animals; and in this connexion it may be proper that I should add, that, in my opinion, (formed upon observation,) the service which horses, which for any considerable time have been accustomed to feeding on grain, are capable of performing *west of the plains, soon after crossing them*, is trifling. Such horses require several months' rest, and grain forage, to recover from their weak and emaciated condition. The horses of Captain Morris's command entered this valley in fine condition for the service they had performed; but a forced march of twenty-five miles only, succeeded by one of thirty or thirty-five miles, was more than many of them were capable of performing, and was equal to the endurance of the best of them.

It was too evident after our loss that the hostile condition of the various Indian bands, in and about this Territory, was such that it was necessary to be fully informed of its extent and of their numbers before prosecuting further explorations. I therefore determined to go into winter quarters at once, that no time might be lost in submitting a report of the explorations to this point.

CHAPTER VIII.

Central Pacific Railroad Report.—Concluding Summary.

The general character of the country traversed and explored, briefly recapitulated, is as follows :

For six hundred miles west of the western line of the State of Missouri the country is a rolling prairie, gradually rising towards the Rocky mountains. For two hundred miles it is very closely assimilated to the soil and character of that State. West of that point it gradually changes its character, becomes more arid and sandy, and much less fertile; and at a point between Walnut creek and Pawnee fork it has entirely changed. Timber almost entirely disappears—it is very scarce east of this—and the short curly buffalo grass takes the place of the coarse tall grass of the east; the soil is hard and dry clay intermixed with sand, with a surface sheet of an inch or two in thickness, intermixed with vegetable mould. Rain falls but seldom, and the cool mountain wind sweeps down at night, affording in summer an agreeable relief from the shadeless heat of the day. The country preserves this character west to the Cimmaron crossing of the Arkansas river. Beyond this the variety of the artemisia, known as sage, first begins to appear in quantity; and grass and water, away from the main water-courses, become scarce. In July, or early in August, the buffalo-grass of these plains becomes entirely dry, although it is still very nutritious, and is fine grazing for buffalo and sheep; but in this short curly form this grass is not large enough for draught cattle. They will subsist on it for some time, but invariably fall away when marching and feeding on it. West of the Big Timber of the Arkansas river, it becomes an important inquiry early in the day at what point grass can be found for a camp; and the march must be lengthened or shortened to suit the locality of this important plant, which is found alone on the narrow river bottom, the hills being very dry and barren. Leaving the Arkansas river for El Sangre de Cristo Pass of the Sierra Blanca—the eastern range of the Rocky mountains—the country becomes more broken and rises more rapidly; its soil is very light, formed from sandstone, shales and slate; but it is much more abundantly supplied with grass than the preceding hundred miles of the Arkansas bottom, and of a superior quality, but it is still scattered and thin. And no part of the surrounding country will compare favorably with the inhabited parts of any of the States. It is alone suited for grazing ranges—not farms, unless they are so extensive as to embrace several miles. It is true the cultivation of grains and of roots, to some extent, on the narrow borders of the streams where water can be commanded, will reward the efforts of labor; but the amount of water is so small that it never can supply more than the limited wants of a sparse pastoral population. Entering the mountains, the small valleys and parks abound in the most luxuriant grass, furnishing abundant pasturage for a given amount of stock; but these fields are very limited in extent, and generally too cold for cultivation. Rains are, however, not wanting in these lovely mountain retreats. The extensive valley of San Luis,

lying between the Sierra Blanca on the east and the Sierra San Juan on the west, and watered by the Rio Grande del Norte and its numerous small tributaries, is in general one vast sage plain from the Rio Colorado to Gunnison's Pass. The grass on the lower tributaries of the Rio del Norte, in this valley, is very limited indeed; it is more abundant on the upper affluents, where a few fields of prairie grass, a mile or two in width, were observed, and the authority of our guide given for extensive grass prairies on the Rio del Norte itself. But all these grass fields, with the greatest amount of cultivation which can be supplied with water from the fine little streams of this valley, can, under the most favorable circumstances, only support a meagre population. The margins of the mountain streams about the Coochetopa pass furnish some fine grass, which extends down to Grand river; but the hills on either side of this route are barren and naked, and no land can be found among them capable of sustaining even small settlements other than for grazing purposes.

The immense valley depression, from thirty to fifty miles in diameter, between the Elk mountains and the Sierra de la Plata, filled with rocky and broken hills, mesas and connecting mountain ranges, through which Grand river flows in cañones, is almost destitute of land which can be cultivated. The hills are often densely covered with sage; but some of the most luxuriant and extensive fields of grass seen on the route were traversed among these hills and tables. The small spaces of bottom land on Grand river, at the junction of the Coochetopa and at Roubideau's old fort, are the only ones on that stream, in the long distance which we followed it, which can be called bottom lands; and these are not only very small for settlements, but are frequently, if not annually, overflowed.

The Roan or Book mountains fill a large space between Grand and Green rivers, and leave to the south of them only an arid, sterile, pulverulent waste, with bunch-grass enough on the hills for passing droves and herds of stock. From Green river to the Wahsatch mountains, the miserable soil maintains the same ash-heap friability. The country is very rocky sandstone, broken, upheaved, and intersected in every direction by ravines, chasms, and beds of creeks. A little bunch-grass is scattered over the hills, but they are generally barren or covered, as on the margins of the streams, with sage. Such, also, is the character of the country from the foot of Book mountain to the Sierra Abajo, near the junction of Grand and Green rivers. The summit of the Wahsatch mountains is a finely-grassed region, but entirely unfit for cultivation. The extensive valleys of the upper Sevier and of the Sevier lake, divided by the Un-kuk-oo-ap mountains, are vast artemisia plains or deserts, with a dry, friable, or sandy soil, quite uninhabitable, except on the grassy bases of the mountains, where an occasional mountain stream affords a limited supply of water for irrigation.

In these plains, as in all those west from the vicinity of Bent's fort, on the Arkansas, to the Basin, and in a few instances in the mountains also, the soil is more or less impregnated with alkali, which is very destructive to vegetation; and salt is often seen efflorescing upon the surface. And as the amount which is annually carried off by lixiviation and drainage, from the very limited amounts of rain and snow

which are precipitated upon this extensive district in proportion to its area, and the very great inequality in their distribution over it, for the great body of the rain and snow annually falls upon the higher peaks and ranges, and is carried down to the main streams through deep cañones and chasms, leaving the plains parched and dry, is constantly renewed from the decomposition of sedimentary rocks, it is impossible to anticipate the period when the supply will be exhausted; and if the progress of science should develop the means of neutralizing their injurious effects, a material change of climate, providing a greatly increased amount of aqueous vapor would be requisite to bring any considerable extent of this arid territory under cultivation. It is not too much, therefore, to say, that, unless this interior country possesses undiscovered mineral wealth of great value, it can contribute but the merest trifle towards the maintenance of a railroad through it, after it shall have been constructed. But for the support of small posts and stations, at suitable intervals for protecting and operating a railroad, there are sufficient lands on this line capable of cultivation at points already indicated.

Permanent water is also found—for we were upon the route during the driest part of the year—at suitable intervals for the wants of a road, both in its construction and operation, at all points of the line explored, except between Grand and Green rivers, a distance of seventy miles, on which none except rain water, which fell while we were passing it, was seen. A spring is said, however, to exist on the Spanish trail, east of the point where we first struck it between these rivers; but, as already stated, its position and size are unknown to me. But if it exists, it will be easily found; and much more extensive explorations of this section than have yet been made will be required before the quantity of water upon it can be determined.

For one hundred and fifty miles west from the State of Missouri, timber is found in sufficient quantities for the construction of a road to the junction of the Smoky Hill and Republican forks of the Kansas river, provided the entire amount suitable for its construction now growing upon the water-courses be applied to it, but not otherwise.

Settlers upon these lands will find the quantity of timber upon them too limited for their necessities; and in the construction of a railroad therefore, subsequent to their occupation, the requisite amount of timber will no longer be found upon them. From the junction of these streams west to the foot of the Sangre de Cristo Pass, a distance of five hundred miles, no timber whatever exists that can be used in the superstructure of a railroad. In and about this pass, Captain Gunnison says, "spruce-pine in abundance is at hand to supply ties for hundreds of miles of railroad, especially if that which the great fire of 1851 swept over and left standing be not left to decay."

In ascending the valley of San Luis but little timber was seen in the mountains; and none exists in the valley which could be used in building roads. From Fort Massachusetts southward the mountains will, however, furnish an abundant supply of excellent pine. In the mountains, about the Cochetopa Pass, one hundred miles from Fort Massachusetts, pine is the only timber, (the quaking asp being only suitable for fuel after it has been dried;) and it is generally small, but, it is

believed, sufficient for the purposes contemplated. From the vicinity of this pass west to the Sevier lake, a distance of five hundred and fifty miles, scarcely a tree was seen, except a few low-branching cedars among the Rock hills west of Green river, which could be used in the construction of a railroad; but it is probable, although very difficult of access, that a limited supply can be drawn from high up on the heads of numerous streams, which enter Grand river from the mountains above and for a short distance below the junction of Blue river. And again, in the mountain between Green and White rivers, and in the Wahsatch mountains, in similar localities, it is probable that more or less timber can be obtained; but if sufficient in quantity, it will necessarily require to be transported to such distances as to make its expense enormous, which will render the substitution of stone necessary wherever it can be used. Coal is found at three points upon the line: on the Wahkarrussi, an affluent of Kansas river; on Grand river, at Salt and Bitter creeks; and near our camp of the 11th of October, on Big Rock creek, at the eastern base of the Wahsatch mountains. That on the Wahkarrussi has been more or less used, and is doubtless abundant and good; and if the supply should not prove abundant upon working the other localities observed, the formation is such, at least, on Grand river as to render it highly probable that an inexhaustible supply of coal exists in the immediate vicinity.

The great scarcity and unequal distribution of timber upon this line renders the character of its rocks an important subject of inquiry. The great body of those underlying the plains are sandstone, more or less argillaceous, the strength and durability of which in superstructures can only be estimated from their appearance, the soil formed from their disintegrations, and the apparent rapid decay of most of the ledges exposed to the weather, which indicate inferior stones. Captain Gunnison says that the barracks at Fort Riley are being built of the white limestone of the vicinity; and a superior quality of limestone is found on the Arkansas, below Bent's Fort.

A more minute and extensive examination of the plains would probably discover the existence of limestone and other rocks in various localities; but as no heavy masonry will be required in carrying a road over the plains, in the absence of other rocks those already known will be sufficient. At the Huerfano butte, where they exist in abundance for building purposes, the first granitic rocks were seen. Thence westward to Sevier lake, soft disintegrating sandstones underlie the plains, and form many of the lower mountain ranges and hills, but the higher ranges of mountains will furnish superior qualities of stones for railroad structure. On Grand river, granite forms the head of the first cañon, overlaid by sandstone, with a thin stratum of igneous rock capping the high tables. Granite is also found in the Sangre de Cristo Pass and at Sahwath butte. In the Sangre de Cristo Pass, the gray rocks have a crystalline porphyritic structure; in the approach to the Coochetopa Pass they are red and more vesicular; and in the Wahsatch Pass approach the basaltic character. From the vicinity of the mouth of the Kansas river to the foot of El Sangre de Cristo Pass, in the eastern range of the Rocky mountains, the features of the country are very favorable for the construction of a railroad. By the line we followed,

the country is generally an open rolling prairie to where we crossed the Arkansas river, with a very gradual but uniformly increasing elevation to the west. West from the mouth of the Apishpa, on the north side of the Arkansas, the prairie hills begin to rise abruptly, and extend closer in to the river; but on the south side rise more gradually, sweeping up in gentle swells to the divide between the small ravines which descend to the Apishpa on the south, and the Arkansas and Huerfano rivers on the north. Preserving the elevation thus gained, the line is easily extended west to the Cuchara and Huerfano rivers above their cañones; entering the valley of the latter stream a few miles below its butte, and ascending it to our camp of August 9th, which may be regarded as the foot of the Sangre de Cristo Pass, fourteen miles above this point. In constructing a railroad across the plains to the foot of this pass, the only obstacle to be overcome not encountered by similar constructions in all open rolling prairie countries, is in their gradual western ascent from the Mississippi river to the foot of the Rocky mountains; and this ascent, as has been already stated, by ascending the main water-courses, (the Kansas and Arkansas rivers and their tributaries,) becomes very gradual, increasing with a general uniformity as we approach the mountains.

The elevation of our camp near Westport, on the western border of the State of Missouri, was 990 feet above the Gulf of Mexico, and 377 above low-water mark at St. Louis. On Pawnee fork, an affluent of the Arkansas, 293 miles by the Santa Fe road, and 322 miles by the Smoky Hill route, from that camp, our elevation was 1,962 feet above the Gulf, giving an average ascent per mile (independent of the ordinary inequalities of the ground, which were noted from day to day) of three feet three inches and three feet respectively. By the path which we followed, it is 68 miles from this point to our camp of July 16th, above Fort Atkinson; and the ascent 418 feet, or six feet two inches to the mile. But if the river be followed between these points, the distance will be increased and the ascent correspondingly decreased; or, by taking a more direct course, the distance would be lessened, slightly increasing the grade, which will be best seen by a reference to the section of this part of our route. For eighty-nine miles west from this camp, following the banks of the river, we ascended five feet four inches to the mile; and in the succeeding 105 miles, to a short distance below Bent's fort, the average ascent per mile was seven and three-fourths feet, and twenty feet seven inches per mile for the next thirty-four miles to the mouth of the Apishpa. The general section which accompanies this report, from this point to the Huerfano butte, is that of the line followed by our wagons, and the distance, eighty miles, given on it, exceeds by one-fourth the length of the line necessary for the construction of a railroad between these points. The general ascent to be gained by the shorter line is twenty-eight feet ten inches to the mile. The natural grade for fourteen and a half miles above this point, following the river, is fifty-two feet ten inches per mile, which brings us slightly within the eastern spurs of the Rocky mountains.

The summit (so to speak) of the great interior trunk of the continent, upon which nearly all its mountain ranges, masses, and peaks are elevated, is reached, upon this line, at the Huerfano butte, which is 6,099

feet above the sea, and 5,109 feet (nearly a mile) above our camp near Westport; and the whole of this remarkable ascent—which has its counterpart, more or less approaching the same elevation, by whatever line the mountains are approached from the east—is gained by the easy grades given over a continuous plain, without once passing a remarkable hill or making at any point a considerable descent.

The estimated distance from our camp, of August 9th, on the Huerfano river, by the circuit indicated for a railroad, ascending the stream through the large amphitheatre drained by the river and its branches, to the Black butte, (twelve miles,) to Williams's Pass fork, (two miles,) and Gunnison's creek, (three miles,) and thence ascending the latter stream to the summit of El Sangre de Cristo Pass, is from twenty-four to twenty-six miles, and the difference of elevation 2,354 feet—an average of ninety-eight feet and one inch to the mile for the shorter, and ninety feet six inches for the longer distance. The altitude of the summit of this pass is 9,219 feet above the sea; and of the highest point passed by our wagons, 9,358 feet; the altitude of the lowest and nearest peak to the pass being 9,852 feet. Captain Gunnison says a single grade can easily be carried from the summit of this pass to the gorge of the Huerfano river, (just below our camp of August 9th;) but two—one along Gunnison's creek, and one on the river—would probably be preferable. The Sangre de Cristo creek rises near the summit of the pass, and descends in a general southwestern direction, through a narrow ravine, for 7.09 miles, which thence gradually opens for six miles towards the valley of San Luis. The mountains on either side rise several hundred feet above the stream. The descent of the stream from the summit of the pass is 101 feet per mile for the first mile and three-fourths, and 103 feet per mile for the succeeding mile and thirty-four hundredths. Six miles below this point we left the stream, and rose to a plain extending along the base of the mountain spurs, which we followed for 4.57 miles, to Utah creek, near Fort Massachusetts, having descended twelve feet to the mile for the 10.57 miles. By descending from the summit of the pass along the side of the mountain on the right of the creek, a road can be constructed, throwing a larger proportion of the descent upon the lower part, where it should be carried around a mass of low hills to the plain indicated above, which subsides gently into the valley of the Rio Grande del Norte.

The broad open valley of San Luis, enclosed on the east by the mountains just crossed, and on the west by the chain of the Sierra San Juan, and drained by the Rio Grande del Norte and its tributaries, is so level that a railroad can be carried over it in any desired direction. From Utah creek we descended forty-nine feet per mile for 10.93 miles, to White mountain spring; and fourteen feet per mile for the following 13.46 miles, to near Roubideau's Pass. This pass was examined, and deemed entirely impracticable for a railroad; the grade to the west being, for the first 1.25 mile, at the foot of the ravine, 298 feet to the mile, and 490 feet to the mile for the succeeding seven-tenths of a mile, and 554 feet per mile for the last three-fourths of a mile at the summit, with a broad slope extending thence north and east to the Huerfano river

Continuing up the valley of San Luis, the grades from camp to camp are respectively as follows: An ascent of nine feet eight inches for 9.78 miles; a descent of twenty-four feet per mile for 9.06 miles; an ascent of 8.7 feet per mile for 11.72 miles; descent of 9.5 feet for 5.96 miles, with an ascent of but nineteen feet in 15.20 miles, to the camp on Sahwatch creek, at its entrance into the valley of San Luis.

Gunnison's Pass lies immediately to the northwest of the Sierra Mojada, between the head-waters of the Rio Grande del Norte, in this direction, and the Puncha creek, an affluent of the Arkansas above its cañon. Captain Gunnison deemed it practicable for a railroad which should ascend the Arkansas river through its cañon, and across the plains which lie above it, ascending a branch of the Puncha creek to the summit of the pass, and descending through Homan's park to the valley of San Luis. The altitude of this pass, 8,603 feet, and the grades in its vicinity, are derived from aneroid observations, referred to our camp of August 27th, 28th, and 29th, in the San Luis valley; but are not relied upon with great confidence for actual altitudes above the sea, although the relative differences of level indicated by them are more satisfactory. They give grades of 185.5 feet per mile for four miles, ascending the pass from the east; then 228 feet per mile for one mile and a half, followed by a grade of 113 feet to the mile for three-fourths of a mile, to the summit. Descending to the west, the difference of level is fifty-six feet per mile for six miles; then sixty-eight feet to the mile for three miles, to the centre of Homan's park, from which a road can be carried in any direction across the San Luis valley.

The approach to the Coochetopa Pass, by the Sahwatch creek, opens very favorably for the construction of a railroad. The mouth of the valley of this stream is from five to seven miles in width, but soon narrows in ascending it to a few hundred yards, and seldom again exceeds half a mile in width to its head. For twelve miles we ascended slightly over thirty-nine feet to the mile; and for the following fifteen miles nearly sixty-one feet to the mile—having, during the day, left the Sahwatch creek and ascended its branches, occasionally overhung by walls of igneous rocks, giving this part of the pass a defile character. But, in the construction of a railroad, it will be necessary to carry it on the side of the ravine considerably above the stream, gaining an elevation of at least 200 feet at the fifteen-mile station referred to; which, from the formation of the hills, must be done upon the last few miles below that point, the elevation of which is 8,960 feet above the sea, while the summit of the pass, 3.83 miles distant, is 10,032 feet, which will require for its passage a grade of 124 feet per mile for the 3.07 miles, and a tunnel, entering the mountain from the east three-fourths of a mile below the summit, diminishing the elevation to be overcome by 490 feet, and terminating to the west, with a deep approach near our camp of September 2d, 1.33 mile below the summit—the length of the tunnel, including the approach, being two miles.

The altitude above the sea, ten thousand feet, indicated by our barometers in this pass, is that to which all the depressions in the vicinity will approximate. It is possible, however, that the summit of the Carnero Pass, just south of the Coochetopa, may be more easily passed by a railroad than the latter; but this can only be determined by a minute

survey. In any future exploration, examination should be made for a passage in these mountains by ascending any small stream entering Homan's park from the northwest, and passing over to the head of the Coochetopa creek, and thence descending to Grand river—the formation of the country indicating a pass in that direction.

Below our station, 1.33 mile west of the summit of the Coochetopa Pass, the grade again becomes practicable; being, by the valley of Pass creek for 2.24 miles, 106 feet to the mile; sixty-eight feet to the mile for the next 2.15 miles; ninety-three feet per mile for the following 2.05 miles; and forty-two feet per mile for the succeeding 3.47 miles. In this descent much cutting and filling would be necessary, the hills on each side of the creek being cut by small ravines deep back towards their summits. Pass creek enters a broken cañon at this point, which extends to its junction with the Coochetopa, sixteen miles below. Lateral cañones enter the main one at several points, but principally from the left, and broken hills rise somewhat above the general level of the descending plain; "but a railroad can be carried over them by rising below for some distance." The descent of the stream in the sixteen miles is seventy-one feet per mile. Seven miles below this point the Coochetopa creek enters Grand river in a bottom, eight or nine miles in length, by from one-half to one mile and a quarter wide, which is frequently overflowed. For 14.75 miles we descended seventeen feet per mile. From this point until we reached the Uncompahgra river, our route followed a very rough and broken country, for the description of which reference should be made to the accompanying section, daily journal, and map from September 6th to September 20th, as it is by far the most difficult and expensive section upon the route for the construction of a road.

From the crossing of the Nahunkahrea to Green river, the greatest difficulty to be overcome in the construction of a road will be to secure a firm bed for it to rest upon; the friable, ash-heap character of the soil being such, that in wet weather, for many miles at a time over the whole surface, it forms miry beds of a brick-clay consistency, in which animals sink half-leg deep in crossing. Fortunately an inexhaustible supply of stone is at hand at various points along the route, for the construction of a suitable foundation.

The heaviest grade upon this section, from camp to camp, is an ascent of 71 feet per mile, on the 27th of September, for 5.66 miles; the other grades varying from 2 to 13 feet per mile between these rivers, a distance of 100 miles from the junction of Grand and Blue rivers. Numerous bridges and culverts will be necessary on this section. The rocky district west of Green river is of the same ravine and chasm-like character (but upon a much smaller scale) with the section on Grand river; but the soft sandstone is here easily cut, and the water-courses more easily passed, the streams not being so torrent-like. But the number of bridges which will be required will be so large that great expense will attend the construction of a railroad on this part of the line explored. The grades upon it are heavy and very variable, besides the ordinary inequalities of hills and ravines. They are from day to day as follows, on the line traversed, and by the shorter one indicated in the journal, will not differ materially:

From Green river to Akanaquint spring, 16.76 miles, ascent 35 feet per mile; and for the succeeding 4.6 miles, 119 feet per mile; and for the next 1.14 mile, 165.7 feet to the mile, to where we left the Spanish trail; but this distance can be increased, bringing the grade down to perhaps 100 feet to the mile. Continuing from this point for 6.08 miles upon the summit-level between Green and White rivers, we next descended for 3.96 miles 111.3 feet per mile, and 16.41 feet per mile for 9.82 miles, to camp on White river.

Ascent to Clover creek, 8.72 miles, 41.85 feet per mile; for the succeeding 11.11 miles, returning to White river, ascent 23 feet per mile; and 38 feet per mile for 13.26 miles, with a descent of 22 feet to the mile for the succeeding 13.17 miles. For the next 11.40 miles we ascended 25.61 feet per mile, and 17.6 feet for the next 13.46 miles; and for the succeeding 15.65 miles, the ascent was 53.16 feet to the mile to the foot of the Wahsatch Pass.

This pass is entered by crossing a small ridge between our camp of October 12th and Akanaquint creek, and ascending that stream through a narrow defile from 100 to 200 yards in width for some distance, and then leaving it by a ravine which rises between open grassy hills to the summit of the pass; the descent to the west being of the same character.

For the passage of this mountain by a railroad it will be necessary to approach it from the east by a heavy grade of 125 feet to the mile after reaching the Akanaquint creek, to within one-third of a mile of the summit, where a tunnel with deep approaches will be required—the whole not exceeding three-fourths of a mile in length—diminishing the elevation to be overcome from 175 to 200 feet, and giving a grade of 131 feet per mile for 3.6 miles west of the summit, and thence to the vicinity of our camp of September 13; or even less than this, by keeping on the side of the ravine above Salt creek. Altitude of the pass, 7,820 feet.

Two miles from this point, towards the valley of the Sevier river, Salt creek (by following which a railroad can alone be carried) enters a rocky cañon, more or less broken by lateral streams, which it follows for sixteen miles. "Through this cañon a railroad may be carried, but, owing to the cutting of rock, only at a very heavy expense." The altitude of our camp, two miles above its head, on Salt creek, was 6,976 feet, to which seventy-five feet must be added, to connect with the estimated grade for a road at that point, which will give a descent of ninety-five feet per mile for the eighteen miles intervening between that point and the foot of the cañon, 1,706 feet below it. For 2.65 miles below the cañon, to the foot of the mountains, we descended ninety-one feet per mile; and from the foot of the mountain to our first camp on the Sevier river, 3.13 miles, the descent was twenty-seven feet to the mile.

No other than the most ordinary obstructions exist to the construction of a railroad from this camp to the most western point of our explorations, near the Sevier lake. It should follow the river, passing with it through its gorge in the Un-kuk-oo-ap mountain; and thence takes its course to the west. The average fall of the river for thirty-one miles, upon which observations were taken for three days, is but four feet to the mile; and it continues this easy descent to the lake. If more mi-

nute surveys shall at any time be made upon this general line, alterations and improvements will doubtless be made in it to some extent, but its general character cannot be improved.

A pass may be found, as suggested, at the head of the Coochetopa creek, in the Sierra San Juan, which may be superior to the Coochetopa Pass itself, and a more direct line from Green river to the Wahsatch Pass be secured, by following the Spanish trail across the Rock Hills, or even by ascending the San Rafael river, but, if found more favorable or direct, will not alter the general character of the route; for the line followed is not only the best that could be discovered in the vicinity, but was pointed out to us as such by the most reliable and experienced guides we could obtain, and who had recommended the route as very superior, and may reasonably be supposed to have done all they could to establish the correctness of their judgment, and by the Indians who inhabit the country, and are as familiar with every fastness and mountain pass in it as with the use of the arms with which they procure their daily subsistence.

And after the most careful observation and study I have been able to bestow upon the various chains of mountains and water-courses upon the route, seen at least during parts of every day, in the clear atmosphere of the elevated mountain regions, with a distinctness of outline and clearness of detail, at distances difficult to be realized by persons who are only familiar with the extent, beauty, and grandeur of landscape views in the comparatively moist and clouded atmosphere of the more civilized portions of our country, I hazard nothing in saying that no other line exists, in the immediate vicinity of this, worthy of any attention in connexion with the construction of a railroad from the Mississippi river to the Great Basin.

For the geographical positions (latitudes) laid down from astronomical observations in this report and accompanying map, I am entirely indebted to my accomplished assistant, Mr. S. Homans, astronomer for the expedition, by whom the observations were taken and the computations made. Our entire failure to obtain suitable observations for longitudes, is explained in the report accompanying the table of latitudes. The longitudes used in the construction of the accompanying map are derived from a comparison of those given by Nicollet and Fremont, for St. Louis and the public surveys carried westward from that place to the western boundary of Missouri, and thence to Fort Riley, in determining the boundaries to Indian lands; and of Fremont and Emory at Bent's fort; and Fremont, at Great Salt lake.

I am also indebted to Mr. Homans for the construction of a map of the route, which he made from the topographical sketches taken by our late comrade, Mr. Kern, and from those taken by himself subsequent to the barbarous massacre of that gentleman; but the more elaborate map, which accompanies the report, has been made from the same notes and from that map by Mr. F. W. Egloffstein, my very able assistant in the topographical department of the explorations prosecuted during the present year, 1854.

Want of time in which to prepare the geological report of this line, to be submitted with this report, compels me, reluctantly, to defer it

until the completion of my report (now in course of preparation) upon the line explored from Green river, by way of Great Salt lake, Humboldt river, and Mud lake, to the valley of the Sacramento river in California.

Respectable collections in botany and natural history were made during the exploration; but, owing to the unfortunate death of Mr. Creutzfeldt, the description of them has been necessarily delayed, but is in course of preparation, and will accompany the report referred to above.

The meteorological tables and tables of distances were kept by my young assistant, Mr. James A. Snyder. The computations of altitudes has been conducted since my arrival in Washington under the superintendence of Mr. Lorin Blodget, and the barometrical observations discussed by him with great care and superior intelligence, which will be apparent by a reference to his notes and the tables in this report.

Until within a few days, I had intended to resume the exploration required by your instructions, immediately after completing and forwarding this report, by proceeding through the Timpanagos cañon to the Kansas prairie, and thence east as far as Bear river; and, in returning, have descended the Weber river to this valley, which, if practicable, would greatly facilitate our spring operations. But, unfortunately, the winter has within the last two weeks become unprecedently cold, the thermometer falling to 10° , 15° , and 20° below zero, while the depth of snow in the valley is considerable, and greater in the mountains, forbidding our ascending them until the winter moderates.

Indian hostilities still continue; but few depredations have, however, been committed on the inhabitants of the territory within the last two months, and hopes are entertained by the civil authorities of effecting a peace, which, if it could be maintained, would promote the prosperity of new settlements.

We shall make the examination above referred to as soon as the winter will permit our animals to subsist in the mountains.

I am, sir, most respectfully, your obedient servant,

E. G. BECKWITH,

First Lieut. 3d Artillery.

GREAT SALT LAKE CITY, U. T.,

January 31, 1854.

CHAPTER IX.

Determinations of altitudes and discussions of barometrical observations from Westport, Missouri, to Great Salt lake, Utah Territory, 1853.

The Buntens barometers (Nos. 496 and 551) are exclusively relied upon for the determination of altitudes of the entire line. The readings of the aneroid barometers exhibits variable errors; and as the mercurial barometers retain their reliable and uniform character throughout, no necessity exists for the use of the aneroids.

The zero errors found by Doctor Engelmann, in his comparison at St. Louis, to apply to the Bunten barometers before the commencement of the work, did not remain as between the two instruments, even at the first considerable camps of the survey. They were, therefore, rejected in all the computations, and no zero error was at any time applied. For mean readings the two barometers usually agreed very nearly—the difference between them being that No. 496 was too slow in its movement when considerable changes of altitude occurred, and required correction or substitution of the other in such cases.

For mean readings at stations where several observations were taken, the results of both are believed to be a very near approximation to standard accuracy, and the instruments appear to have been but slightly, if at all, deranged at the termination of the survey. The zero errors found in them by Doctor Engelmann, on their return, were obviously introduced after the close of the work, and do not require to be applied to it.

In the discussion of the observations, the readings were first corrected for temperature to the height of the mercurial column at 32° Fahrenheit. A minor error of non-adaptation of the common formula to the temperature expansion determined by Shumaker for barometers of this construction is thus avoided, and the greater advantage gained of combining all the observations at a station in a correct mean reading, to be used in a single computation of the altitude. The mean of the observed air temperatures is used in these cases also, as avoiding, to some extent, a source of error in extremes of surface temperature; for which, in single observations, a table of corrections is appended.

All the observations were also corrected for *horary variation* of atmospheric pressure through the day, thus bringing each to the true mean position for the day.

The accompanying scale of horary corrections gives the values employed for each hour. They are derived primarily from well-determined curves of daily variation of pressure for the eastern United States, but with material and important modifications and additions established by the observations of other surveys in the interior of the continent, principally by that of Lieutenant Whipple. By the observations through the winter months at Great Salt Lake City, the measures of this horary scale are shown to be less for that season, and to conform the more nearly than in summer to those observed in the eastern United States and in Europe. For the months occupied in the field-work of this survey, however, and for the districts traversed, the measure of the correction here employed is fully confirmed. At the sea-level, or so near it, as both extremities of the line are, the measures of horary variation again fall off to those belonging to well-known districts; yet, as no determinations of importance occur at these extremities, it is not necessary to give the scale belonging to them.

A correction previously found to be required for extremes of air temperature has been so well determined by the comparison of survey by levels, and with the barometer at the passes of the Sierra Nevada, surveyed by Lieutenant Williamson, that a scale of corrections sufficiently precise for practical use has been constructed. Where the error from this cause could not be eliminated by the use of mean temperatures

this scale has been employed in the determinations here made. The measures given for this correction belong to extremely arid climates, and to elevated districts, requiring modification in the position of the point where no correction is required; also in different seasons. As it affects great elevations in these arid districts by an extreme amount of at least 150 feet, it is too important to be neglected, notwithstanding a discretionary use of the values is usually necessary.

The reduced observations at stations on the plains, from Pawnee fork to camp 33, the first after crossing the Arkansas river, were referred to the mean barometric reading noted by Dr. Engelmann at St. Louis for July, 1853—the month in which they were made. The altitude of his station above the Gulf of Mexico, as determined by him from a long series of observations, was added to make up the entire altitude. For these stations and dates the results thus obtained are very nearly identical with those computed by direct reference to the barometric mean at the level of the sea for the latitude.

For altitudes beyond this point direct comparisons of each camp is made to an assumed mean barometric reading at the level of the sea, in this latitude, of 30,000 inches—the barometer corrected to 32° Fahrenheit, and a mean air temperature taken of 57°. The constant belonging to the latitude and climate of the Gulf is 30.050 inches of the barometer, and 64° of air temperature, which would add unduly to the altitudes. The principle is assumed that the constants of pressure and temperature employed belong to the latitude, and that the resulting determinations of elevation belong correctly and alike to both the Gulf and the Atlantic and the Pacific. There are no well-determined mean readings of the barometer on the Pacific coast, yet the most of those recently made in California give the impression that a slightly greater mean atmospheric pressure exists there than in the same latitudes of the Atlantic. The constant has not, however, been altered for any portion of this line.

The discussion of observations at the principal passes has been in part upon simultaneous observations at an hour's interval in time and distance. The slower movement of one barometer, however, rendered it necessary in many cases to take successive readings of the best one, corrected for horary variation for determination of successive differences. The termini of these lines of ascent and descent were also checked by comparison of preferred results, as of the mean of several at the summit, or elsewhere, with the nearer camps. The coincidence of results, by single and by successive steps, has been so satisfactory as to warrant the conclusion that the grades and altitudes of these passes are quite accurately determined. The correct use of such data, in the joining of intermediate with main lines, and in the correspondence of single observations with the means of observation, is the severest test of barometric survey; and discrepancies cannot be wholly removed.

The principal cause of these discrepancies is in the non-periodic variation of atmospheric pressure, for which no constant or correction can be given except by reference to continued readings for a month or more at some station near. Mean results best eliminate this error, and they are therefore preferred in the order of their number, or of the number of days they cover. In the ascent of the Arkansas, the uni-

form grade of the stream permits the use of four or five successive camps as a mean result, and two or three non-periodic variations are thus eliminated. Subsequently to Great Salt lake, a less error from this cause is likely to occur, as this variation is least in August and September. For the survey eastward from Great Salt lake to the valley of Green river, the field readings are compared with those of the same date by the other barometer at Great Salt Lake city. These may be regarded as nearly simultaneous, though the hours are not always the same, from the fact that the same days, and portions of the day, were compared. For the remainder of the line to California, no mode of correction of this error existed, except in the preference of the means embracing the greatest number of observations; yet the errors have probably no practical importance.

The observations generally sustain the checking and criticism which rank the results as a determinate survey, with a near approximation to absolute accuracy, and, as among themselves, sufficiently conclusive of grades and points of comparison.

Horary corrections of barometer.

Hour.	Inches.	Hour.	Inches.
6 a. m.....	+.007	3 p. m.....	-.030
7 a. m.....	+.020	4 p. m.....	-.045
8 a. m.....	+.030	5 p. m.....	-.050
9 a. m.....	+.040	6 p. m.....	-.030
10 a. m.....	+.050	7 p. m.....	-.020
11 a. m.....	+.055	8 p. m.....	-.005
12 m.....	+ .025	9 p. m.....	-.000
1 p. m.....	+.005	10 p. m.....	+.010
2 p. m.....	-.015	11 p. m.....	+.020

Scale of corrections for extreme air temperatures.

Low temperatures.	High temperatures.
At 35° add 25°.	At 95° subtract 15°.
At 40° add 23°.	At 93° subtract 12°.
At 45° add 21°.	At 90° subtract 11°.
At 47° add 20°.	At 88° subtract 10°.
At 50° add 18°.	At 85° subtract 8°.
At 53° add 15°.	At 83° subtract 7°.
At 55° add 13°.	At 80° subtract 5°.
At 57° add 10°.	At 78° subtract 3°.
At 60° add 5°.	At 75° subtract 2°.

NOTE.—The measures of this correction are variable, to some extent, with the season, and apply nearly to departures from the mean of the month in which observations are made. It is here given as required for summer months, in which most of the observations in field surveys have been taken.

Captain Gunnison's barometers compared with the standard barometer of Dr. G. Engelmann, St. Louis, June 4 to 9, 1853.

Ten observations were made—

Range of standard barometer in that period, from 29."505 to 29."748, range 0."240.

Bunten, No. 551 = E + 0."006 var. from -0."021 to +0."027 = 0."048
 Bunten, " 496 = E + 0."080 " +0."046 to +0."109 = 0."063
 Aneroid, " 7889 = E - 0."015 " -0."055 to +0."035 = 0."090
 Aneroid, " 7293 = E - 0."025 " -0."005 to -0."045 = 0."040

E represents Engelmann's standard barometer.

Both of Bunten's barometers are very slow in their movements. B. 551 gives a very dull sound when the tube is reversed, indicating air in the tube; 496 gives a clearer sound, and is probably free of air.

The station of Dr. Engelmann's barometer is above low-water mark of the Mississippi 106.'5, and above the Gulf of Mexico 482.'0.

Barometer Engelmann was, in June, 1853, equal to—

Bunten, No. 551 - 0."006

Bunten, No. 496 - 0."080

The Aneroids were both set to correspond exactly with barometer E. After the voyage to California and back, barometer Engelmann was found, in September, 1854, equal to—

Bunten, No. 551 - 0."072

Bunten, " 496 + 0."116

Aneroid, " 7889 - 0."448

Aneroid, " 9293 + 0."263

Therefore, as barometer E. has remained unaltered—

Barometer Bunten, 551, is now higher by 0."066 than 14 months ago.

" 496, is now lower by 0."196 " "

Aneroid, 7889, is now higher by 0."448 " "

" 9293, is now lower by 0."263 " "

Bunten, 551, is by far the best instrument of the whole set; but both barometers have the inside of the tubes at the lower as well as the upper levels so much soiled and darkened by oxydized mercury, that at a certain elevation of the barometer, at least, the reading off becomes very difficult if not impossible.

The aneroids are certainly very unreliable; but within the limited range of my observations, (between twenty-nine and thirty inches,) they performed well and corresponded pretty accurately with the fluctuations of my own barometer.

In calculating elevations from barometrical data, it seems best not to compare isolated observations made on the same day, or at the same hour, but to refer the observations made in the field (or the mean of several if they can be had) to the monthly means of the stationary barometer. I add, therefore, my monthly means for the last fourteen months. But the observations made west of the Rocky mountains cannot be referred to my barometer at all.

It is hardly necessary to add—what everybody who is in the habit of observing the barometer knows—that observations made in the forenoon, principally from 8 to 10 o'clock a. m., are generally higher, and those in the afternoon, principally between 2 and 4 o'clock, are mostly lower than the average of the day. The noon observations comes nearest the mean of the day.

The barometer—at least in the Mississippi valley—is usually highest with westerly and northwesterly winds, and lowest with southerly and southeasterly winds. It is mostly higher, but much more irregular, in winter, and lower but more regular in summer.

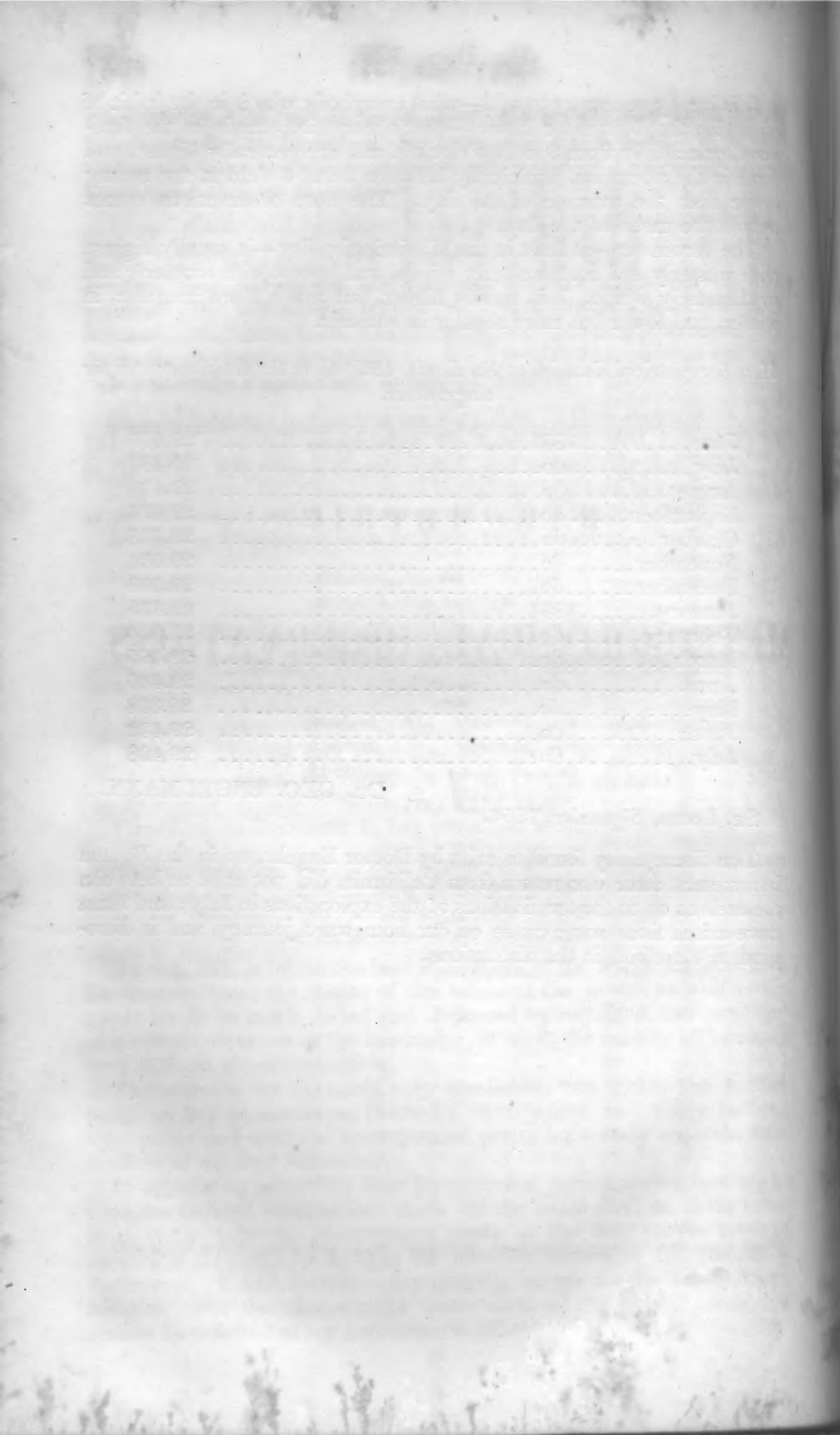
Mean barometrical elevation at St. Louis, 482° above the Gulf, corrected for temperature.

June.....1853.....	29.466
July.....do.....	29.483
August.....do.....	29.431
September.....do.....	29.474
October.....do.....	29.538
November.....do.....	29.601
December.....do.....	29.508
January.....1854.....	29.575
February.....do.....	29.514
March.....do.....	29.465
April.....do.....	29.445
May.....do.....	29.338
June.....do.....	29.432
July.....do.....	29.498

DR. GEO. ENGELMANN.

ST. LOUIS, *September, 1854.*

The discrepancy found to exist by Doctor Engelmann in the Buntens barometers, after our return from California, did not exist as between themselves up to the terminations of the explorations in July; and must have arisen from some cause on our homeward journey, and is disregarded, therefore, in the discussions.



BAROMETRIC

AND

METEOROLOGICAL OBSERVATIONS,

WITH

DETERMINATIONS OF ALTITUDES AND DATA FOR PROFILE OF THE
LINE OF SURVEY FROM WESTPORT TO GREAT
SALT LAKE CITY—1853.

*Barometric and meteorological observations, with determinations of
Great Salt*

Station.	Day.	Hour.	Distance from West- port.	Barometric reading, No. 496.	Attached thermom- eter, (C.)	Barometric reading, No. 551.
	1853.		<i>Miles.</i>			
Camp No. 1, 3 miles west of Westport.	June 17	11 a. m.	3	744.4	Mean attached thermometer, 33° 2', (C.)	743
	17	2 p. m.		744.7		741.2
	17	3.30 p. m.		738.7		742.7
	17	6.30 p. m.		742		742.6
	18	9 a. m.		742.4		742
	18	12.30 p. m.		742.6		740.6
	18	3.30 p. m.		740.9		740.5
	18	8 p. m.		739.6		
	19	6.30 a. m.		739.3		740.6
	19	9 a. m.		739.8		740.6
	19	1 p. m.		739.3		739.5
	19	3 p. m.		738.9		739.8
	19	8 p. m.		737.7		739.9
Camp 18, Pawnee fork	July 13	7 p. m.	297.50	714.6	30	712.8
	13	9 p. m.		713.6	27	713.9
	14	6 a. m.		715.8	22	715
Camp 19, first Coon creek..	14	3 p. m.	318.21	717.5	35.5	715.2
	15	6 a. m.		714.3	28.5	716
Camp 20, second Coon creek.	15	3 p. m.	336.71	703.2	32	704.9
	15	6 p. m.		705.6	27.5	706.3
	15	9 p. m.		706.8	23	707.4
Camp 21, near Fort Atkin- son, Arkansas river.	16	6 a. m.		709.5	21.5	712.6
	16	4.30 p. m.	365.33	698.4	25.5	700.2
	16	6 p. m.		704.9	26.5	706.7
	16	9 p. m.		708.2	23	699.5
	17	6 a. m.		705.5	21	705.9
	17	9 a. m.		701	27.5	700.6
	17	12 m.		708.5	32.5	706.1
	17	3 p. m.		705.5	31.5	704.3
	17	6 p. m.		703.6	28.5	702.6
	17	9 p. m.		694.8	28	697.3
	18	6 a. m.		701.6	22	704.6
	18	9 a. m.		704.5	27.5	703.6
	18	12 m.		705.9	31.5	704.1
	18	3 p. m.		706.1	30.5	705.1

NOTE.—It is to be noted that in the entries in the column headed "barometric means" 551. This note applies to all the sheets.

altitudes and data for profile of the line of survey from Westport to Lake City.

Attached thermometer, (C)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches.	Feet.	
Mean attached thermometer, 33° 2', (C.)	84					NOTE.—The arrangement of the results of the corrected barometric readings, computed in means at camps or stations, is, to place them opposite the <i>last</i> observations made at the locality; those of barometer No. 496 being entered first or above in the column. The altitudes are entered opposite the <i>first</i> readings at the camp or station.
	87.5					
	89.5					
	77					
	74.5					
	83.5					
	90					
	93					
	80					
	74					
	94					
78						
-----	-----	28.959	28.975	28.967	990.6	
30	84	28.016	27.945	-----	1962	Cloudy in northwest; light southwest wind.
27	80	27.973	27.984	28.020	-----	Do do.
22	69	28.076	28.044	27.992	-----	Cloudy; wind southwest.
36	77	28.117	28.026	28.050	2004	Cloudy, with rain; strong northwest wind.
28.5	72	27.985	28.052	28.040	-----	Do do.
31	87	27.574	27.644	-----	2244.6	Cloudy.
28	81	27.688	27.715	-----	-----	Light southeast wind; clouds in southwest.
23.5	73	27.725	27.774	27.702	-----	Hazy.
21.5	72	27.832	27.954	27.765	-----	Light clouds.
25.5	88	27.427	27.502	-----	2330.7	Clear; light breeze from southeast.
27.5	75	27.664	27.731	-----	-----	Do do.
23	74	27.780	27.438	-----	-----	Light clouds in east; wind southeast.
21	70	27.674	27.690	-----	-----	Clear; wind southeast.
27.5	83	27.433	27.417	-----	-----	Do.
33	93	27.723	27.633	-----	-----	Clear.
31.5	88	27.664	27.617	-----	-----	Stormy, with thunder.
28.5	83	27.605	27.566	-----	-----	Do.
28	83	27.233	27.331	-----	-----	Do.
22	71	27.517	27.635	-----	-----	Cloudy; strong wind from northeast.
28	84	27.574	27.535	-----	-----	Cloudy in southeast.
31.5	92	27.625	27.554	-----	-----	Cloudy in north; wind from southeast.
30.5	86	27.692	27.652	-----	-----	Light clouds in southeast; wind northeast.

the first entry is the mean of barometer No. 496; the second is the mean of barometer No.

Barometric and meteorologic

Station.	Day.	Hour.	Distance from West port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		<i>Miles.</i>			
Camp 21—Continued.....	July	18 6 p. m.		706.1	23	704.7
		18 9 p. m.		706.4	21	705.1
		19 6 a. m.		703.9	20	704
Camp 22, on Arkansas river.		19 3.30 p. m. ...	390.65	702.8	28.5	703.5
		19 6 p. m.		704.1	25	703.2
		19 9 p. m.		703	23	704.3
Camp 23, Arkansas river....		20 6 a. m.		706.5	21	705.5
		20 1.30 p. m. ...	410.55	702.3	30	703
		20 3 p. m.		698.9	30.5	696.4
		20 6 p. m.		701.5	27.5	700.4
		20 9 p. m.		699.2	23.5	699
		21 6 a. m.		697.7	21.5	698
Camp 24, Arkansas river....		21 2.30 p. m. ...	432.60	697.8	32.5	698.4
		21 3 p. m.		696.8	33	696.6
		21 6 p. m.		696.1	29	696.9
		21 9 p. m.		695.6	24.5	695.1
		22 6 a. m.		694.4	20.5	698.4
		22 2 p. m.	454.33	695.2	29	696.7
Camp 25, Arkansas river....		22 3 p. m.		694.7	30	693.1
		22 6 p. m.		691.6	27	692.5
		22 9 p. m.		687.5	23	691
Camp 26, Arkansas river....		23 6 a. m.		689.1	20	690.8
		23 2.30 p. m. ...	478.71	684.6	36.5	685.4
		23 6 p. m.		680.3	26.5	685.4
		23 9 p. m.		685.0	23	685.7
		24 6 a. m.		685.6	21	684.6
		24 9 a. m.		687.6	26.5	683.4
		24 12 m.		684.8	29	682.8
		24 3 p. m.		683.1	25.5	682.6
		24 6 p. m.		683.4	21.5	686.6
		24 9 p. m.	478.71	687.1	18.5	683.1
		25 6 a. m.		688.2	15	687
		25 2 p. m.	500.58	684.3	22	683.5
Camp 27, Big Timbers of Arkansas river.		25 6 p. m.		687.3	20	683.7
		25 9 p. m.		686.8	18	686.7
		26 6 a. m.		687.2	15	686.4
Camp 28, Timbers of Arkansas river.		26 2.15 p. m. ...	520.86	680.5	21.5	677.2
		26 3.15 p. m. ...		682	22.5	680.8
		26 6 p. m.		677.3	24.5	679.3
		26 9 p. m.		682.4	16.5	679.4
		27 6 a. m.		680.6	12	678.3
		27 3.30 p. m. ...	544.12	676.4	30	674.8
Camp 29, Arkansas river....		27 6 p. m.		674.7	25	676.3

observations—Continued.

Attached thermom- eter, (C.)	Air thermometer, (F.)	Corrected barome- ter, No. 496.	Corrected barome- ter, No. 551.	Barometric means.	Height above sea.	Remarks.
		<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>	
23	72	27.727	27.672	-----	-----	Cloudy; strong wind from northeast.
21	70	27.717	27.666	27.624	-----	Rain; strong wind from northeast.
20	68	27.615	27.619	27.596	-----	Cloudy; light northeast breeze.
29	84	27.574	27.597	-----	2431.2	Cloudy in northwest; light south- east breeze.
24.5	77	27.640	27.605	-----	-----	Do do.
23.5	75	27.575	27.622	27.623	-----	Do do.
21	69	27.714	27.674	27.623	-----	
30	87	27.526	27.554	-----	2556.2	Cloudy in northeast; light north- east wind.
30.5	88	27.412	27.314	-----	-----	Cloudy in northeast; light south west wind.
27.5	82	27.527	27.483	-----	-----	Cloudy in northwest; light north- east wind.
23.5	76	27.426	27.418	27.451	-----	
21.5	72	27.368	27.379	27.431	-----	Light clouds; light northeast wind.
33	91	27.354	27.366	-----	2692.2	Light clouds in southwest.
33	91	27.318	27.310	-----	-----	Do do.
29	85	27.310	27.342	-----	-----	Do do.
24.5	78	27.230	27.264	27.298	-----	Do do.
20.5	69	27.242	27.399	27.337	-----	Cloudy in west; light northwest wind.
29.5	79	27.260	27.315	-----	2852	Light clouds; wind southeast.
30.5	86	27.247	27.184	-----	-----	Do do.
27	81	27.180	27.176	-----	-----	Cloudy in west; wind southeast.
23	73	26.969	27.107	27.129	-----	Cloudy; wind southeast.
20	68	27.037	27.104	27.176	-----	Do do.
36.5	94	26.870	26.898	-----	3047.3	Cloudy; light southeast breeze.
26.5	80	26.895	26.856	-----	-----	Cloudy in southwest; southeast breeze.
23	75	26.917	26.744	-----	-----	Do do.
21	72	26.810	26.723	-----	-----	Clear.
28	84	26.814	26.794	-----	-----	Light clouds in northwest.
30.5	88	26.841	26.967	-----	-----	Light clouds; strong northeast wind.
25.5	79	26.973	26.811	-----	-----	Cloudy; strong northeast wind.
21.5	71	27.021	26.974	-----	-----	Rain.
19	67	26.973	26.969	26.892	-----	Cloudy; light northeast wind.
15.5	61	27.035	26.988	26.845	-----	Cloudy in north.
22	72	26.862	26.830	-----	3166.2	Clear; light breeze from northeast.
20	68	27.003	26.861	-----	-----	Cloudy in west; light breeze from northeast.
18	66	26.961	26.965	26.950	-----	Cloudy; light breeze from north- east.
15	59	26.985	26.954	26.899	-----	Do do.
22	70	26.712	26.582	-----	3328.5	Broken clouds; light southwest breeze.
22.5	73	26.782	26.696	-----	-----	Do do.
20.5	69	26.609	26.688	-----	-----	Do do.
16.5	63	26.796	26.678	26.727	-----	Clear; light southwest breeze.
12.5	55	26.738	26.643	26.656	-----	Light clouds in the east.
31	82	26.500	26.434	-----	3536.6	Clear; light breeze from northeast
25	78	26.487	26.550	-----	-----	Dark clouds in west.

Barometric and meteorologic

Station.	Day.	Hour.	Distance from West- port.	Barometric reading, No. 496.	Attached thermom- eter, (C.)	Barometric reading, No. 551.
	1853.		<i>Miles</i>			
Camp 29—Continued	July 27	9 p. m.		676.2	21	673.1
	28	6 a. m.		675.9	19	676.6
Camp 30, Arkansas river, near Bent's Fort.	28	2 p. m.	559.20	674.6	31	674.6
	28	3 p. m.		672.7	30	672.5
	28	6 p. m.		670.3	26.5	674.4
	28	9 p. m.		670.5	19.5	672.8
	29	6 a. m.		668.5	12.5	673.1
Camp 31, Arkansas river..	29	5 p. m.	583.20	660.6	25.5	661.5
	29	9 p. m.		660.5	19	661.8
	30	6 a. m.		661.2	15.5	661.9
Camp 32, ford of Arkansas..	30	2 p. m.	593.20	661	27	661.5
	30	5 p. m.		660.3	25.5	660.5
	30	7 p. m.		658.3	21	657.5
	30	9 p. m.		658.3	21	657.5
	30	11 p. m.		660.8	17	657.7
	31	6 a. m.		656.9	15	658.8
	31	9 a. m.		657.7	26.5	658.1
	31	11 a. m.		656	27	656
	Aug. 1	6 a. m.		654.5	14	656.4
	1	9 a. m.		655.6	32.5	655
	1	11 a. m.		656.1	34.5	655.1
	1	1 p. m.		651.2	33.5	653.1
	1	3 p. m.		653.9	33.5	649.6
	2	6 a. m.		653	12	656.8
Camp 33, Apishpa river.....	2	4.30 p. m. ...	607.84	648.5	33.5	645.8
	2	6 p. m.		647.8	29.5	648.3
	2	9 p. m.		647.3	20.5	648.4
	3	6 a. m.		645.6	20	645.8
Camp 34, Apishpa river.....	3	2 p. m.	620.82	643.5	33	643.7
	3	3 p. m.		643.6	25	644.2
	3	6 p. m.		642.2	25	643.1
	3	9 p. m.		642.2	18	642.4
	4	6 a. m.		642.7	12	642.9
Camp 35, plain near Apishpa river.	4	3.30 p. m. ...	636.08	625	30.5	625.5
	4	6 p. m.		623.4	20.5	623.3
	4	9 p. m.		624.3	20.5	622.8
	5	6 a. m.		623.1	15	623.5
Camp 36, plain near Cuchara river.	5	6 p. m.	653.15	618	20	620.3
	5	9 p. m.		617.8	18	619.8
	6	6 a. m.		618.9	12.5	620.5
Camp 37, Cuchara river....	6	3.40 p. m. ...	663.54	615.5	32.5	615.9
	6	6 p. m.		616.6	27	615.9
	6	9 p. m.		616	22	616.4
	7	6 a. m.		617.4	16	617.8
	7	9 a. m.		617.5	26	616.4
	7	12 m.		616.9	33	616.3

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches.	Feet.	
21	71	26.532	26.410	26.512	-----	Cloudy; light northeast wind.
19	57	26.521	26.549	26.489	-----	Clear; light northeast wind.
31	87	26.441	26.441	-----	3671.5	Light clouds; southeast wind.
29.5	87	26.385	26.381	-----	-----	Do do.
27	81	26.306	26.468	-----	-----	Clear; southeast wind.
20	70	26.355	26.402	26.348	-----	Cloudy; southeast wind.
12.5	55	26.261	26.442	26.428	-----	Do do.
25.5	78	25.952	25.987	-----	4091.2	Cloudy; strong southwest wind.
19	63	25.926	25.977	25.948	-----	Stormy; light southwest wind.
15.5	50	25.962	25.990	25.983	-----	Clear.
27.5	81	25.925	25.945	-----	4370.6	-----
25.5	77	25.940	25.948	-----	-----	Light clouds; breeze from southeast.
21	71	25.851	25.820	-----	-----	Light clouds; breeze from northeast.
21	67	25.831	25.800	-----	-----	Cloudy in southwest; breeze from northeast.
17	63	25.925	25.803	-----	-----	Do do.
15	60	25.793	25.867	-----	-----	Cloudy and foggy.
27.5	69	25.783	25.756	-----	-----	Light clouds; light southwest wind
27.5	81	25.662	25.658	-----	-----	Do do.
11.5	53	25.702	25.789	-----	-----	Do do.
31	77	25.638	25.618	-----	-----	Light clouds; light southeast wind.
36	91	25.634	25.587	-----	-----	Cloudy; light southeast wind.
33.5	93	25.495	25.570	-----	-----	Dark clouds in west; light southeast wind.
33.5	89	25.622	25.452	25.746	-----	-----
12	55	25.651	25.801	25.742	-----	-----
33.5	92	25.439	25.333	-----	4723.1	Cloudy; light southwest wind.
30	85	25.412	25.432	-----	-----	Do do.
21	68	25.402	25.441	25.395	-----	Dark clouds in the northwest.
20.5	69	25.328	25.336	25.384	-----	Light hovering clouds.
33.5	91	25.216	25.220	-----	4860	Cloudy; light southwest wind.
27.5	78	25.267	25.282	-----	-----	Rain; fresh southeast breeze.
25.5	78	25.211	25.247	-----	-----	Light hovering clouds.
18	67	25.213	25.221	25.232	-----	Clear.
12	53	25.249	25.257	25.248	-----	Light clouds in the southeast.
31.5	86	24.520	24.535	-----	5702	Light clouds; light breeze from southeast.
20.5	69	24.491	24.487	-----	-----	Cloudy; light breeze from southeast.
20.5	70	24.496	24.437	24.492	-----	Do do.
15	60	24.466	24.482	24.484	-----	-----
20	71	24.282	24.373	-----	5851.2	Dark clouds; strong wind from northeast.
18	69	24.252	24.363	24.284	-----	Do do.
12.5	56	24.312	24.375	24.371	-----	Clear; light breeze from northeast.
30.5	84	24.138	24.161	-----	6109	Light clouds; light southeast wind.
27	80	24.200	24.172	-----	-----	Do do.
22	68	24.170	24.142	-----	-----	Clear; strong southeast wind.
16	60	24.237	24.253	-----	-----	Do do.
-----	75	24.169	24.130	-----	-----	Do do.
-----	89	24.129	24.105	-----	-----	Do do.

Station.	Day.	Hour.	Distance from West port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		<i>Miles.</i>			
Camp 37—Continued	Aug. 7	3 p. m. ....	.....	615.8	32	612.8
	7	6 p. m. ....	.....	614.7	25.5	613.7
	7	9 p. m. ....	.....	615.8	22.5	615.2
	8	6 a. m. ....	.....	614.7	20	615
Camp 38, Huerfano river, near butte.	8	2 p. m.	673.63	617.3	33.5	618.6
	8	3 p. m. ....	.....	616.2	31	615.5
	8	6 p. m. ....	.....	615	29.5	614
	8	9 p. m. ....	.....	616	21	615.7
	9	6 a. m. ....	.....	617.2	18	615.4
Camp 39, Huerfano river...	9	3.30 p. m. ...	688.17	600.4	32.5	600.2
	9	6 p. m. ....	.....	600.1	31	599.9
	9	9 p. m. ....	.....	599.3	20.5	599.4
	9	12 m. ....	.....	598.9	20	598.8
	10	3 a. m. ....	.....	599.6	20	599.5
	10	6 a. m. ....	.....	599.3	18	599.1
Camp 40, base of mountain..	10	2.30 p. m. ...	695.76	584.4	19.5	583.6
	10	3 p. m. ....	.....	584.1	18	583.2
	10	6 p. m. ....	.....	582.9	16	582.7
	10	9 p. m. ....	.....	583.4	15	583.3
	11	6 a. m. ....	.....	583.4	15.5	583.9
Camp 41, in Sangre de Cristo Pass	11	9 a. m.	700.88	569.3	20	569.2
	11	10 a. m. ....	.....	566.5	22.5	567.2
	11	10.30 a. m. ...	.....	570.1	24	570.1
	11	11 a. m. ....	.....	566.8	12.7	566.4
	11	12 m. ....	.....	560	24	559.6
	11	2 p. m. ....	.....	552.4	20	552.2
	11	3 p. m. ....	.....	551	13.5	550.9
	11	6 p. m. ....	.....	549.7	13.5	550.1
	11	9 p. m. ....	.....	549.8	13	549.6
	12	6 a. m. ....	.....	549.5	12	549.5
Top of mountain	12	9 a. m. ....	.....	536	17	536.1
First summit of El Sangre de Cristo Pass.	12	10 a. m.	701.58	545.2	14.5	544.2
	12	2 p. m. ....	.....	546.9	17	546.7
	12	3 p. m. ....	.....	546.9	17	546.7
	12	4 p. m. ....	.....	546.7	13.5	546
Near Camp 42	13	10 a. m. ....	.....	552.1	19	548.8
	13	11 a. m. ....	.....	552.3	18	549.1
	13	12 m. ....	.....	552.3	20	548.7
Second summit of Pass	13	1 p. m. ....	.....	545.5	16.5	547.3
	13	2 p. m. ....	.....	545.5	14	547.3
	13	3 p. m. ....	.....	545.5	13.5	547.3
	13	4 p. m. ....	.....	545.4	14	546.7
	13	5 p. m. ....	.....	545.4	14	546.7
	13	6 p. m. ....	.....	545.4	12	546.7
On summit	17	9 a. m. ....	.....	548.9	17.5	547.7
	17	10 a. m. ....	.....	548.9	19.5	547.7
	17	11 a. m. ....	.....	548.6	21	547.7
	17	12 m. ....	.....	548.6	23	547.2
	17	1 p. m. ....	.....	548.6	25	547.2
Camp 42, Sangre de Cristo Valley.	14	6 a. m.	705.38	550.5	7	551.1
	14	9 a. m. ....	.....	551.3	15	550.5

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches.	Feet.	
32	91	24.145	24.026	.....	.....	Light clouds in southwest; light southwest wind.
26	79	24.129	24.030	.....	.....	Light clouds in southwest; light northeast wind.
22.5	76	24.154	24.130	24.159	.....	Do do.
21	72	24.115	24.123	24.135	.....	Light clouds; strong southwest wind
.....	96	24.189	24.240	.....	6099.1	Dark clouds; light southwest breeze.
31	85	24.168	24.141	.....	.....	Do do.
29.5	84	24.125	24.086	.....	.....	Do do.
21	71	24.170	24.158	24.176	.....	Do do.
18	65	24.222	24.151	24.156	.....	Do do.
32	93	23.543	23.535	.....	6976.1	Light clouds; light southwest wind.
31	88	23.534	23.526	.....	.....	Light clouds.
21	69	23.516	23.520	.....	.....	Clear.
20	72	23.474	23.470	.....	.....	Clear; light northeast breeze.
20	69	23.539	23.535	23.523	.....	Do do.
18	65	23.553	23.545	23.520	.....	Dark clouds.
19.5	67	22.954	22.923	.....	7463.3	Stormy.
18	65	22.919	22.964	.....	.....	Rain; light southwest wind.
16	62	22.956	22.948	.....	.....	Light clouds.
15	60	22.947	22.943	22.953	.....	Do.
16.5	60	22.927	22.946	22.945	.....	Light clouds; strong northwest wind
20	65	21.728	21.720	.....	8757.1	.....
22.5	68	21.684	21.680	.....	.....	.....
24	74	21.633	21.643	.....	.....	.....
27	74	22.315	22.313	.....	.....	.....
23.5	75	22.187	22.183	.....	.....	.....
20	57	22.312	22.312	.....	.....	.....
13.5	57	22.174	22.158	.....	.....	.....
13.5	58	21.940	21.925	.....	.....	.....
14	63	21.603	21.591	21.657	.....	Cloudy; light breeze from southwest
12	55	21.580	21.580	21.657	.....	Do do.
17	60	21.039	21.040	.....	9852	Cloudy; strong southwest wind.
14.5	58	21.053	21.058	.....	9358	Rain in the distance.
17	60	21.511	21.508	.....	.....	Dark clouds.
17	60	21.526	21.518	21.408	.....	Rain, with thunder.
13.5	56	21.541	21.535	21.404	.....	Rain.
19	63	21.678	21.540	.....	.....	Light clouds; light southeast breeze.
18	61	21.705	21.580	.....	.....	Dark clouds; light southeast breeze.
21.5	66	21.735	21.560	.....	.....	Do do.
17	58	21.416	21.487	.....	9219.8	Rain.
14	56	21.448	21.515	.....	.....	Do.
14	55	21.459	21.534	.....	.....	Cloudy.
14	56	21.474	21.526	.....	.....	Light clouds; light northwest wind.
14	55	21.479	21.531	21.457	.....	Do do.
12	53	21.459	21.511	21.517	.....	Do do.
18	65	21.512	21.464	.....	9396.2	.....
20	68	21.502	21.450	.....	.....	.....
21	70	21.465	21.426	.....	.....	.....
23	75	21.491	21.436	21.488	.....	.....
25	76	21.508	21.453	21.446	.....	.....
7	43	21.643	21.667	.....	9041.1	Clear; light northeast breeze.
15	58	21.626	21.594	.....	.....	Do do.

Station.	Day.	Hour.	Distance from West-port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		<i>Miles.</i>			
Camp 42, Sangre de Cristo valley.	Aug. 14	11 a. m.		551.6	19.5	550.4
	14	1 p. m.		552	21	550
	14	3 p. m.		552	21	550
	14	6 p. m.		552.1	19	551.8
	14	9 p. m.		550.9	11.5	551.2
	15	6 a. m.		552.3	11.5	551.4
	15	9 a. m.		552.8	17.5	551.1
	15	11 a. m.		553.1	21	551
	15	1 p. m.		553.6	24	551.2
	15	3 p. m.		553.6	24	551.2
	15	6 p. m.		552.3	18	550.4
	15	9 p. m.		551.2	9	550.7
	16	6 a. m.		553.1	6	552.4
	16	10 a. m.		554.6	22	553
	16	12 m.		554.4	22	552.9
	Camp 43, Sangre de Cristo valley.	16	3 p. m.		553.6	22	552.9
16		6 p. m.		552.7	15	552.3
16		9 p. m.		552	8	551.5
17		5.30 p. m. ...	710.72	565.7	26.5	565.2
17		6 p. m.		565.2	25	565.1
17		9 p. m.		564.3	13.5	563.9
18		6 a. m.		564.6	7	565.6
18		7 a. m.		564.4	13.5	563.5
18		10.30 a. m. ...		569.9	23.5	568.7
18		11.30 a. m. ...		569	25	568.3
18		12.30 p. m. ...		568.7	27.5	567.1
18		1.30 p. m.		568.6	28.5	567
18		2.30 p. m.		568.6	30	567.5
18		3.30 p. m.		568.3	31.5	566.3
18		4.30 p. m.		566.7	31	566.2
Camp 44, Utah creek, San Luis valley, near Fort Massachusetts.		18	6 p. m.		566.3	26	565.7
	20	9 a. m.	721.29	569.3	20.5	568.4
	20	11 a. m.		569.4	30	567.5
	20	12 m.		568.6	25	567.4
	20	2 p. m.		567.1	18.5	566.4
	20	4 p. m.		567.2	22.5	566.2
	20	6 p. m.		566.8	19	566.3
	20	9 p. m.		566.8	15	566.7
	21	6 p. m.		566.4	20	566.2
	21	9 p. m.		566	14	566.6
	22	6 a. m.		566	9	565
	22	9 a. m.		567.3	23	566.9
	22	12 m.		567.6	25	567.1
	22	3 p. m.		567.2	23	567.2
	22	6 p. m.		566.8	15.5	567.4
	22	9 p. m.		566.9	13	567.7
23	6 a. m.		567	13	568.1	
Crossing Utah creek.....	23	11 a. m.	725.25	577.8	24	576.5
Camp 45, White Mountain spring.	23	2 p. m.	732.04	578	25	577.4
	23	4 p. m.		576.8	21	575.9
	23	6 p. m.		576.8	18	575.9

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>	
19.5	66	21.591	21.544	.....	.....	Clear; light northeast breeze.
21	70	21.649	21.570	.....	.....	Do do.
21	70	21.685	21.605	.....	.....	Light clouds; northeast breeze.
19	45	21.708	21.696	.....	.....	Clear; light southeast breeze.
11.5	53	21.650	21.662	.....	.....	Light clouds; light southeast breeze.
11.5	52	21.698	21.663	.....	.....	Cloudy; light southeast breeze.
17.5	63	21.665	21.598	.....	.....	Do do.
21	69	21.642	21.559	.....	.....	Do do.
24	66	21.700	21.605	.....	.....	Do do.
24	65	21.735	21.640	.....	.....	Light clouds; light southeast breeze.
18	65	21.716	21.640	.....	.....	Clear; light southeast breeze.
9	49	21.666	21.646	.....	.....	Do do.
6	42	21.746	21.722	.....	.....	Do do.
22	71	21.707	21.643	.....	.....	Do do.
22	71	21.724	21.664	.....	.....	Do do.
22	71	21.779	21.719	.....	.....	Do do.
15	59	21.739	21.723	21.634	.....	Do do.
8	52	21.701	21.632	21.645	.....	Do do.
24.5	82	22.214	22.202	.....	8412.1	Clear; light breeze from southeast.
25	77	22.192	22.188	.....	.....	Clear.
13.5	59	22.174	22.158	.....	.....	Do.
7	42	22.194	22.233	22.183	.....	Do.
13.5	57	22.150	22.114	22.179	.....	Do.
23	73	22.297	22.258	.....	.....	Do.
25	76	22.269	22.241	.....	.....	Do.
27.5	80	22.273	22.249	.....	.....	Do.
28.5	83	22.281	22.217	.....	.....	Do.
31	86	22.308	22.264	.....	.....	Do.
31.5	88	22.291	22.213	.....	.....	Do.
30.5	86	22.246	22.217	22.275	.....	Do.
26	79	22.235	22.202	22.232	.....	Do.
20	67	22.299	22.260	.....	8365.1	Cloudy, with thunder.
30	88	22.245	22.170	.....	.....	Rain in distance.
25	79	22.271	22.223	.....	.....	Stormy.
19	66	22.283	22.252	.....	.....	Cloudy; light breeze from southeast.
22.5	73	22.297	22.258	.....	.....	Do. do.
19	67	22.282	22.263	.....	.....	Do. do.
15.5	61	22.268	22.260	.....	.....	Do. do.
20	68	22.270	22.263	.....	.....	Do. do.
10	62	22.240	22.268	.....	.....	Do. do.
10	49	22.245	22.193	.....	.....	Do. do.
22	77	22.212	22.197	.....	.....	Do. do.
25.5	82	22.233	22.215	.....	.....	Dark clouds; light breeze from southeast.
23	77	22.263	22.263	.....	.....	Do. do.
15.5	60	22.294	22.318	.....	.....	Do. do.
13	56	22.276	22.308	22.266	.....	Do. do.
13	61	22.273	22.316	22.250	.....	Do. do.
				22.603	.....
23.5	83	22.603	22.560	22.560	8079.1	
26	76	22.681	22.653	.....	7829.1	Light clouds; slight northeast wind.
21	70	22.675	22.640	.....	.....	Light clouds; strong northeast wind.
18	64	22.680	22.645	.....	.....	Do.

Barometric and meteorology

Station.	Day.	Hour.	Distance from West port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		Miles.			
Camp 45—Continued.....	Aug. 23	9 p. m. ....	.....	577.3	15	576.8
	24	6 a. m. ....	.....	577	14	577.1
Foot of Roubideau's Pass...	24	5.30 p. m. ....	.....	.....	.....	572.6
	24	6 p. m. ....	.....	.....	.....	572.6
	24	6.30 p. m. ....	.....	.....	.....	572.4
Camp 46, near Roubideau's Pass.	25	6 a. m.	745.50	.....	.....	581.2
	25	7.30 a. m. ....	.....	.....	.....	581.3
	25	8 a. m. ....	.....	.....	.....	582
	25	8.30 a. m. ....	.....	.....	.....	582.7
	25	9 a. m. ....	.....	.....	.....	582.7
Camp 47, near Williams's Pass.	25	4 p. m.	755.28	.....	.....	579.4
	25	6 p. m. ....	.....	.....	.....	579.8
	25	9 p. m. ....	.....	581.4	17	580.4
	26	6 a. m. ....	.....	581.3	16	580.7
Camp 48, Chatillon's creek.	26	6 p. m.	764.34	583.8	21	583.4
	26	9 p. m. ....	.....	583.2	15	583.5
	27	6 a. m. ....	.....	583.8	12	583.5
Camp 49, Leroux's creek...	27	3 p. m.	776.66	583.8	23	583.5
	27	6 p. m. ....	.....	582.2	18	582.4
	27	9 p. m. ....	.....	582.2	15.5	582.4
	28	6 a. m. ....	.....	582.3	11	582.8
	28	9 a. m.	776.06	583.1	15	582.7
	28	11 a. m. ....	.....	583.8	21.5	582.2
	28	1 p. m. ....	.....	583.8	25	582.2
	28	3 p. m. ....	.....	582.4	27	581.2
	28	6 p. m. ....	.....	581	18	581.5
	28	9 p. m. ....	.....	581	17	581.5
Camp 50, Homans's creek...	29	1 p. m.	782.02	584.1	25.5	584.9
	29	3 p. m. ....	.....	583.4	27	583
	29	6 p. m. ....	.....	582.4	20	583.3
	30	6 a. m. ....	.....	584.9	12	584.9
Sahwatch spring and Butte.	30	12.30 p. m. ...	792.56	585.5	27	582.8
Camp 51, Sahwatch creek.	30	3 p. m.	797.22	582.7	27	582.7
	30	6 p. m. ....	.....	582.1	22	582.4
	30	9 p. m. ....	.....	582.4	16	583
	31	6 a. m. ....	.....	580	6	580.7
Camp 52, approach to Coochetopa.	31	12.30 p. m. ...	809.49	572.3	27	571.4
	31	3 p. m. ....	.....	570	18	570.2
	31	6 p. m. ....	.....	571.1	17	570.7
Camp 53, foot of Coochetopa Pass.	Sept, 1	6 a. m. ....	.....	572.8	11	573.5
	1	4.30 p. m. ...	824.49	552.9	18	552.5
	1	6 p. m. ....	.....	553	20	552.3
	1	9 p. m. ....	.....	551.7	12	552.8
	2	6 a. m. ....	.....	551.6	5	552.1
Coochetopa Pass—						
1st station	2	9.55 a. m. ...	.....	.....	.....	555.6
2d station	2	10.55 a. m. ...	826.11	.....	.....	550.3

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>	
15	58	22.678	22.658	22.675	.....	Clear; strong northeast wind.
14	57	22.667	22.671	22.652	.....	Light clouds; light northeast breeze.
15	58	.....	22.549	.....	.....	Not used in general profile.
15	56	.....	22.539	.....	.....
14	54	.....	22.526	22.473	.....
11	57	.....	22.836	.....	7638	Light clouds; light southeast breeze.
13	60	.....	22.814	.....	.....	Do. do.
18.5	70	.....	22.821	.....	.....	Do. do.
19	74	.....	22.804	.....	.....	Do. do.
19.5	75	.....	22.795	22.832	.....	Do. do.
25	77	.....	22.766	.....	7723.1	Dark clouds.
24	75	.....	22.767	.....	.....	Do.
16.5	64	.....	22.796	.....	.....	Do.
16.5	60	.....	22.801	22.781	.....	Do.
21	69	22.937	22.921	.....	7503.2	Do.
15	60	22.910	22.922	22.910	.....	Do.
12	55	22.935	22.923	22.906	.....	Rain.
23	72	22.933	22.921	.....	7608.2	Dark clouds; light breeze from southeast.
18	65	22.893	22.901	.....	.....	Do. do.
15.5	61	22.871	22.879	.....	.....	Do. do.
11	52	22.876	22.896	.....	.....	Do. do.
15	61	22.867	22.863	.....	.....	Do. do.
22	76	22.852	22.783	.....	.....	Light clouds; light breeze from southeast.
25	81	22.890	22.826	.....	.....	Do. do.
27	82	22.861	22.814	.....	.....	Do. do.
18	67	22.846	22.865	22.868	.....	Do. do.
17	65	22.820	22.839	22.856	.....	Do. do.
25	74	22.898	22.933	.....	7548.3	Light clouds; light southeast breeze.
27	82	22.901	22.885	.....	.....	Dark clouds; light southeast breeze.
20	69	22.893	22.929	22.919	.....	Do. do.
12	54	22.978	22.978	22.930	.....	Clear; light southeast breeze.
				22.938	.....
27	81	22.938	22.842	22.842	7676.2	Clear.
27	76	22.873	22.873	.....	7567.1	Do.
22	72	22.869	22.881	.....	.....	Do.
16	61	22.879	22.903	22.856	.....	Do.
6	43	22.805	22.832	22.872	.....	Do.
27	75	22.422	22.387	.....	8047	Light clouds; light southeast wind.
18	61	22.413	22.421	.....	.....	Rain and hail; strong southwest wind.
17	60	22.460	22.444	22.477	.....	Dark clouds.
12	50	22.502	22.529	22.443	.....	Rain.
17	64	21.754	21.738	.....	8960.2	Light clouds; light southwest breeze.
20	60	21.735	21.708	.....	.....	Do. do.
12	55	21.674	21.717	21.680	.....	Clear; light southeast breeze.
5	36	21.690	21.710	21.684	.....	Do. do.
22	65	.....	21.817	21.817	8898	
23	68	.....	21.627	21.627	9210	

Station.	Day.	Hour.	Distance from West- port.	Barometric reading, No. 496.	Attached thermome- ter, (C.)	Barometric reading, No. 551.
Coochetopa Pass—Cont'd.	1853.		<i>Miles.</i>			
3d station	Sept. 2	11.55 a. m.	827.50	.....	.....	544.1
4th station	2	12.55 p. m.	828.08	.....	.....	540
5th on summit of pass....	2	1.15 p. m.	828.32	532.3	15	532.9
Do.....	2	2 p. m.	.....	.....	.....	532.8
Camp 54, west of pass	2	3 p. m.	829.65	542.3	20	542.1
	2	6 p. m.	.....	541.8	19	541.9
	2	9 p. m.	.....	541.8	15	541.7
	3	6 a. m.	.....	541.4	11	540.7
Camp 55, near Camp Rock.	3	6 p. m.	849.65	563.6	24	564.2
	3	9 p. m.	.....	562.2	13	562.5
	4	6 a. m.	.....	562.4	9	563.4
	4	9 a. m.	.....	564	19	563.3
	4	11 a. m.	.....	564	22	563.4
	4	1 p. m.	.....	564.3	22	563.4
	4	3 p. m.	.....	563.9	21	563.7
	4	6 p. m.	.....	563.3	13	564.7
	4	9 p. m.	.....	558.4	13	558.1
	5	6 a. m.	.....	562.7	8	563.2
Camp 56, Coochetopa creek.	5	4 p. m.	865.53	577.3	20	577.6
	5	6 p. m.	.....	577.5	15	578.9
	5	8.30 p. m.	.....	577.6	15	578.2
	6	6 a. m.	.....	577.5	4	577.9
Camp 57, Grand river.....	6	5 p. m.	880.28	583.5	22	584.5
	6	6 p. m.	.....	583.2	19.5	584.4
	6	9 p. m.	.....	582.6	13	584.2
	7	6 a. m.	.....	582.4	4	584.9
Camp 58, Grand river.....	7	6 p. m.	894.28	587.5	25	587.8
	7	9 p. m.	.....	587.4	10.5	588.5
Camp 59, ravine near Grand river.	8	5.30 p. m.	898.28	579.7	23.5	579.6
	8	9 p. m.	.....	579	18	579.4
	9	6 a. m.	.....	578.4	2	579.4
	9	8 a. m.	.....	580.4	10	580.4
	9	3 p. m.	.....	577.3	25.5	577.7
	9	4 p. m.	.....	571.6	25.5	571.7
Summit of right bank of Lake Fork.	9	5.30 p. m.	902.28	588.9	22.5	589.4
Camp 60, Lake Fork, (on stream.)	10	6 a. m.	.....	587.7	10	589.4
	10	8 a. m.	.....	588.1	12.5	592.2
	10	9 a. m.	.....	591.1	19	590.2
	10	10 a. m.	.....	591.1	20	590.2
Summit of left bank of Lake Fork.	10	1.20 p. m.	.....	581.4	23.5	581.5
	10	2.15 p. m.	.....	580.9	23.5	580.9
	10	2.30 p. m.	.....	580.4	24	580.6
Camp 61, Mountain creek...	10	7 p. m.	906.98	572	16	573.1
	10	9 p. m.	.....	571.3	12	572.2
	11	6 a. m.	.....	571.2	10	572.3
	11	9 a. m.	.....	571.3	12	572.3
	11	12 m.	.....	571.7	18	571.3
	11	3 p. m.	.....	570	18.5	570.8
	11	6 p. m.	.....	569.8	15.5	570.1

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches.	Feet.	
25	65	.....	21.340	21.340	9510	
23	64	.....	21.195	21.195	9740.3	
15	59	.....	20.935	20.935	1003.2	
13	58	.....	20.905	20.905	10032.0	
20	61	21.314	21.306	.....	9540	Dark clouds; strong wind from W.
19	66	21.298	21.302	.....	.....	Light clouds; light southeast breeze.
15	62	21.684	21.280	21.289	.....	Do do.
11	55	21.265	21.234	21.281	.....	Clear.
23	68	22.133	22.160	.....	8515	Cloudy; light breeze from west.
13.5	59	22.091	22.103	.....	.....	Clear and calm.
9	49	22.104	22.143	.....	.....	Do.
19	65	22.102	22.065	.....	.....	Light clouds; light southeast breeze.
22	71	22.067	22.044	.....	.....	Dark clouds in the northwest.
24	78	22.129	22.040	.....	.....	Rain; light southwest breeze.
21.5	71	22.152	22.145	.....	.....	Do do.
13.5	59	22.150	22.212	.....	.....	Dark clouds.
13.5	60	21.933	21.922	22.091	.....	Do.
8	40	22.115	22.135	22.091	.....	Clear.
20	68	22.707	22.719	.....	7681.2	Dark clouds.
15	61	22.710	22.767	.....	.....	Do.
15	56	22.688	22.711	22.703	.....	Clear.
4	36	22.714	22.730	22.731	.....	Do.
22	72	22.941	22.968	.....	7428	Do.
19.5	67	22.925	22.972	.....	.....	Do.
13	57	22.891	22.953	22.917	.....	Do.
4	36	22.907	23.006	22.975	.....	Do.
25	65	23.070	23.082	23.079	7293.1	Do.
10	61	23.083	23.127	23.102	.....	Clear; light southwest breeze.
23.5	75	22.786	22.782	.....	7639.1	Light clouds; southwest breeze.
18	68	22.737	22.752	.....	.....	Do do.
2	35	22.757	22.797	22.766	.....	Do do.
10	55	22.782	22.782	22.778	.....	Do do.
25	60	22.668	22.686	.....	.....	Do do.
25	76	22.459	22.463	.....	8171.2	Do do.
22	72	23.143	23.163	.....	7236.2	Do do.
10	56	23.092	23.159	.....	.....	Do do.
12.5	60	23.077	23.238	.....	.....	Do do.
19	62	23.165	23.130	23.126	.....	Do do.
20	70	23.151	23.155	23.161	.....	Do do.
23.5	71	22.802	22.806	.....	.....
24.5	71	22.799	22.795	.....	.....
24.5	73	22.780	22.788	22.793	7716.2	
16	62	22.489	22.533	22.796	8054.3	Dark clouds; light breeze from northeast.
12	60	22.445	22.481	.....	.....	Do do.
10	46	22.442	22.486	.....	.....	Do do.
12	60	22.405	22.445	.....	.....	Rain; light breeze from southeast.
18	70	22.420	22.405	.....	.....	Dark clouds; light breeze from northeast.
18.5	67	22.405	22.436	.....	.....	Do do.
15.5	67	22.405	22.407	.....	.....	Do do.

Barometric and meteorological

Station.	Day.	Hour.	Distance from West port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		Miles.			
Camp 61—Continued	Sept. 11	9 p. m. ....	.....	569	10	570
	12	6 a. m. ....	.....	569.2	4	570.7
On succeeding creek	12	8 a. m.	910.02	568.7	16	568.4
On summit of Mesa	12	9.30 a. m. ..	911.10	558.2	17	558.4
On small creek	12	10.20 a. m. ..	911.79	568.2	17.5	568.4
On second small creek	12	1.30 p. m.	913.81	563.7	20	564.1
Camp 62, Cebolla creek, first branch.	12	7 p. m.	920.16	590.6	13	598.4
	12	9 p. m. ....	.....	589.3	11	590.7
	13	6 a. m. ....	.....	588.6	9	589.6
Camp 63, Cebolla creek, second branch.	13	12 m.	923.91	588.9	22.5	589.1
	13	3 p. m. ....	.....	587.3	23	587.2
	13	6 p. m. ....	.....	586.4	17	587.4
	13	9 p. m. ....	.....	585.3	12	586.5
Summit of mountain	14	10 a. m.	927.71	560	18.5	561.2
Camp 64, Cedar creek	14	Night .....	.....	.....	.....	.....
	15	Morning	936.91	.....	.....	.....
Crossing, Cedar creek	15	10 a. m.	938.91	599.1	21.5	598.6
Camp 65, Uncompahgra river	15	4 p. m.	949.20	617.3	27.5	615.2
	15	5 p. m. ....	.....	617.3	27.5	615.2
	15	6 p. m. ....	.....	616	25	615
	15	8 p. m. ....	.....	615.7	21	614.9
	15	9 p. m. ....	.....	615.2	12	613.3
	16	6 a. m. ....	.....	614.8	14	614.5
Camp 66, Uncompahgra river	16	3 p. m.	967.43	632.4	26.5	631.9
	16	5 p. m. ....	.....	631.9	25	630.2
	16	6 p. m. ....	.....	631.9	25	630.2
	16	9 p. m. ....	.....	631.3	15	629.3
	17	6 a. m. ....	.....	630.4	5	629.8
Camp 67, on hill	17	Night	987.76	.....	.....	.....
Camp 68, Kah-nah creek	18	11 a. m.	996.21	646	21.5	646.4
	18	1 p. m. ....	.....	645.2	20	645.6
	18	3 p. m. ....	.....	645.2	23	645.6
	18	6 p. m. ....	.....	643.6	20.5	645
	18	9 p. m. ....	.....	643.9	12	645.4
	19	6 a. m. ....	.....	642.2	3	645.3
Creek	19	10.30 a. m. ..	1000.43	651.8	27	652.4
Small ridge	19	11.30 a. m. ..	1003.21	649.2	24	648.1
Second ridge	19	12.30 a. m. ..	1004.93	645.1	24	644.9
Foot of ridge	19	12.45 p. m.	1006.07	649.7	27.5	649.3
Camp 69, Blue river	19	2 p. m.	1009.61	652.1	23.5	652.3
	19	2.30 p. m. ....	.....	652.1	23.5	652.3
	19	6 p. m. ....	.....	651	21	650.5
	19	9 p. m. ....	.....	649.9	10.5	650.4
	20	6 a. m. ....	.....	650.5	10.5	651.9
	20	7.15 a. m. ....	.....	651.2	13	652.6
Camp 70, Blue river	20	1 p. m.	1018.71	655.9	32	655.8
	20	3 p. m. ....	.....	655.6	33	653.4
	20	5 p. m. ....	.....	654	26.5	651.2
	20	9 p. m. ....	.....	652.5	10	650.6
	21	6 a. m. ....	.....	653.3	10	652.9
Camp 71, Little Salt creek ..	21	4 p. m.	1033.00	656.6	20.5	654.7
	21	9 p. m. ....	.....	653.8	15	653
	22	6 a. m. ....	.....	654.2	5	653.9

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches	Feet.	
10	59	22.363	22.402	22.418	.....	Dark clouds; light northeast breeze.
4	35	22.388	22.446	22.449	.....	Do do.
15	67	22.305	22.293	.....	8297.2	
17	60	22.267	22.254	.....	8286.2	
17.5	69	22.260	22.247	.....	8373	Rain.
19.5	73	22.124	22.144	.....	8559	
13	55	23.221	23.528	.....	7026.4	Light clouds; light southeast breeze.
11	51	23.158	23.213	23.170	.....	Do do.
9	47	23.132	23.171	23.304	.....	Do do.
22.5	66	23.078	23.086	.....	7355.1	Dark clouds; light southwest breeze.
23	78	23.070	23.066	.....	.....	Do do.
17	64	23.062	23.101	23.052	.....
12	60	22.997	23.044	23.077	.....
18.5	68	21.920	21.970	21.945	8755	
-----						No barometric observations at this camp.
21.5	76	23.454	23.435	23.444	6962	
27.5	82	24.238	24.156	.....	6085	Clear; fresh breeze from southeast.
27.5	81	24.243	24.161	.....	.....	Do do.
25	79	24.180	24.141	.....	.....	Do do.
21	71	24.159	24.127	.....	.....	Do do.
12	64	24.174	24.099	24.190	.....	Do do.
14	59	24.143	24.131	24.135	.....	Light clouds.
26.5	79	24.822	24.802	.....	5331.9	Cloudy; strong southwest wind.
25	77	24.826	24.759	.....	.....	Do do.
25	73	24.806	24.739	.....	.....	Do do.
15	61	24.796	24.717	24.809	.....	Do do.
5	37	24.793	24.769	24.757	.....	Clear; light southwest breeze.
-----						No barometric observations.
21.5	66	25.292	25.308	.....	4703.6	Clear; light southeast breeze.
20	66	25.314	25.314	.....	.....	Do do.
23	69	25.338	25.353	.....	.....	Do do.
20.5	67	25.286	25.341	.....	.....	Do do.
12	51	25.304	25.363	25.295	.....	Do do.
3	35	25.265	25.387	25.346	.....	Do do.
27	63	25.500	25.523	.....	4514.6	
24	87	25.421	25.378	.....	4754.2	
24	87	25.285	25.277	.....	4886.4	
27.5	89	25.454	25.438	.....	4710.5	
23.5	87	25.594	25.602	.....	4449	Clear; light breeze from southeast.
23.5	87	25.604	25.612	.....	.....	Do do.
21	68	25.574	25.554	.....	.....	Do do.
10.5	50	25.544	25.563	.....	.....	Do do.
10.5	50	25.560	25.615	25.574	.....	Do do.
13	57	25.567	25.622	25.594	.....	Do do.
32	92	25.688	25.684	.....	4410.3	
33	95	25.684	25.617	.....	.....	Do do.
26.5	83	25.788	25.625	.....	.....	Do do.
10	54	25.650	25.575	25.679	.....	Do do.
10	43	25.675	25.659	25.624	.....	Do do.
20.5	87	25.813	25.738	.....	4274.1	
15	63	25.678	25.646	25.742	.....	Do do.
5	31	25.730	25.718	25.698	.....	Do do.

Barometric and meteorological

Station.	Day.	Hour.	Distance from West-port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 561.
	1853.		<i>Miles.</i>			
Noon halt.....	Sept. 22	12 m.....	1042. 11	646. 1	27	646. 2
Camp 72, Bitter Water creek	23	6 a. m.....	1054. 75	655. 2	2	653. 2
	23	9 a. m.....		655. 5	19	653. 8
	23	12 m.....		655. 7	33. 5	653. 7
	23	3 p. m.....		654. 4	36. 5	652
	23	6 p. m.....		652. 7	26	651. 1
	24	6 a. m.....		651. 3	6	651. 1
	24	6 p. m.....		648. 9	19	646. 4
	24	9 p. m.....		647. 7	15. 5	647
	25	6 a. m.....		649. 4	13	648. 2
	26	7 a. m.....		651. 5	16	651. 6
Camp 73, Rain Water creek.	26	6.30 p. m...	1071. 03	648. 3	18	647. 6
	27	6 a. m.....		651. 8	4	649. 6
Camp 74, on hill.....	27	5 p. m.....	1076. 70	640. 8	19	642. 1
	27	8 p. m.....		640. 5	19	639. 6
	28	6 a. m.....		639. 9	9	639. 7
Camp 75, creek.....	28	7 p. m.....	1093. 42	645. 3	16	644. 5
	29	9 p. m.....		645. 3	16	644. 5
	29	6 a. m.....		644. 4	6. 5	644. 4
	29	8 a. m.....		646. 4	13	649. 4
	29	12 m.....	1100. 52	651. 2	23	649. 4
Camp 76, water in holes in dry creeks.	29	4.30 p. m...	1107. 52	649. 9	20	650. 1
	29	6 p. m.....		649. 3	18	649. 3
	29	9 p. m.....		649. 2	14. 5	649
	30	6 a. m.....		651. 4	12. 5	649. 8
	30	8 a. m.....		651. 4	14	650. 1
On ridge.....	30	12 m.....	1115. 51	658. 5	19. 5	656. 8
Camp 77, Green river.....	30	3 p. m.....	1121. 52	664. 3	20	664. 6
	30	4 p. m.....		664. 2	20	663. 7
	30	6 p. m.....		663. 7	17	663. 2
	30	9 p. m.....		663. 7	15	663. 2
	Oct. 1	6 a. m.....		663. 5	7	664. 1
	1	8 a. m.....		664. 5	14	665. 6
Camp 78, west bank of Green river.	1	12 m.....	1122. 60	667. 6	22	667. 3
	1	3 p. m.....		666. 8	26	665
	1	6 p. m.....		665. 8	19	664. 5
	1	9 p. m.....		665. 2	13. 5	664. 9
	2	6 a. m.....		664. 5	6	665. 9
Station on ridge.....	2	12 m.....	1130. 81	663. 6	24	663. 2
Camp 79, Spanish trail, Akanaquint spring.	2	6 p. m.....	1139. 35	650. 9	24	651. 3
	2	9 p. m.....		649. 9	10	650. 4
	3	6 a. m.....		649. 1	7	649. 4
	3	8 a. m.....		650	17	649. 8
Station, bed of creek.....	3	12 m.....	1143. 95	642. 5	25	643. 8
Leaving Spanish trail.....	3	1 p. m.....	1145. 09	639. 9	25	637
Camp 80, Dry creek.....	3	7 p. m.....	1155. 13	642. 7	16	643. 9

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>	
27	86	25.302	25.306	.....	4855.6	Clear; light breeze from southeast.
2	32	25.781	25.702	.....	4486.4	Do do.
19	56	25.689	25.622	.....	.....	Do do.
33.5	91	25.653	25.574	.....	.....	Do do.
36.5	90	25.644	25.550	.....	.....	Do do.
24	78	25.621	25.566	.....	.....	Do do.
6	32	25.611	25.604	.....	.....	Do do.
19	76	25.503	25.404	.....	.....	Do do.
15.5	60	25.437	25.410	.....	.....	Do do.
13	58	25.509	25.462	25.575	.....	Rain; light breeze from southwest.
16	58	25.563	25.567	25.524	.....	Do do.
18	64	25.474	25.447	25.557	4454.3	Cloudy; light breeze from southwest.
4	45	25.639	25.552	25.498	.....	Do do.
19	62	25.204	25.251	.....	4856.2	Rain.
19	56	25.147	25.112	25.166	.....	Cloudy.
9	50	25.151	25.143	25.170	.....	Rain; light southwest breeze.
16	64	25.363	25.331	.....	4641.9	Clear; light southeast breeze.
16	56	25.343	25.311	.....	.....	Do do.
6.5	46	25.336	25.336	25.351	.....	Do do.
13	54	25.368	25.486	25.367	.....	Do do.
				25.558	.....
23	74	25.558	25.448	25.448	4575.5	Do do.
20	67	25.549	25.557	.....	4468.8	Cloudy.
18	65	25.519	25.519	.....	.....	Do.
14.5	59	25.540	25.492	.....	.....	Do.
12.5	49	25.584	25.525	25.552	.....	Do.
14	56	25.561	25.510	25.520	.....	Do.
				25.822	.....
19.5	67	25.822	25.755	25.755	4231.5	Do.
20	69	26.101	26.113	.....	3873.3	Light clouds; light breeze from southeast.
20	67	26.112	26.089	.....	.....	Light clouds.
17	62	26.089	26.070	.....	.....	Do.
15	60	26.067	26.126	.....	.....	Do.
7	44	26.092	26.112	26.086	.....	Clear.
14	58	26.073	26.116	26.102	.....	Do.
22	68	26.164	26.153	.....	3828.3	Do.
26	80	26.172	26.101	.....	.....	Do.
19	67	26.164	26.113	.....	.....	Do.
13.5	60	26.134	26.122	26.152	.....	Do.
6	37	26.131	26.186	26.136	.....	Do.
				25.999	.....
24	79	25.999	25.983	25.983	4062	
24	72	25.558	25.574	.....	4457	Do.
10	55	25.548	25.567	.....	.....	Do.
7	43	25.521	25.533	25.526	.....	Do.
17	54	25.490	25.482	25.542	.....	Do.
				25.172	.....
25	92	25.172	25.224	25.224	5005.5	Do.
				25.090	.....
25	92	25.090	24.976	24.976	5194.5	
16	65	25.265	25.312	.....	4753.5	Do.

Barometric and meteorological

Station.	Day.	Hour.	Distance from West port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		Miles.			
Camp 80—Continued.....	Oct. 3	9 p. m. ....	.....	642.3	14	642.5
	4	6 a. m. ....	.....	642.9	7	640.9
Leaving Dry creek.....	4	10.30 a. m..	1159.92	648.6	22	648
Station near White river ...	4	12 m.	1162.02	651.1	25	648.5
Camp 81, White river.....	4	3 p. m.	1164.95	648.9	29	648.9
	4	6 p. m. ....	.....	647.4	21	646.3
	4	9 p. m. ....	.....	647.3	15	647.3
	5	6 a. m. ....	.....	646.6	7	647.7
Camp 82, Clever creek.....	5	3 p. m.	1173.65	640.2	26.5	640.4
	5	6 p. m. ....	.....	639.9	23	639.9
	5	9 p. m. ....	.....	638.4	14	638.1
	6	6 a. m. ....	.....	637.5	6	632.2
Leaving Clever creek.....	6	11 a. m.	1178.15	635.2	19.5	633.7
Noon halt.....	6	12 m.	1180.67	632	23.5	630
Camp 83, hill overlooking White river.	6	4.30 p. m..	1184.77	632.3	25	633
	6	6 p. m. ....	.....	632.1	21	631.6
	6	9 p. m. ....	.....	631.5	13	632.5
	7	6 a. m. ....	.....	630.7	5	632.7
Station.....	7	12 m.	1191.35	630.2	25.5	628.6
Camp 84, Standing Water creek.	7	6 p. m.	1198.03	620.8	23	619.9
	7	9 p. m. ....	.....	620.7	11	620.7
	8	6 a. m. ....	.....	619.7	5	620
Station near San Rafael, first branch.	8	12 m.	1205.75	626.2	26	624
Camp 85, San Rafael, second branch.	8	6 p. m.	1211.23	629.3	24	626.6
	8	9 p. m. ....	.....	635.4	14	635.3
	9	6 a. m. ....	.....	626.5	4	626
	9	9 a. m. ....	.....	627.4	13	626.8
	9	12 m. ....	.....	628.7	24	627.4
	9	3 p. m. ....	.....	627.7	22	625.5
	9	6 p. m. ....	.....	626.3	17	624.9
	9	9 p. m. ....	.....	626.3	14	624.9
	10	6 a. m. ....	.....	625.7	12	626.7
Spanish trail.....	10	12 m.	1218.85	623.6	25	621.6
Camp 86, Garambulla river.	10	3.30 p. m..	1222.63	620.8	24	619.3
		6 p. m. ....	.....	620.5	18	620
		9 p. m. ....	.....	620.5	11	620
	11	6 a. m. ....	.....	619.4	3	621.2
Dividing ridge.....	11	12 m.	1230.43	613.1	24.5	612.1
Camp 87, Big Rock creek..	11	3.30 p. m..	1236.09	616.4	22.5	614
	11	6 p. m. ....	.....	615.7	17	613.2
	11	9 p. m. ....	.....	614.8	6	612.9
	12	6 a. m. ....	.....	613.5	.....	612
Noon halt.....	12	11.45 a. m..	.....	617.3	24	615.9
Crossing of stream.....	12	12 m.	1243.30	617	21	615.6
Camp 88, Oak springs.....	12	6 p. m.	1251.74	597.1	17	597.9
	12	9 p. m. ....	.....	596.9	16	598.1
	13	6 a. m. ....	.....	596.2	9	595.8
	13	8 a. m. ....	.....	596.6	9	597.2

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barome- ter, No. 496.	Corrected barome- ter, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches.	Feet.	
14	60	25.233	25.241	25.256	-----	Clear.
7	38	25.277	25.198	25.249	-----	Do.
22	82	25.395	25.372	-----	4747.5	Do.
25	83	25.511	25.408	-----	4667.3	
29	81	25.460	25.460	-----	4592.5	Clear; light breeze from north.
21	69	25.440	25.397	-----	-----	Do. do.
15	59	25.426	25.426	25.435	-----	Do. do.
7	38	25.423	25.466	25.435	-----	Do. do.
26.5	78	25.133	25.141	-----	4957.8	Light clouds; light southeast wind.
23	77	25.137	25.137	-----	-----	Do. do.
14	60	25.079	25.067	25.104	-----	Do. do.
5	34	25.072	25.100	25.108	-----	Do. do.
				24.899	-----	
19.5	64	24.899	24.835	24.835	5221.2	Do. do.
23.5	73	24.771	24.692	-----	5436	
	77	24.849	24.876	-----	5213.4	Clear; light breeze from northeast.
21	69	24.838	24.818	-----	-----	Do. do.
13	56	24.815	24.855	24.825	-----	Do. do.
5	31	24.804	24.883	24.856	-----	Do. do.
				24.696	-----	
25.5	82	24.696	24.633	24.633	5564	Do. do.
23	75	24.389	24.353	-----	5718.7	Cloudy.
11	51	24.394	24.394	24.382	-----	Do.
5	34	24.371	24.333	24.375	-----	Do.
				24.534	-----	
	74	24.534	24.444	-----	24.444	5718.4
				-----	-----	
				-----	5428.9	Light clouds.
24	77	24.719	24.613	-----	-----	Do.
14	58	24.973	24.969	-----	-----	Clear.
4	26	24.643	24.623	-----	-----	Do.
13	44	24.614	24.590	-----	-----	Cloudy; light northeast breeze.
24	66	24.641	24.590	-----	-----	Cloudy.
22	73	24.660	24.574	-----	-----	Do.
17	59	24.633	24.578	-----	-----	Do.
14	50	24.607	24.552	24.675	-----	Do.
12	50	24.580	24.619	24.631	-----	Do.
				24.436	-----	
25	76	24.436	24.357	-----	5837.5	
24	74	24.390	24.331	-----	5728.8	Clear; light breeze from southwest.
18	60	24.401	24.381	-----	-----	Do. do.
11	48	24.386	24.367	24.386	-----	Do. do.
3	32	24.367	24.438	24.378	-----	Do. do.
				24.027	-----	
24.5	69	24.027	23.987	23.957	6246.1	Clear.
22.5	74	24.224	24.130	-----	5957.8	Do.
17	61	24.215	24.117	-----	-----	Do.
6	45	24.182	24.107	24.193	-----	Do.
	21	24.147	24.088	24.110	-----	Do.
	74	24.168	24.113	24.178	-----	Do.
24	70	24.188	24.133	24.123	6098.2	
17	62	23.484	23.515	-----	6789.7	Dark clouds; light northwest wind.
16	58	23.446	23.493	-----	-----	Do. do.
9	48	23.431	23.415	23.444	-----	Do. do.
9	50	23.424	23.447	23.467	-----	Cloudy; strong northwest wind.

Barometric and meteorological

Station.	Day.	Hour.	Distance from West port.	Barometric reading, No. 496.	Attached thermometer, (C.)	Barometric reading, No. 551.
	1853.		Miles.			
Camp 88—Continued	Oct. 13	10 a. m.				595.8
Summit of Wahsatch Pass..	13	2.15 & 1.15 p. m.	1258.39	574.5	14.7	574.4
Camp 89, Salt creek—western slope of Wahsatch mountains.	13	5 p. m.	1262.96			591
	13	6 p. m.		590.2	14	589.5
	13	9 p. m.		590.5	11	590.9
	14	6 a. m.		590.1	7	590.7
Camp 90, Swambah creek ..	14	6 p. m.	1267.96	577.1	8	576.7
	14	9 p. m.		582.7	11	577
	15	6 a. m.		575.5	2	576.9
	15	8.30 a. m.		577.7	12	577.3
Camp 91, Ungottahbikin creek.	15	5 p. m.	1276.46			602
	15	6 p. m.		602	13	602.1
	15	9 p. m.		602	10	603
	16	6 a. m.		602.7	8	603
	16	9 a. m.		603	18	603.2
	16	12 m.		603.7	20	603.2
	16	3 p. m.		603.7	21	603.2
	16	6 p. m.		602.8	16	602.8
	16	9 p. m.		599.2	9	603.1
	17	6 a. m.		601.8	7	603.2
Camp 92, Sevier river.....	17	5.30 p. m.	1290.71			636.1
	17	6.30 p. m.		637.3	16	636.1
	17	9 p. m.		636.8	10	636.6
	18	6 a. m.		635.9	2	636.3
	18	8 a. m.		637.4	15	636.6
	18	9 a. m.		637.4	16	636.6
Camp 93, San Pete creek...	18	6 p. m.	1302.53	637.7	19	637.5
	18	9 p. m.		636.5	12	637
	19	6 a. m.		635.8	1	637.5
Station above Sevier river ..	19	12 m.	1312.62	639.7	23	637.2
Camp 94, Sevier river.....	19	6 p. m.	1321.63	640.6	18	639.9
	19	9 p. m.		639	15	637.8
	20	6 a. m.		640.4	1	640.2
Camp 95, on north bend of Sevier river, one mile above bridge.	20	9.30 a. m.	1324.08	642.2	19	641.6
	20	12 m.		642.2	20	641.6
	20	3 p. m.		641.9	21	640.7
	20	6 p. m.		642.5	17	642.2
	20	9 p. m.		642.5	7	642.2
	21	6 a. m.		640.8	—	642.3
Summit of ridge north of Lake valley.	21	11 a. m.	1328.57	631.1	15	629.4
In Lake valley.....		12 m.	1335.96	633.8	17	632.9
Summit of ridge south of Lake valley.		3 p. m.	1339.48	616.9	13	615.5
Camp 96, Cedar Springs....	21	6.30 p. m.	1348.28	633.9	13	632.8
	21	9 p. m.		632.7	11	632.5
	22	6 a. m.		632.6	7	630.8
	22	9 a. m.		632.8	8	631.9
	22	12 m.		631.7	9	632.6
	22	3 p. m.		632	6	632.9
	22	6 p. m.		632	6	632.9

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Height above sea.	Remarks.
		Inches.	Inches.	Inches.	Feet.	
12	50	.....	23.360	.....	.....
9	58&48	22.619	22.615	.....	7820	
13	50	.....	23.271	.....	6976.6	
14	47	23.229	23.192	.....	.....	Cloudy.
11	38	23.205	23.221	23.205	.....	Do.
7	35	23.198	23.222	23.213	.....	Do.
8	47	22.720	22.704	.....	7623.1	Clear.
11	53	22.899	22.674	.....	.....	Do.
2	35	22.643	22.696	22.730	.....	Do.
12	48	22.663	22.644	22.679	.....	Do.
15	56	.....	23.692	.....	6551.2	Light clouds.
13	55	23.680	23.684	.....	.....	Do.
10	53	23.663	23.701	.....	.....	Clear.
8	48	23.686	23.698	.....	.....	Do.
19	65	23.630	23.638	.....	.....	Do.
20	69	23.660	23.641	.....	.....	Do.
21	70	23.712	23.771	.....	.....	Do.
16	65	23.700	23.700	.....	.....	Do.
9	49	23.556	23.709	23.659	.....	Do.
7	44	23.659	23.714	23.694	.....	Do.
22	69	.....	24.998	.....	5019.1	Clear; light breeze from northwest.
16	60	25.053	25.006	.....	.....	Do do.
10	54	25.032	25.024	.....	.....	Do do.
2	33	25.021	25.037	.....	.....	Do do.
15	63	25.006	24.974	25.018	.....	Do do.
16	63	24.992	24.960	25.002	.....	Do do.
19	60	25.062	25.054	.....	4960.5	Clear.
12	58	25.012	25.032	25.032	.....	Do.
1	34	25.021	25.088	25.056	.....	Do.
				25.066	.....
23	76	25.066	24.968	24.968	5128.3	
18	65	25.180	25.152	.....	4869.1	Broken clouds.
15	64	25.099	25.052	25.158	.....	Cloudy.
1	32	25.202	25.194	25.134	.....	Do.
19	61	25.164	25.140	.....	4782.7	Do.
20	69	25.176	25.152	.....	.....	Do.
21	70	25.215	25.168	.....	.....	Do.
17	60	25.259	25.247	.....	.....	Do.
7	47	25.268	25.256	25.222	.....	Do.
— 6	20	25.245	25.304	25.210	.....	Do.
15	56	24.733	24.666	.....	5376.1	
17	60	24.861	24.826	.....	5237.5	
13	52	24.267	24.212	.....	5871.2	
13	54	24.931	24.889	.....	5131.1	Light floating clouds.
11	57	24.867	24.859	.....	.....	Do do.
7	40	24.871	24.801	.....	.....	Do do.
8	52	24.842	24.807	.....	.....	Do do.
9	59	24.810	24.845	.....	.....	Do do.
6	45	24.889	24.924	.....	.....	Do do.
6	45	24.889	24.924	.....	.....	Do do.

Barometric and meteorological

Station.	Day.	Hour.	Distance from West- port.	Barometric reading, No. 496.	Attached thermome- ter, (C.)	Barometric reading, No. 551.
	1853.		Miles.			
Camp 96—Continued	Oct. 22	9 p. m. ....	.....	632	6	632.4
	23	6 a. m. ....	.....	631.8	— 8	632.2
	23	9 a. m. ....	.....	634.5	10	633.8
	23	12 m. ....	.....	632.9	10	631.6
Camp 98, Sevier river.....	24	12 m.	1373.71	645	14	649.9
	24	3 p. m. ....	.....	642.2	21	647
	24	6 p. m. ....	.....	637.5	12	641.2
	24	9 p. m. ....	.....	637.5	12	645.2
	25	6 a. m. ....	.....	641	3	641.6
Camp 102, Pioneer creek...	30	6 a. m.	1419.80	639	.....	639.3
	30	9 a. m. ....	.....	640.3	14	639.2
	30	12 m. ....	.....	640.2	19	637.6
	30	3 p. m. ....	.....	640.2	20	637.6
	30	6 p. m. ....	.....	638.5	12	634.2
Camp 103, Sevier river, } near former camp 95. }	Nov. 1	6 a. m.	1448.04	634.3	— 2	633.3
Camp 104, Nephi city	2	6 a. m.	1472.89	636.7	—10	636
	2	9 a. m. ....	.....	638	8	636.1
	2	12 m. ....	.....	637.6	15	636.3
	2	3 p. m. ....	.....	636.9	17	635.4
	2	6 p. m. ....	.....	635.5	5	634.6
	3	6 a. m. ....	.....	634.1	— 1	633.6
Camp 105, Payson city	3	6 p. m.	1498.07	646.9	9	646.7
	3	9 p. m. ....	.....	646.5	7	646.3
	4	6 a. m. ....	.....	640.7	— 1	641.7
Camp 106, Provo city.....	4	6 p. m.	1517.30	650.3	18	649.8
	4	9 p. m. ....	.....	649.8	9	649.6
	5	6 a. m. ....	.....	649.5	.....	651
Camp 107, American Fork..	5	3 p. m.	1531.30	617.5	19	647
	5	6 p. m. ....	.....	646	12	644.4
	5	9 p. m. ....	.....	646	9	644.4
	6	6 a. m. ....	.....	645.7	6	644.6
Camp 108, Willow creek ...	6	3 p. m.	1546.70	643.9	16	642.9
	6	6 p. m. ....	.....	642.8	12	642
	6	9 p. m. ....	.....	642.8	12	642
	7	6 a. m. ....	.....	642.6	11	642
Camp 109, Cottonwood, near Great Salt Lake city.	7	3 p. m.	1558.15	650.6	5	650.7
	7	6 p. m. ....	.....	650.5	3	651.3
	7	9 p. m. ....	.....	650.8	2	651.6
	8	6 a. m. ....	.....	650.8	.....	651.6
Great Salt Lake city.....	.....	.....	1567.95	.....	.....	.....

observations—Continued.

Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 49i.	Corrected barometer, No. 55I.	Barometric means.	Height above sea.	Remarks.
		<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>	
6	44	24.859	24.874	.....	.....	Light floating clouds.
— 8	15	24.899	24.915	.....	.....	Do do.
10	49	24.901	24.874	24.873	.....	Do do.
10	52	24.853	24.802	24.865	.....	Do do.
14	52	25.314	25.507	.....	4692.7	Clear; light breeze from southwest.
21	71	25.227	25.416	.....	.....	Do do.
12	56	25.082	25.227	.....	.....	Light clouds.
12	20	25.052	25.355	25.176	.....	Dark clouds; snow fell during the night.
3	20	25.218	25.242	25.349	.....	Snow in mountains.
0	20	25.151	25.163	.....	4921.6	Not used in profile.
14	58	25.114	25.071	.....	.....	Clear.
19	66	25.105	25.003	.....	.....	Do.
20	66	25.152	25.050	25.128	.....	Do.
12	49	25.121	24.952	25.050	.....	Do.
— 2	18	24.974	24.934	24.974	4887.5	
.....	.....	.....	.....	24.934	.....
—10	15	25.100	25.072	.....	4938.4	Clear; light northwest breeze.
8	44	25.047	24.972	.....	.....	Clear.
15	56	25.019	24.968	.....	.....	Do.
17	56	25.038	24.979	.....	.....	Do.
5	38	25.030	24.995	25.033	.....	Do.
— 1	28	24.962	24.942	24.990	.....	Do.
9	49	25.463	25.456	.....	4540.7	Do.
7	42	25.426	25.418	25.371	.....	Do.
— 1	24	25.222	25.261	25.379	.....	Do.
18	56	25.562	25.503	.....	4362.6	Do.
9	42	25.548	25.540	25.556	.....	Do.
0	26	25.564	25.623	25.556	.....	Light clouds.
19	68	25.448	25.423	.....	4596.1	Light clouds; light breeze from northwest.
12	52	25.416	25.353	.....	.....	Light clouds.
9	48	25.398	25.335	25.411	.....	Do.
6	42	25.391	25.348	25.364	.....	Do.
16	56	25.318	25.279	.....	4733.4	Cloudy; strong northwest wind.
12	52	25.290	25.259	.....	.....	Cloudy.
12	50	25.260	25.229	25.277	.....	Do.
11	50	25.249	25.226	25.246	.....	Do.
5	39	25.625	25.629	.....	4241.1	Cloudy; strong northwest wind.
3	36	25.629	25.660	.....	.....	Do do.
2	30	25.614	25.646	25.620	.....	Clear; light northwest wind; snow-storm at night.
	25	25.662	25.647	25.643	.....	Do do.
.....	.....	.....	.....	.....	4351	Altitude determined from all the observations taken at this place, from November, 1853, to May, 1854. Tables will accompany subsequent report.

CHAPTER X.

Roubideau's Pass—Altitudes above Camp 46, (Creek.)

Station.	Hour.	Barometer, in inches, No. 496.	Attached ther., (F.)	Corrected barometer, in inches.	Det'd ther- mometer.	Height above camp 46.	Entire alti- tude.	Dist. from camp 46.
Camp 46							7638	
Level of base of mountain.....	3.30 p. m.....	22.496	85.1	22.420	73	517.86	8155.9	6.25
Outlet of pass.....	2.30 p. m.....	22.390	82.4	22.225	76	968.12	8606.1	7.85
Two miles from summit	10.40 a. m.....	21.855	59.9	21.764	65	} 1341.00	8979.1	9.10
Two miles from summit	2 p. m.....	21.855	64.4	21.778	62.5			
One mile from summit	1.30 p. m.....	21.551	84.2	21.449	72	1718.15	9356.1	9.80
Summit station.....	12½ p. m.....	21.272	78.8	21.163	62	2134.11	9772.1	10.55

Simultaneous observations at Coochetopa Pass.

ADVANCE PARTY.							REAR PARTY.					
Date.	Hour.	Station.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, in inch's.	Attached thermometer, (F.)	Station.	Hour.	Barometer, No. 551.	Attached thermometer, (C.)	Barometer, in inch's.	Attached thermometer, (F.)
Sept. 2	9 a. m.....	Station 1.....	536	20	21.890	68						
	10 a. m.....	Station 2.....	550.5	22.5	21.634	72.5	Station 1.....	10 a. m.....	555.6	22	21.874	71.6
	11 a. m.....	Station 3.....	544.7	24.5	21.445	76.1	Station 2.....	11 a. m.....	550.3	23	21.666	73.4
	12 m.....	Station 4.....	539.2	20	21.229	68	Station 3.....	12 m.....	544.1	25	21.421	77
	1 p. m.....	Summit.....	532.4	17	20.961	62.6	Station 4.....	1 p. m.....	540	23	21.260	73.4
	1.30 p. m.....	do.....	532.3	15	20.957	59	Summit.....	1.30 p. m...	532.9	15	20.981	59
							Do.....	2 p. m.....	532.8	13	20.977	55.4

Observations for a deep cut or tunnel, allowing fifty yards as width of the ridge at top.

Sept. 2	12.45 p. m..	Summit.....	532.4	17	20.961	62.6	.....	.....	.....	.....	.....	.....
	1 p. m.....	*350 feet east...	534.4	17.5	21.240	63.5	.....	.....	.....	.....	.....	.....
	1.15 p. m...	Summit.....	532.5	17.5	20.965	63.5	.....	.....	.....	.....	.....	.....
	1.20 p. m...	*350 feet west ..	533	16.5	20.985	61.7	.....	.....	.....	.....	.....	.....
	1.30 p. m...	Summit.....	532.3	15.5	20.957	59.9	.....	.....	.....	.....	.....	.....

Besides 150 feet, the width of ridge at summit level.

Simultaneous observations at Coochetopa Pass—Continued.

ADVANCE PARTY.							REAR PARTY.					
Date.	Hour.	Station.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, in inches.	Attached thermometer, (F.)	Station.	Hour.	Barometer, No. 551.	Attached thermometer, (C.)	Barometer, in inches.	Attached thermometer, (F.)
Sept. 3	6 a. m.	Camp 54.	541.4	11	21.316	51.8	Camp 54.	6 a. m.	540.7	11	21.288	57.8
	8 a. m.	Station 1.	547.4	21	21.552	69.8	Do.	8 a. m.	541.5	18	21.320	64.4
	9 a. m.	Station 2.	550.3	23.7	21.666	74.6	Station 1.	9 a. m.	546.8	23	21.528	73.4
	10 a. m.	Station 3.	554	25	21.811	77	Station 2.	10 a. m.	549	23	21.614	73.4
	11 a. m.	Station 4.	556.4	22.2	21.906	71.9	Station 3.	11 a. m.	553.5	25	21.792	77
	1 p. m.	Station 5.	554.1	25	21.815	77	Station 4.	1 p. m.	560	24	22.048	75.2
	2 p. m.	Station 6.	548	22.8	21.575	73	Station 5.	2 p. m.	554.1	26	21.815	78.8
	3 p. m.	Station 7.	555.4	26	21.867	77	Station 6.	3 p. m.	545.8	25	21.489	77
	4 p. m.	Station 8.	559	25.5	22.009	77.9	Station 7.	4 p. m.	554.5	24	21.831	75.2
	5 p. m.	Camp 55.	564.4	27	22.221	80.6	Station 8.	5 p. m.	557.5	24	21.950	75.2
	6 p. m.	do.	564.4	24	22.221	75.2	Camp 55.	6 p. m.	564.2	23.5	22.213	74.3
	9 p. m.	do.	562.2	13	22.134	55.4	Do.	9 p. m.	562.5	13	22.146	55.4

Data for profile of Coochetopa Pass.

Date.	Hour.	Station.	Corrected barometer, 496.	Air thermometer.	Station.	Corrected barometer, 551.	Air thermometer.	Difference of altitudes.	Entire altitude.	Intermediate dist'ce	Entire distance.
1853.				o			o	<i>Feet.</i>	<i>Feet.</i>	<i>Miles.</i>	<i>(Miles from camp 53.)</i>
Sept. 2	9 a. m.	Station 1...	21.812	70	Camp 53...	21.682*	84	— 62	8898		
	10 a. m.	Station 2...	21.550	66	Station 1...	21.790	65	312	9210	1.62	1.62
	11 a. m.	Station 3...	21.354	71	Station 2...	21.581	68	300	9510	1.39	3.01
	12 m.	Station 4...	21.154	60	Station 3...	21.328	65	230.3	9740.3	.58	3.59
	1 p. m.	Station 5, summit.	20.897	64	Station 4...	21.174	64	291.7†	10032	.24	3.83
	1.30 p. m. ...	Station 5, summit.	20.900	59	Station 5, summit.	20.924	59				
					Station 5, summit.	20.936	58				
	Means at...	Camp 54...	21.289	61	Camp 54...	21.281	61	—492	9540	1.33	5.16

Declivities near summit.

Sept. 2	12.45 p. m. ...	Summit....	20.897	64							
	1 p. m.	Station east.	20.974	59	-----	-----	-----	—102.3	-----	350 ft. east of summit.	
	1.15 p. m. ...	Summit....	20.899	59							
	1.20 p. m. ...	Station west.	20.962	58	-----	-----	-----	— 82.5	-----	350 ft. west of summit.	
	1.30 p. m. ...	Summit....	20.898	58							

* Station 1 compared with camp 53 and corrected.

† The altitude of station 5, at summit, determined by comparison of all the observations made there with the mean at camp 54.

Data for profile of Cochetopa Pass—Continued.

Date.	Hour.	Station.	Corrected barometer, 496.	Air thermometer.	Station.	Corrected barometer, 551.	Air thermometer,	Difference of altitude.	Entire altitude.	Intermediate dist'ce,	Entire distance.	
1853,				°			°	Feet.	Feet.	Miles.	(Miles from camp 54.)	
Sept. 3	6 a. m.	Camp 54...	21, 271	55	Camp 54...	21, 244	55	-----	9540			
	8 a. m.	Station 1...	21, 472	59	... do.	21, 251	58	—243	9297	2, 24	2, 24	
	9 a. m.	Station 2...	21, 578	66	Station 1...	21, 442	64	—147	9150	2, 15	4, 39	
	10 a. m.	Station 3...	21, 716	70	Station 2...	21, 582	69	—191	8959	2, 05	6, 44	
	11 a. m.	Station 4...	21, 821	68	Station 3...	21, 697	74	—144	8815	3, 47	9, 91	
	1 p. m.	Station 5...	21, 720	66	Station 4...	21, 957	73	195	9010	1, 28	11, 19	
	2 p. m.	Station 6...	21, 490	71	Station 5...	21, 716	76	232	9342	1, 74	12, 93	
	3 p. m.	Station 7...	21, 772	74	Station 6...	21, 396	72	—353	8939	2, 14	15, 07	
	4 p. m.	Station 8...	21, 912	74	Station 7...	21, 740	75	—277	8712	2, 20	17, 27	
	5 p. m.	Camp 55, ...	22, 118	74	Station 8...	21, 859	73	} —197				
	6 p. m. do.	22, 130	68	Camp 55...	22, 123	68			8515	2, 73	20
9 p. m. ....	... do.	22, 082	59	... do.	22, 094	59					

Simultaneous observations at the pass and on the route followed across the Wahsatch range.—Camp 88 to Camp 89.

ADVANCE PARTY.							REAR PARTY.					
Date.	Hour.	Station.	Barometer, No. 551.	Attached ther.(C.)	Barometer, in inches.	Attached ther.(F.)	Station.	Hour.	Barometer, No. 496.	Attached ther.(C.)	Barometer, in inches.	Attached ther.(F.)
Oct. 13	8 a. m.	Camp 88.....	597.2	9	23.512	48.2						
	9 a. m.	Station 1.....	595.8	12	23.456	53.6	Camp 88	9 a. m.	598.4	9.8	23.560	49.6
	10 a. m.	Station 2.....	594.1	11	23.390	51.8	Station 1	10 a. m.	595.2	11.7	23.432	53
	11 a. m.	Station 3.....	589.7	11	23.217	51.8	Station 2	11 a. m.	594.3	11.4	23.398	52.5
	12 m.	Station 4.....	584.1	11	22.997	51.8	Station 3	12 m.	588.6	10.3	23.174	50.5
	1 p. m.	Station 5.....	577.1	11	22.721	51.8	Station 4	1 p. m.	582.9	12.3	22.952	54.1
	1.15 p. m.	Summit	574.4	9	22.615	48.2						
	2 p. m.	Station 6.....	583.1	12.5	22.957	54.5	Station 5	2 p. m.	575.5	13.1	22.658	55.6
							Summit	2.15 p. m.	574.5	14.7	22.619	58.4
	3 p. m.	Station 7.....	587.2	12	23.119	53.6	Station 6	3 p. m.	582.3	12.7	22.926	54.8
	4 p. m.	Camp 89.....	591	13	23.268	55.4	Station 7	4 p. m.	586.9	13	23.107	55.4
	5 p. m.	do.....	589.9	14	23.225	57.2	Camp 89	5 p. m.	590.2	13	23.237	55.4

Simultaneous observations at the pass and on the route followed across the Wahsatch range.—Camp 89 to Camp 90.

ADVANCE PARTY,							REAR PARTY.					
Date.	Hour.	Station.	Barometer, No. 551.	Attached ther.(C.)	Barometer, in inches,	Attached ther.(F.)	Station.	Hour.	Barometer, No. 496.	Attached ther.(C.)	Barometer, in inches,	Attached ther.(F.)
Oct. 14	6 a. m.	Camp 89.....	590, 7	7	23, 257	44, 6						
	9 a. m.	Station 1.....	592, 2	8	23, 316	46, 4	Camp 89	9 a. m.	591, 4	8	23, 284	46, 4
	10 a. m.	Station 2.....	591, 4	14	23, 284	57, 2	Station 1	10 a. m.	592, 2	15	23, 316	59
	11 a. m.	Station 3.....	584, 1	21	22, 997	69, 8	Station 2	11 a. m.	590, 6	16, 3	23, 253	61, 34
	12 m.	Station 4.....	585, 7	21	23, 060	69, 8	Station 3	12 m.	584, 1	21	22, 997	69, 8
	1 p. m.	Station 5.....	584, 1	21	22, 997	69, 8	Station 4	1 p. m.	585, 9	24, 5	23, 068	76, 1
	2 p. m.	Station 6.....	584, 8	20	23, 025	68	Station 5	2 p. m.	583, 8	25, 4	22, 985	77, 72
	3 p. m.	Station 7.....	582, 3	20	22, 926	68	Station 6	3 p. m.	582, 3	20	22, 926	68
	4 p. m.	Station 8.....	581	20	22, 875	68	Station 7	4 p. m.	581	20	22, 875	68
	5 p. m.	Camp 90.....	576, 7	8	22, 706	46, 4	Station 8	5 p. m.	576, 7	8	22, 706	46, 4
	6 p. m.	do.....	576, 7	8	22, 706	46, 4						

Simultaneous observations at the pass and on the route followed across the Wahsatch range.—Camp 90 to Camp 91.

ADVANCE PARTY.							REAR PARTY.						
Date.	Hour.	Station.	Barometer, No. 551.	Attached ther.(C.)	Barometer, in inches.	Attached ther.(F.)	Hour.	Station.	Barometer, No. 496.	Attached ther.(C.)	Barometer, in inches.	Attached ther.(F.)	
Oct. 15	8.30 a. m.	Camp 90.	577.3	12	22.729	53.6	8.30 a. m.	Camp 90.	577.3	12	22.729	53.6	
	9 a. m.	Station 1.	577	14	22.717	57.2		9 a. m.	Station 1.	577	14	22.717	57.2
	10 a. m.	Station 2.	570.6	20	22.465	68		10 a. m.	Station 2.	570.6	20	22.465	68
	11 a. m.	Station 3.	566.7	20	22.312	68		11 a. m.	Station 3.	566.7	20	22.312	68
	11.45 a. m.	Station 4.	556.3	18	21.903	64.4		1 p. m.	Station 4.	555.6	22.6	21.875	72.7
	1 p. m.	Station 5.	569.8	19	22.434	66.2		2 p. m.	Station 5.	568.8	17.9	22.395	64.2
	2 p. m.	Station 6.	579	20	22.796	68		3 p. m.	Station 6.	577.2	17	22.725	62.6
	3 p. m.	Station 7.	587.4	20	23.127	68		4 p. m.	Station 7.	586.6	20.4	23.107	68.7
	4 p. m.	Station 8.	590.7	19	23.257	66.2		5 p. m.	Station 8.	590.3	20.3	23.241	68.5
	5 p. m.	Camp 91.	602	15	23.701	59							
	6 p. m.	de.	602.1	15	23.705	59							

NOTE.—The first four observations recorded for the rear party are taken from barometer No. 551, as observed the previous hour.

Data for profile of the pass and the route followed across the Wahsatch range.—Camp 88 to camp 89.

Date.	Hour.	Station.	Corrected barometer, No. 551.	Air therm., (F.)	Station.	Corrected barometer, No. 496.	Air therm., (F.)	Difference of altitudes.	Entire alti- tude above camp 88.	Interme- diate distance.	Distance from camp 88.
										<i>Miles.</i>	<i>Miles.</i>
Oct. 13	8 a. m.	Camp 88	23.471	50							
	9 a. m.	Station 1	23.403	46	Camp 88	23.516	48	129.7	129.7	.61	.61
	10 a. m.	Station 2	23.342	50	Station 1	23.380	49	43.9	173.6	1.08	1.69
	11 a. m.	Station 3	23.169	50	Station 2	23.348	48	231.9	405.5	1.66	3.35
	12 m.	Station 4	22.949	50	Station 3	23.130	50	250.2	655.7	1.34	4.69
	1 p. m.	Station 5	22.674	49	Station 4	22.898	49	327.1	982.8	1.74	6.43
	1.15 p. m.	Summit	22.576	47				48.9	1031.7	.22	6.65
	2 p. m.	Station 6	22.904	54	Station 5	22.605	49	-359.8*	623	1.90	8.55
	2.15 p. m.				Summit	22.559	50	-415.6	616.1		
	3 p. m.	Station 7	23.067	50	Station 6	22.871	52	-232.8	383.3	1.70	10.25
	4 p. m.	Camp 89	23.212	50	Station 7	23.051	49	-190.1	193.2	.97	11.22
	5 p. m.	do	23.180	50	Camp 89	23.193	47				

* The next determination is used for the difference between stations 5 and 6—in effect using the previous barometric reading at station 5, instead of that of barometer No. 496. From station 2 to the summit the successive readings of barometer 496 are used, with a horary correction—those of No. 551 being in error. The summit not being a station, the first barometer arriving there at 1h. 15m. p. m. had no corresponding observation of the second barometer; at 2 p. m. the observations were simultaneous on opposite sides of the summit; at 2h. 15m. p. m. the second barometer, at the summit, was alone observed.

Data for profile of the pass and the route followed across the Wahsatch range.—Camp 89 to camp 90.

Date.	Hour.	Station.	Corrected barometer, No. 551.	Air therm., (F.)	Station.	Corrected barometer, No. 496.	Air therm., (F.)	Difference of altitudes.	Entire alti- tude above camp 89.	Interme- diate distance.	Distance from camp 89.
										<i>Miles.</i>	<i>Miles.</i>
Oct. 14	6 a. m.	Camp 89	23.244	35							
	9 a. m.	Station 1	23.275	48	Camp 89	23.254	43	- 24.9	- 24.9	.84	.84
	10 a. m.	Station 2	23.226	56	Station 1	23.273	49	+ 56.2	+313	1.25	2.09
	11 a. m.	Station 3	22.934	59	Station 2	23.192	58	+310.7	+342	.99	3.08
	12 m.	Station 4	22.995	60	Station 3	22.934	60	- 51	291	.60	3.68
	1 p. m.	Station 5	22.928	62	Station 4	23.007	58	+ 95.5	386.5	.31	3.99
	2 p. m.	Station 6	22.960	60	Station 5	22.918	61	- 50.1	336.4	.11	4.10
	3 p. m.	Station 7	22.861	60	Station 6	22.960*	60	+ 95.5	431.9	.20	4.30
	4 p. m.	Station 8	22.814	58	Station 7	22.861	60	+ 56.9	488.8	.12	4.42
	5 p. m.	Camp 90	22.669	47	Station 8	22.814	58	+174.9	663.7	.58	5
	6 p. m.	do.	22.669	47							

*The three following observations are taken from the readings of barometer 551 on the previous hours.

Data for profile of the pass and the route followed across the Wahsatch range.—Camp 90 to camp 91.

Date.	Hour.	Station.	Corrected barometer, No. 551.	Air therm., (F.)	Station.	Corrected barometer, No. 496.	Air therm., (F.)	Difference of altitudes.	Entire alti- tude above camp 90.	Interme- diate distance.	Distance from camp 90.
										<i>Miles.</i>	<i>Miles.</i>
Oct. 15	8.30 a. m.	Camp 90	22.690	48							
	9 a. m.	Station 1	22.676	49	Camp 90	22.690	58	28.8	28.8	.33	.33
	10 a. m.	Station 2	22.404	59	Station 1	22.676	49	355.9	384.7	.54	.87
	11 a. m.	Station 3	22.225	72	Station 2	22.404	59	251.7	636.4	.16	1.03
	11.45 a. m.	Station 4	21.828	66	Station 3	22.225	72	485.5	1121.9	.60	1.63
	1 p. m.	Station 5	22.357	67	Station 4	21.807	63	—700.4	421.5	2.24	3.87
	2 p. m.	Station 6	22.709	71	Station 5	22.330	61	—475.3	— 53.8	.78	4.65
	3 p. m.	Station 7	23.052	65	Station 6	22.685	60	—449.3	— 503.1	1.60	6.25
	4 p. m.	Station 8	23.186	63	Station 7	23.040	61	—176.4	— 679.5	.50	6.75
	5 p. m.	Camp 91	23.643	56	Station 8	23.174	61	—556.2	—1235.7	1.75	8.50
	6 p. m.	do.	23.649	55							

NOTE.—The first four observations entered, as at the rear stations, are taken from the readings of barometer 551 the previous hour.

CHAPTER XI.

Latitudes from Westport to Salt Lake City—1853.

In the following table of geographical positions the latitudes only are given. Lunar distances and culminations were also observed; but, from imperfections in the instruments, the results were deemed useless. The selection of astronomical instruments for this expedition was most unfortunate; they have all proved defective, and some entirely unfit for use.

In the duty of constructing the map, which devolved upon me by the death of Mr. Richard H. Kern, I have adopted the method of "course and distance," corrected by latitudes found by meridional observations, as being more reliable than the chronometric determinations. The accuracy of positions on the map, referred to the assumed longitudes, attest the fidelity and skill of the topographical notes and sketches by that gentleman.

SHEPPARD HOMANS,

In charge of Astronomical department.

Lieut. E. G. BECKWITH,

United States army, commanding expedition.

Geographical positions from Westport to Salt Lake City.

Date.	Locality.	Observation.	Declination.	Index error.	Double obs'd alt.	Corr. alt.	Latitude.
1853.			° ' "	' "	° ' "	° ' "	° ' "
June 16	Camp near Westport.....	Polaris.....		1 40.5			39 01 34
23	Indian creek.....	do.....		1 49.2			38 55 56
24	Cedar creek.....	do.....		2 15			38 52 41
26	Wahkarrussi ferry.....	do.....		2 15			38 55 15
27	Prairie spring.....	do.....		2 10			39 00 38
July 1	Near Kansas river.....	do.....		2 10			39 04 29
3	Opposite Fort Riley.....	do.....		2 10			39 03 19
5	.....	do.....		2 10			38 59 30
6	Solomon's Fork.....	do.....		2 05			38 55 29
7	Saline Fork.....	do.....		2 05			38 53 03
8	.....	do.....		2 05			38 44 51
9	.....	.....					38 27 38
11	Cow creek.....	Antares.....	—26 06 11	1 45	50 42 45	25 20 20	38 33 29
12	Walnut creek.....	do.....	—26 06 11	1 45	51 03 40	25 30 54	38 22 55
13	Pawnee Fork.....	Jupiter.....	—22 15 25	1 45	59 08 30	29 33 32	38 11 03
15	Coon creek.....	Antares.....	—26 06 11	1 45	52 11 30	26 04 49	37 49 00
21	Arkansas river.....	Jupiter.....	—22 13 15	1 43.5	59 39 40	29 49 11	37 57 34
23	do.....	Antares.....	—26 06 11	1 43.5	51 45 35	25 51 54	38 01 56
26	do.....	do.....	—26 06 11	1 43.5	51 22 50	25 40 31	38 13 18
27	do..... noon halt.....	Sun.....	19 08 10	1 40	141 27 10	70 59 57	38 08 13
28	do.....	do.....	18 54 19	1 40	141 09 00	70 50 52	38 03 27
30	do..... noon halt.....	do.....	18 25 37	2 06	140 00 00	70 16 32	38 09 05
30	Crossing Arkansas river.....	Altair.....	8 29 17	2 06	120 41 40	60 21 25	38 07 52
31	do..... do.....	Jupiter.....	—22 12 05	2 06	59 21 30	29 40 24	38 07 30
Aug. 1	Apishpa river, noon halt.....	Sun.....	17 55 40	2 06	139 10 40	69 51 57	38 03 43
2	do.....	Jupiter.....	—22 12 04	2 06	59 43 20	29 51 24	37 56 42
3	do..... noon halt.....	Sun.....	17 24 37	2 11	138 39 45	69 26 34	37 48 03
3	do.....	Jupiter.....	—22 12 05	2 11	60 03 10	30 01 20	37 46 35
4	do..... noon halt.....	Sun.....	17 08 39	1 37.5	138 16 20	69 24 34	37 44 06
4	In cañon.....	Jupiter.....	—22 12 07	1 37.5	60 04 25	30 01 44	37 46 09
6	Cuchara river.....	Sun.....	16 35 54	1 37.5	137 22 00	68 57 25	37 38 30

Sept.

6	do.	Altair	8 29 08	1 37.5	121 40 00	60 50 24	37 38 44
7	do.	Sun	16 19 08	1 37.5	136 47 45	68 40 17	37 38 51
8	Huerfano butte.	do.	16 02 05	1 37.5	137 04 30	68 17 01	37 45 04
8	Near Huerfano river	Altair	8 29 09	1 37.5	121 27 45	60 44 16	37 44 52
9	do. noon halt	Sun	15 44 47	1 37.5	135 30 25	68 01 37	37 43 10
9	do. camp	Altair	8 29 09	1 37.5	121 29 10	60 45 00	37 44 09
10	Valley, noon halt	Sun	15 27 14	1 37.5	134 56 50	67 44 49	37 42 25
14	In Saugre de Cristo Pass.	do.	14 14 28	30	132 46 30	66 38 35	37 36 52
17	do. noon halt	do.	13 17 41	2 00	130 52 00	65 42 36	37 35 05
18	Pass, on creek	do.	12 58 14	2 00	130 20 55	65 27 03	37 31 10
21	Utah creek	do.	11 58 58	2 00	128 26 35	64 29 54	37 29 04
22	Fort Massachusetts	do.	11 38 53	2 00	128 43 55	64 06 54	37 31 59
23	White Mountain spring	Altair	8 29 11	2 05	121 56 10	60 58 45	37 30 26
26		Sun	10 16 19	2 05	124 26 40	62 29 57	37 47 22
27		do.	9 55 16	2 05	123 21 30	61 57 22	37 57 24
28	Leroux creek	do.	9 34 04	2 05	123 33 50	61 31 49	38 02 15
29	Homans' creek	do.	9 12 43	2 05	121 22 50	60 58 01	38 14 42
29	Branch Puncha creek	Altair	8 29 11	2 05	120 07 00	60 04 07	38 25 04
30	Homans' creek	do.	8 29 11	2 05	120 20 00	60 10 38	38 18 33
1	Sahwatch creek, noon halt	Sun	8 07 46	2 00	119 26 50	59 59 59	38 07 46
2	Cochetopa Pass	Altair	8 29 11	2 00	120 30 00	60 16 37	38 12 35
3	do.	do.	8 29 11	2 00	120 13 00	60 07 06	38 22 06
4		Sun	7 01 31	2 00	116 46 15	58 39 40	38 21 50
5	Noon halt	do.	6 39 15	2 00	115 49 20	58 11 21	38 27 53
5	Cochetopa creek	Altair	8 29 11	2 00	119 55 50	59 58 30	38 30 41
6	Noon halt	Sun	6 16 51	2 00	114 56 20	57 44 43	38 32 08
6	Grand river	Altair	8 29 11	2 00	119 56 00	59 58 31	38 30 38
7	do.	do.	8 29 11	2 00	119 59 10	60 00 10	38 29 02
10		Sun	4 46 18	2 00	112 06 25	56 19 45	38 26 33
11		do.	4 23 27	2 00	111 23 35	55 58 20	38 25 07
12	Cebolla creek	Altair	8 29 12	2 00	120 10 10	60 05 47	38 23 26
13		Sun	3 37 32	2 00	109 56 30	55 14 47	38 22 44
14	Noon halt	do.	3 14 22	2 00	109 05 50	54 49 26	38 24 56
14	Cedar creek	Altair	8 29 12	2 00	119 58 40	59 59 55	38 29 17
16	Noon halt	Sun	2 28 05	1 38	107 11 20	53 51 58	38 36 07
16	Uncompahgra river	Altair	8 29 12	1 38	119 32 25	59 46 34	38 42 38
17		Sun	2 04 52	1 38	106 10 05	53 21 20	38 43 21
18		do.	1 41 36	1 38	104 59 00	52 45 46	38 55 50
18		Altair	8 29 12	1 38	119 06 00	59 33 20	38 55 52

Geographical positions—Continued.

Date.	Locality.	Observation.	Declination.	Index error.	Double obs'd alt.	Corr. alt.	Latitude.
			° ' "	' "	° ' "	° ' "	° ' "
1853.							
Sept. 19	Noon halt.....	Sun.....	1 18 18	1 38	104 01 50	52 16 43	39 01 35
20	do.....	do.....	54 58	1 38	103 04 10	51 48 22	39 06 36
20	Nah-un-kah-rea river.....	Altair.....	8 29 12	1 38	118 42 55	59 21 48	39 07 24
21	Noon halt.....	Sun.....	31 36	1 38	102 11 00	51 21 48	39 09 49
21	Little Salt creek.....	Altair.....	8 29 12	1 38	118 31 20	59 16 01	39 13 12
22	Noon halt.....	Sun.....	8 13	1 38	101 15 40	50 54 09	39 14 15
23	Bitter creek.....	do.....	— 15 11	1 38	100 45 10	50 38 52	39 05 57
24	do.....	do.....	— 38 35	1 55	99 58 25	50 11 38	39 09 47
28	Noon halt.....	do.....	— 2 12 14	1 55	97 07 05	48 49 56	38 57 50
28	do.....	Altair.....	8 29 13	1 55	119 12 05	59 36 32	38 52 40
29	Noon halt.....	Sun.....	— 2 35 37	1 55	96 34 25	48 33 35	38 50 48
29	do.....	Altair.....	8 29 13	1 55	119 15 45	59 38 22	38 50 50
30	Noon halt, Spanish trail.....	Sun.....	— 2 58 59	2 05	95 37 35	48 05 16	38 55 45
30	Green river.....	Altair.....	8 29 13	2 05	119 02 45	59 31 46	38 57 26
Oct. 2	Noon halt.....	Sun.....	— 3 45 36	2 05	93 57 40	47 15 19	38 59 05
3	do.....	do.....	— 4 08 51	2 05	92 55 45	46 44 22	39 06 47
3	do.....	Altair.....	8 29 13	2 05	118 30 00	59 15 35	39 13 38
4	Noon halt.....	Sun.....	— 4 32 03	2 05	91 48 05	46 10 31	39 17 26
4	White river.....	Enif.....	9 12 27	2 05	119 45 50	59 53 30	39 18 57
5	Clever creek.....	do.....	9 12 27	2 05	119 35 20	59 48 15	39 24 12
6	Noon halt.....	Sun.....	— 5 18 17	2 05	89 56 30	45 14 42	39 27 00
6	White river.....	Altair.....	8 29 13	2 05	118 03 40	59 02 25	39 26 48
7	Noon halt.....	Sun.....	— 5 41 19	2 05	89 17 35	44 55 15	39 23 26
8	do.....	do.....	— 6 04 17	2 05	88 51 00	44 41 57	39 13 46
8	Branch San Rafael river.....	Altair.....	8 29 13	2 05	118 34 15	59 17 43	39 00 30
10	Garambulla creek, noon halt.....	Sun.....	— 6 49 58	1 57.5	89 34 35	44 03 41	39 06 21
10	do..... do.....	Altair.....	8 29 13	1 57.5	118 48 00	59 24 31	39 04 42
11	Noon halt.....	Sun.....	— 7 12 39	1 57.5	87 05 30	43 49 08	38 58 13
12	do.....	do.....	— 7 35 13	1 57.5	86 35 10	43 33 58	38 50 49
13	Summit of Wahsatch Pass.....	do.....	— 7 57 42	1 57.5	86 00 30	43 16 42	38 45 37
13	Camp.....	Enif.....	9 12 27	1 57.5	120 45 10	60 23 08	38 49 19

	14	Noon halt.....	Sun	— 8 20 03	1 57.5	85 06 50	42 49 50	38 50 07
	15	do.....	do	— 8 42 23	1 57.5	84 25 15	42 38 57	38 48 40
	16	Wahsatch Pass.....	do	— 9 04 25	1 57.5	83 37 33	42 05 09	38 50 27
	17	Noon halt.....	do	— 9 26 26	1 32.5	82 48 35	41 40 26	38 53 08
	17	Sevier river.....	Enif	9 12 27	1 32.5	120 24 40	60 12 39	38 59 48
	18	San Pete creek.....	do	9 12 27	1 32.5	120 04 20	60 02 29	39 09 58
	19	do.....	Sun	—10 10 02	1 32.5	80 45 50	40 39 02	39 10 56
	20	Sevier river.....	do	—10 31 36	1 32.5	79 40 10	40 06 01	39 22 23
	21	Noon halt, California road.....	do	—10 52 00	1 32.5	79 05 15	39 48 42	39 19 18
	22	Cedar springs.....	Markab	14 25 14	1 32.5	130 37 20	65 19 05	39 06 09
	23	do.....	Sun	—11 35 19	1 32.5	78 04 40	39 18 22	39 06 18
	24	Sevier river.....	do	—11 56 13	1 32.5	76 53 35	38 42 50	39 20 57
	29	California road.....	do	—13 37 51	1 25.5	74 06 15	37 19 07	39 03 02
	30	do.....	do	—13 57 34	1 25.5	73 27 05	36 59 33	39 02 53
Nov.	2	Nephi.....	do	—14 55 23	1 25.5	70 13 30	35 22 41	39 41 56
Dec.	6	Salt Lake City.....	do	—22 34 32	1 37	52 49 00	26 39 51	40 45 37

The latitude given in the above table for October 8th—"Branch of San Rafael river"—should have been $39^{\circ} 11' 30''$.

Table of distances travelled, including those from point to point at which barometrical observations were made, on the route from Westport, Missouri, to Great Salt Lake City.

Date.	No. of camp.	Interme- diate dis- tances.	Days' travel.	Distance from West- port.	Localities.
1853.					
June 22	1	-----	-----	4.92	
23	2	-----	8.70	13.62	Indian creek.
24	3	-----	8.42	22.04	Cedar creek.
25	4	-----	9.40	31.44	Bull creek.
26	5	-----	20.25	51.69	Willow springs.
27	6	-----	23.84	75.53	110 mile creek.
28	7	-----	20.56	96.09	Prairie Hen creek.
29	8	-----	21.02	117.11	Rock creek.
30	9	-----	8.19	125.30	Elm creek.
July 1	10	-----	16.55	141.85	Diamond spring.
2	11	-----	15.70	157.55	Lost spring.
3	12	-----	17.82	175.37	Cotton-wood creek.
5	13	-----	22.59	197.96	Turkey creek.
6	14	-----	23.18	221.14	Little Arkansas.
7	15	-----	20.44	241.58	Big Cow creek.
8	16	-----	20.10	261.68	Big Bend of the Arkansas.
9	17	-----	7.23	268.91	Walnut creek.
13	18	-----	28.59	297.50	Pawnee fork.
14	19	-----	20.71	318.21	Coon creek—first fork.
15	20	-----	18.50	336.71	Do. second fork.
16	21	-----	28.62	365.33	Arkansas river, near Fort Atkinson.
19	22	-----	25.32	390.65	Do. near Cimmaron ford.
20	23	-----	19.90	410.55	Do.
21	24	-----	22.05	432.60	Do.
22	25	-----	21.73	454.33	Do.
23	26	-----	24.38	478.71	Do.
25	27	-----	21.87	500.58	Do.
26	28	-----	20.28	520.86	Do.
27	29	-----	23.26	544.12	Do.
28	30	-----	15.08	559.20	Arkansas river, below Bent's Fort.
29	31	-----	24.00	583.20	Arkansas river.
30	32	-----	10.00	593.20	Arkansas river, opposite mouth of Apishpa.
August 2	33	-----	14.64	607.84	Apishpa river.
3	34	-----	12.98	620.82	Do.
4	35	-----	15.26	636.08	Between Apishpa and Cuchara.
5	36	-----	17.07	653.15	Near Cuchara river.
6	37	-----	10.39	663.54	Cuchara river.
8	38	-----	10.09	673.63	Huerfano river, near Butte.
9	39	-----	14.54	688.17	Huerfano river, above the gorge.
10	40	-----	7.59	695.76	Base of mountain.
11	41	-----	5.12	700.88	Near summit of pass.
13	-----	.70	-----	701.58	First summit
13	-----	.32	1.02	701.90	Descent from summit.
13	42	3.48	3.48	705.38	Sangre de Cristo creek.
17	43	-----	5.34	710.72	Sangre de Cristo valley.
19	44	-----	10.57	721.29	Utah creek.
23	45	-----	10.75	732.04	White Mountain spring.
24	46	-----	13.46	745.50	Near Roubideau's Pass.
25	47	-----	9.78	755.28	Near Williams' Pass.
26	48	-----	9.06	764.34	Chatillon creek.
27	49	-----	11.72	776.06	Leroux creek.
29	50	-----	5.96	782.02	Homans' creek.
30	-----	10.54	-----	-----	Sahwatch spring.

Table of distances—Continued.

Date.	No. of camp.	Intermediate distances.	Days' travel.	Distance from West-port.	Localities.
1853.					
August 30	51	4.66	15.20	797.22	Sahwatch creek.
31	52	-----	12.27	809.49	Do.
Sept. 1	53	-----	15	824.49	Foot of Coochetopa Pass.
2		-----	-----	-----	Station No. 1.
2		1.62	-----	-----	Station No. 2.
2		1.39	-----	-----	Station No. 3.
2		.58	-----	-----	Station No. 4.
2		.24	-----	-----	Summit of Coochetopa Pass, No. 5.
2	54	1.33	5.16	829.65	West of Pass.
3		2.24	-----	-----	Station No. 1.
3		2.15	-----	-----	Station No. 2.
3		2.05	-----	-----	Station No. 3.
3		3.47	-----	-----	Station No. 4.
3		1.28	-----	-----	Station No. 5.
3		1.74	-----	-----	Station No. 6.
3		2.14	-----	-----	Station No. 7.
3		2.20	-----	-----	Station No. 8.
3	55	2.73	20	849.65	Near Camp Rock.
5		1.30	-----	-----	Station No. 1.
5		3.16	-----	-----	Station No. 2.
5		2.88	-----	-----	Station No. 3.
5		1.79	-----	-----	Station No. 4.
5		1.51	-----	-----	Station No. 5.
5		1.72	-----	-----	Station No. 6.
5		2.28	-----	-----	Station No. 7.
5	56	1.24	15.88	865.53	Coochetopa creek.
6		1.50	-----	-----	Station No. 1.
6		.89	-----	-----	Station No. 2.
6		1.08	-----	-----	Station No. 3.
6		2.16	-----	-----	Station No. 4.
6		1.46	-----	-----	Gate Rock.
6		1.39	-----	-----	Station No. 5.
6		2.88	-----	-----	Station No. 6.
6		.57	-----	-----	Crossing Grand river.
6		.83	-----	-----	Station No. 7.
6	57	1.99	14.75	880.28	Grand river.
7	58	-----	14	894.28	Do.
8	59	-----	4	898.28	Mountain ravine.
9		2.92	-----	-----	East summit of Lake Fork bank.
9	60	1.08	4	902.28	Lake fork.
10		.54	-----	-----	Summit of bank west of Lake fork.
10	61	4.16	4.70	906.98	Mountain valley.
12	62	-----	13.18	920.16	Cebolla creek—first branch.
13	63	-----	3.75	923.91	Cebolla creek—second branch.
14		3.78	-----	-----	Summit of mountain.
14	64	9.22	13.00	936.91	Cedar creek.
15		2.03	-----	-----	Crossing of Cedar creek.
15	65	10.26	12.29	949.20	Uncompahgra river.
16	66	-----	18.23	967.43	Do.
17	67	-----	20.33	987.76	Hill.
18	68	-----	8.45	996.21	
19	69	-----	13.40	1009.61	Blue river.
20	70	-----	9.10	1018.71	Do.
21	71	-----	14.29	1033	Little Salt creek.
22	72	-----	21.75	1054.75	Bitter creek.
26	73	-----	16.28	1071.03	Rain-water creek.
27	74	-----	5.67	1076.70	Hill.

Table of distances—Continued.

Date.	No. of camp.	Intermedi-ate distan-ces.	Days' travel.	Distance from West-port.	Localities.
1853.					
Sept.	28	75	16.72	1093.42	Creek in cañon.
	29	76	14.10	1107.52	Junction of creeks.
	30	77	14	1121.52	Green river.
Oct.	1	78	1.08	1122.60	Do.
	2	79	16.75	1139.35	Akanaquint spring.
	3	80	15.78	1155.13	Dry creek.
	4	81	9.82	1164.95	White river.
	5	82	8.70	1173.65	Clever creek.
	6	10.86			Station on White river.
	6	83	.26	1184.77	Hill.
	7	3.52			Station.
	7	84	9.74	1198.03	Standing Water creek.
	8	7.61			Near San Rafael.
	8	85	5.59	1211.23	San Rafael river.
	9	2.19			Spanish trail.
	9	86	9.21	1222.63	Garambulla river.
	11	7.85			Dividing ridge.
	11	87	5.61	1236.09	Big Rock creek.
	12	5.82			Crossing stream.
	12	88	9.83	1251.74	Oak spring.
	13	.61			Station No. 1.
	13	1.08			Station No. 2.
	13	1.66			Station No. 3.
	13	1.34			Station No. 4.
	13	1.74			Station No. 5.
	13	.22			Summit of Wahsatch Pass.
	13	1.90			Station No. 6.
	13	1.70			Station No. 7.
	13	89	.97	1262.96	Salt creek.
	14	.84			Station No. 1.
	14	1.25			Station No. 2.
	14	.99			Station No. 3.
	14	.60			Station No. 4.
	14	.31			Station No. 5.
	14	.11			Station No. 6.
	14	.20			Station No. 7.
	14	.12			Station No. 8.
	14	90	.58	1267.96	Swambah creek.
	15	.33			Station No. 1.
	15	.54			Station No. 2.
	15	.16			Station No. 3.
	15	.60			Station No. 4—summit.
	15	2.24			Station No. 5.
	15	.78			Station No. 6.
	15	1.60			Station No. 7.
	15	.50			Station No. 8.
	15	91	1.75	1276.46	Ungottabbikin creek.
	17	1.20	8.50		Station No. 1.
	17	.65			Station No. 2.
	17	2.25			Station No. 3.
	17	1.56			Station No. 4.
	17	.84			Station No. 5.
	17	.84			Station No. 6.
	17	1.15			Station No. 7—Salt creek.
	17	2.63			Station No. 8.
	17	92	3.13	1290.71	Sevier river.
	18	93	11.82	1302.53	Sau Pete creek.

Table of distances—Continued.

Date.	No. of camp.	Intermediate distances.	Days' travel.	Distance from West-port.	Localities.
1853.					
Oct. 19	94	-----	19. 10	1321. 63	Sevier river.
20	95	-----	2. 45	1324. 08	Do.
21		4. 51	-----	-----	Summit of ridge north of Lake valley.
21		7. 39	-----	-----	In Lake valley.
21		3. 52	-----	-----	Ridge south of Lake valley.
21	96	8. 78	24. 20	1348. 28	Cedar springs.
23	97	-----	18. 13	1366. 41	Sevier River valley.
24	98	-----	7. 30	1373. 71	Sevier river.
25	99	-----	14. 25	1387. 96	Do.
26	100	-----	7. 45	1395. 41	Foot of mountain.
27	101	-----	20. 93	1416. 34	Cedar springs.
28	102	-----	3. 46	1419. 80	Pioneer creek.
31	103	-----	28. 24	1448. 04	Sevier river.
Nov. 1	104	-----	24. 85	1472. 89	City of Nephi.
3	105	-----	25. 18	1498. 07	City of Payson.
4	106	-----	19. 23	1517. 30	City of Provo.
5	107	-----	14	1531. 30	American fork.
6	108	-----	15. 40	1546. 70	Willow creek.
7	109	-----	11. 45	1558. 15	Cotton-wood creek.
8	110	-----	7. 80	1565. 95	Great Salt Lake city.

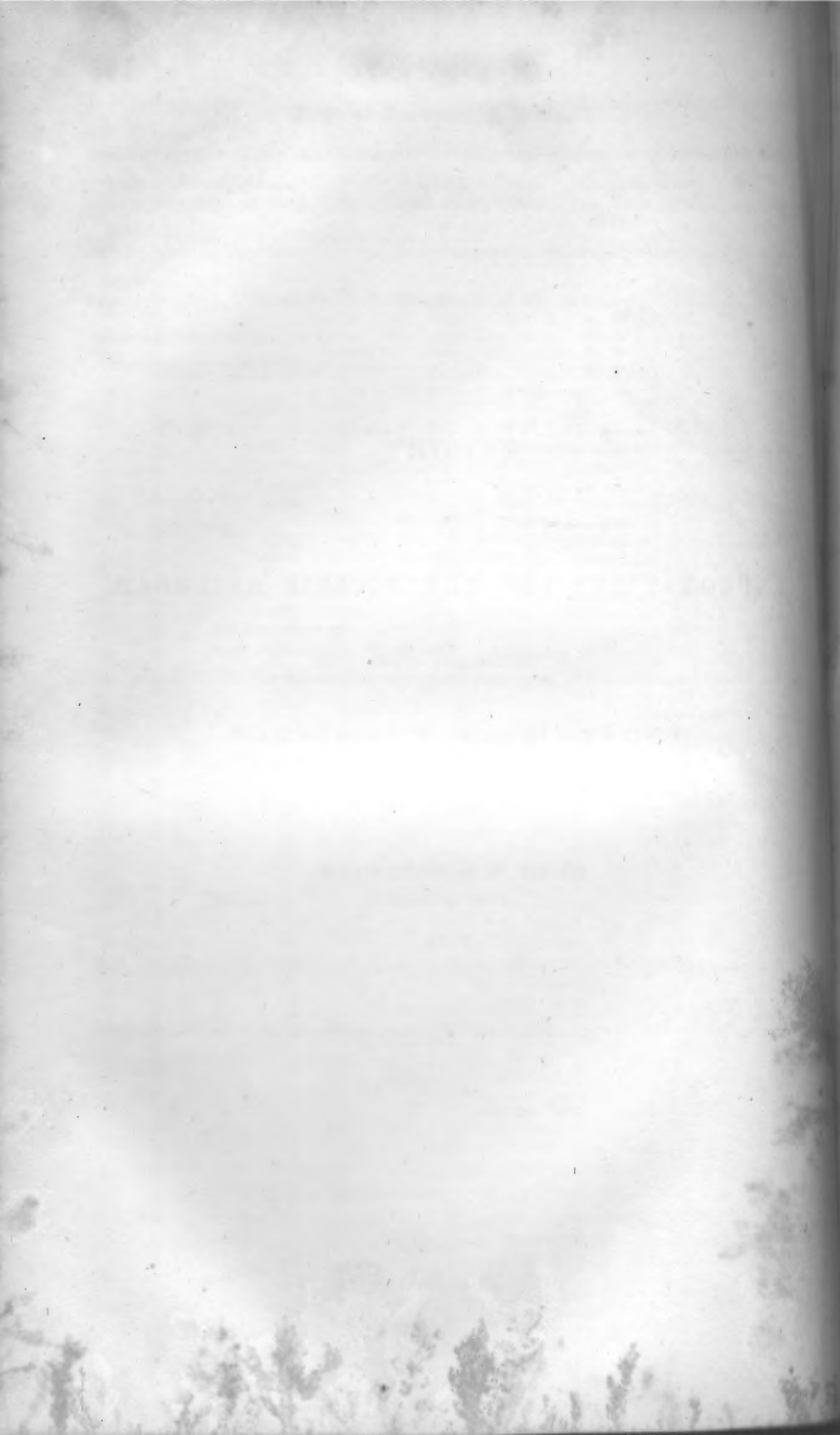
Year	Month	Day	Event	Location	Notes
1880	Jan	1	...	...	...
1880	Jan	2	...	...	...
1880	Jan	3	...	...	...
1880	Jan	4	...	...	...
1880	Jan	5	...	...	...
1880	Jan	6	...	...	...
1880	Jan	7	...	...	...
1880	Jan	8	...	...	...
1880	Jan	9	...	...	...
1880	Jan	10	...	...	...
1880	Jan	11	...	...	...
1880	Jan	12	...	...	...
1880	Jan	13	...	...	...
1880	Jan	14	...	...	...
1880	Jan	15	...	...	...
1880	Jan	16	...	...	...
1880	Jan	17	...	...	...
1880	Jan	18	...	...	...
1880	Jan	19	...	...	...
1880	Jan	20	...	...	...
1880	Jan	21	...	...	...
1880	Jan	22	...	...	...
1880	Jan	23	...	...	...
1880	Jan	24	...	...	...
1880	Jan	25	...	...	...
1880	Jan	26	...	...	...
1880	Jan	27	...	...	...
1880	Jan	28	...	...	...
1880	Jan	29	...	...	...
1880	Jan	30	...	...	...
1880	Jan	31	...	...	...

REPORT

EXPLORATIONS FOR THE PACIFIC RAILROAD

BY

1854



REPORT
OF
EXPLORATIONS FOR THE PACIFIC RAILROAD,
ON THE LINE OF THE
FORTY-FIRST PARALLEL OF NORTH LATITUDE.

BY LT. E. G. BECKWITH,
THIRD ARTILLERY.

1854.

REPORT

COMMISSION FOR THE PACIFIC ISLANDS

1917

REPORT OF THE COMMISSION FOR THE PACIFIC ISLANDS

1917

1917

WASHINGTON, D. C., *December 30, 1854.*

SIR: The very limited time left for the preparation of the accompanying report, after completing, on the last of November, that of Captain Gunnison's explorations of last year, has only permitted me to complete it in the most hasty manner; for it has been entirely written within the past three weeks, from rude field-notes.

The outline-map which accompanies it was also made in the greatest haste, but it is believed will be sufficient for the immediate wants of the government. The more finished maps are in course of preparation, and will be transmitted to the department as soon as they can be completed. A geological report of the country explored by Captain Gunnison and myself is nearly complete, and, with the reports upon the plants and specimens of natural history collected during the trip, will be submitted as early as practicable, the drawings for their illustration not yet being complete.

My assistants in the explorations embraced in the accompanying report, were Mr. Sheppard Homans, astronomer, by whom the observations and computations for latitude were made, our defective instruments not admitting of observations for longitude; Dr. James Schiel, geologist, who is still engaged upon his report; Mr. F. W. Egloffstein, topographer, to whom I am indebted for superior topographical sketches and the preparation of the accompanying outline-map, and who is still engaged in making the elaborate maps of the survey; and Mr. J. A. Snyder, to whom the collection of botanical specimens was intrusted, but who was also constantly employed in making meteorological observations, and who has been employed, since my return, as an assistant in making computations of barometric observations under Mr. Lorin Blodget, by whom they were discussed, and whose notes accompany the tables. For the energy, ability, and cordial cooperation of each of these gentlemen, and of Brevet Captain R. M. Morris and Lieutenant L. S. Baker, of the regiment of mounted riflemen in charge of the escort from that regiment, in the execution of the duties of the exploration, I desire to express my obligations and esteem.

I am, sir, with much respect, your obedient servant,

E. G. BECKWITH,

1st Lieutenant 3d Artillery.

Hon. JEFFERSON DAVIS,
Secretary of War.

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CHAPTER I.

Trip from Great Salt lake east, to Green river and back, by the Weber and Timpanogos rivers respectively—April, 1854.

SIR: Explorations were resumed on the 4th of April, 1854, for a route for the Pacific railroad under my direction, by the surviving portion of Captain Gunnison's party, (which had wintered at Great Salt Lake City,) under the original instructions given to that officer to explore the most available passes and cañones of the Wahsatch range, and cross the Weber and Bear rivers to the coal basin of Green river, and thence proceed to Fort Laramie.

Leaving the city, we proceeded north along the shore of the lake, passing through the Mormon settlements and farms, which occupy the most fertile and best watered sections of the narrow belt of land lying between the shore and the base of the mountains. Spring was already considerably advanced in the valley; fresh grass and plants were springing up on its sunny slopes; farmers were busy in ploughing and sowing their fields, and the snow had disappeared to such an extent on the sides of the mountains, that it was deemed practicable for our animals to subsist upon the dry grass of the previous year's growth.

The winter of 1853-'54 at Great Salt lake, from the middle of November to the 20th of January, was delightfully mild and open and the fall of snow, which was light in the mountains, seldom extended into the valleys; but after the latter date the climate became much more severe, the temperature falling during the colder part of the day, for several successive days, below zero of Fahrenheit's thermometer, and storms became more frequent—snow falling in the plain to the depth of six or eight inches without drifts, while in the mountain plains and passes it exceeded a foot, and accumulated to great depths in the narrow ravines, and on the high slopes of the mountains, least exposed to the winds. In the vicinity of the city of the Great Salt Lake timber is confined almost exclusively to these ravines, which are difficult of access at all times, and become entirely inaccessible during the prevalence of deep snows, producing at once great scarcity of fuel in that city. The passage of the uninhabited mountain to the east at such times by the ordinary road leading over it, which, of course, is not kept open, is entirely impracticable; and the mail which passes monthly to and from Independence, Mo., is carried on pack-mules, which subsist themselves almost entirely on the grass along the route, by way of the Weber river cañon—the object in part of our present explorations.

April 5.—On the afternoon of the fifth of April we reached the mouth of this cañon at the immediate base of the Wahsatch mountains, where it opens into the valley of Great Salt lake, thirty miles north of the city, and about seventeen from the mouth of the river, which we immediately crossed to its right bank. This river at this season of the year (not yet swollen by the melting snows of the mount-

ains) is thirty yards wide, by from one to three feet in depth, flowing with a rapid, powerful current over a bed of water-worn stones and fallen rocks of all sizes, from pebbles to immense blocks of the adjacent mountain. Our altitude at this point was 73 feet above the city of Great Salt lake, and 4,424 feet above the sea. Entering the pass, we at once left the usual low-water trail, which frequently crosses the river, and followed a precipitous and rocky path leading over the retreating craggy sides of the cañon, so steep that a single mis-step would have precipitated both mule and rider into the foaming torrent, hundreds of feet below us. At some points the precipitous sides of this passage become almost vertical, and rise, we judged, from 1,500 to 2,500 feet above the river, and are separated at the base by a passage averaging 175 yards in width, in which the river winds from side to side, frequently impinging against the bases of the mountains. At one point only, near the upper end of the gorge, which is four miles in length, the river is narrowed to one half its usual width, having cut a passage 20 or 30 feet in depth through the solid rock, which on the north side overhangs the stream, which, by a low projecting mass, is deflected from its course for a few yards at nearly a right angle, but again almost immediately resumes its direction; the cañon, as it is called—and at some points it well deserves the name—being remarkably direct in its general course. Above this gorge the mountain opens rapidly to the right and left, forming an immense oblong amphitheatre, the summits of the mountain peaks on opposite sides being separated by from 10 to 15 miles, while the river bottom, which is a plain, varies in width from half a mile to three miles. This is the finest grazing district we have seen in Utah, the bottom being covered with luxuriant grass which extends well up the mountain sides, to where they are at present covered with snow. The stream is skirted with poplar or cotton-wood trees and willow-bushes, and limited amounts of cedar, fir, and pine adorn the ravines and mountain sides, but are difficult of access. We encamped, after a march of 27 miles, at the junction of Ben Simons' creek with the Weber, where we found our Delaware guide (after whom the creek is named,) with his brother and their respective squaws and little Indians, encamped with a small band of horses and herd of cows grazing near their lodges. These cattle appear in fine condition, having subsisted here through the entire winter by grazing alone. A much larger herd of cattle, on their way to the California market, which had been grazed in the vicinity of Fort Bridger during the early part of the winter, were subsequently driven here, where they remained for several weeks, having left but a day or two previous to our arrival. A considerable trade is carried on in cattle in and near the valley of Great Salt lake; its main profit arising from the exchange of cattle in good condition for those of emigrants broken down on their arrival here, compelling an exchange or a ruinous delay in their journey to California. The stock obtained by this traffic is turned out to graze during the winter; and although a few of the weakest and most emaciated die of cold, the great body of them come out in fine condition in the spring, and are sent forward to the California market, or form a new stock in trade for the ensuing season.

Our average ascent from the mouth of the cañon to camp, 7.80

miles, has been 53.50 feet per mile. The rocks in the gorge partake largely of the character of gneiss; but in descending the river with a railroad, no unusual difficulty would be encountered at this point, as the walls of the pass are sufficiently retreating to admit of its being carried at a suitable height above the stream to escape the danger of floods, and extensive blasting of rocks would be required only at a few points. Snows have formed no obstruction to its passage at any time during the past winter, nor, so far as I have been able to learn after much inquiry, do they at any time. In the valley, at our guide's camp, its greatest depth during the last winter was twelve inches, but seldom exceeded four, and for much of the winter was quite as free of it as the main valley of Salt lake. Our guide thinks a much more favorable emigrant road could be opened through this pass, ascending Ben Simons' creek to the vicinity of Green river, than that now followed over the mountains, which is still impassable from snow.

April 6.—We traversed the amphitheatre described yesterday, following the bottom lands along the Weber river to the foot of the second mountain and gorge of this stream, our ascent being 28.50 feet per mile for 12.20 miles, to Sheep Rock. The sides of this gorge are less precipitous than those of the lower, and the bottom or passage in which the river winds is frequently much wider, while the mountains are of nearly the same altitudes with those, but much more broken by ravines. The bottom, too, is less firm, being frequently miry, and numerous small channels into which the river is divided are dammed by beaver—green trees of six inches in diameter having just been cut down by these animals for their damming purposes—making part of it a swamp, miles of which are covered with thick willows, where the soil is too soft for a good wagon road without carrying it on an artificial bed, which can be easily made along the base of the mountains. The river winds so much that we were forced to cross it sixteen times, the water being icy cold. We encamped on Dry creek, which enters the river at the head of the gorge, eight and a half miles from Sheep Rock, from which we ascended 27 feet to the mile. In constructing a railroad through this defile, it will be necessary to bridge the stream several times, which can be readily done; but for the most part the road would be carried immediately at the base of the mountains, where it can be constructed with facility by cutting along their sides and filling in at their bases. These bases are formed of earth and loose stones overlying strata of shale, limestone, conglomerate, and argillaceous sandstone, dipping at every angle, and in almost all eastern directions from south to north; and in a few instances strata bent (before induration) were seen; and in one, vertical, parallel, walled dikes intersect the northern slope of a mountain near the head of the passage, extending from the water's edge to near the summit of the mountain, only separated by about ten feet, and rising thirty feet above the mountain slope.

April 7.—A cold rain, which continued to fall throughout the night, poured down upon us as we wrapped ourselves in our blankets last evening; and as we were without tents or other protection from the weather, but little sleep refreshed the party; and at 9 o'clock this morning the rain changed to snow, (which had been falling all

night on the high peaks in the mountains,) and continued to fall heavily throughout the day, melting as it reached the ground.

Above the junction of Dry creek with the Weber river, the latter comes from the south, cutting through a red conglomerate sandstone mountain six or eight hundred feet high, which is rapidly disintegrating, the talus at some points being entirely swept away by the river, and at all others it stands at too steep an angle towards the water to be easily climbed over.

The Indian trail, however, passes through this cañon at low water, a part of the way in the stream. It is five hundred yards long. We rode to its upper end and clambered in to examine it. The trail by which we passed ascends Dry creek half a mile, and then passes without difficulty to its head, by a low pass in the ridge through which the cañon itself is cut. This is the proper site, also, for a railroad. Above this cañon a considerable valley extends south to the Kamas prairie. This valley varies in width from three or four miles to a few hundred yards, and is drained by the Weber river, having on its margins considerable bottom lands, which at this season of the year are quite wet, and in many parts are covered by cotton-wood trees and willow-bushes. Ascending this valley we came to the emigrant road leading from the South Pass to Great Salt lake, which we followed to the mouth of Echo cañon, where we left it and continued up the river to the mouth of White Clay creek (Moran's fork.) The mountains on the left of the valley, as we ascended it, are conglomerate sandstone, full of cavities numerous inhabited by ravens. The snow was falling so fast that we were unable to see a hundred yards, and were obliged to dismount and wait for it to diminish; when we again remounted, and, turning east, left the Weber river to ascend White Clay creek and pass over to Bear and Green rivers. The valley of our path after leaving the Weber was from one-half to three-fourths of a mile in width, finely covered with dry and green grass, the hills being covered with a stunted growth of cedar, and cotton-wood and willows line the stream, which has upon it little or no bottom land. The storm ceased as we encamped, having travelled but 10.50 miles, with an average ascent of 16.50 feet per mile.

April 8.—A piercing cold wind sprang up during last night, the thermometer falling to 27°, and continued all day blowing from E.N.E. directly in our faces as we ascended White Clay creek, which is one foot in depth and five in width, with a free rapid current. Its narrow bottom is from one to two hundred yards in width, with low spurs of hills occasionally extending to the stream. It is lined with cotton-wood and willows in the lower part of its course, but is quite destitute of timber higher up, while scattered cedars are seen on the nearest hills, and pine, fir, and aspen fill the ravines of the mountains, the highest peaks of which are 14 miles south of us on the northern bank of Weber river, whence it descends from the east to Kamas prairie. Numerous tracks of grizzly bears and porcupines were seen in the snow, beaver dams and lodges in the creek bottom, and a fine silver-gray fox watched our progress for some time from a high hill, safely beyond gun-shot. Fourteen miles out we came into continuous fields of snow, six inches in depth, except on the southern

exposures, where it had almost entirely disappeared. Its surface was hard and stiff, though not strong enough to bear either men or animals, and as we broke through at every step, our progress was tedious and fatiguing; and these were greatly increased whenever we had to pass slight inequalities in the ground filled with snow, and the narrow driits always accumulated on the northeastern declivities of the hills—our mules literally rolling, pitching, tumbling, and floundering through. Thermometer at noon 38°. For the benefit of our animals, we ascended the side of a hill, where the snow had disappeared, on a branch of White Clay creek coming in from the south-east, and encamped just before sundown on a soft, muddy soil, sprinkled with dry grass. The Uinta mountains, whose general course is apparently nearly due east and west, have been plainly in sight for the last two days, some 25 miles south of our path, with numerous high peaks covered with vast fields of snow from the lowest points visible on them to their summits, the sources of the Uinta, Timpanogos, Weber, and Bear rivers, and of Black's fork, and numerous smaller streams. From the northern foot of this range to our path, a level, timbered terrace country extends, called, in the Sho-sho-nee or Snake language, Yaw-ning-got-it, or Porcupine terrace; from the west it extends from the sources of the White Clay creek, (To-sho-sho-coop, in the Snake tongue,) across Bear river, the Muddy and Black's fork, broken only by a few low detached hills and the ravines of the water-courses. Its timber, pine and fir, is abundant, and of a suitable size for bridges and building purposes.

For the first ten miles this morning our ascent averaged 84.20 feet per mile, and 54.20 feet per mile for the following 8.75 miles, to the junction of the branch on which we encamped, with White Clay creek.

April 9. - A bright clear morning; thermometer at daylight 21° below the freezing-point. We returned to White Clay creek, striking it near its head, by passing over the hill on which we had encamped, a distance of 11.50 miles, by the windings of that stream, from the junction of the branch where we left it to encamp, which we examined in repassing this point on our return trip on the 18th instant. This creek preserves its open character, with easy, gentle curves, to its source, the grade averaging 41.80 feet per mile, and the country becoming more level and open as we ascend. We were here upon the divide between the waters of Weber and Bear rivers, immediately overlooking the latter stream a mile and a half distant and but a few feet below us, our altitude being 7,491 feet above the sea.

We immediately descended to the first channel of Bear river, which is forty feet wide and one deep, with a firm bed, crossed without difficulty to a large level plain, four or five miles wide by ten or twelve in length, extending southward to the foot of Porcupine terrace, through which the river winds in a narrow ravine. The snow upon this plain was from six to ten inches in depth—hard and stiff, but not sufficiently so to bear our animals—with pools of water and soft ground beneath it, affording no firm footing, and our progress was consequently very laborious. The sun was very bright, and its powerful reflection from the snow very severe upon our eyes. Three

miles from the first we crossed the second channel of Bear river, a small stream four feet wide, beyond which we rose a bluff 12 or 15 feet high, to a second plain extending to our camp on Sulphur creek, which descends in a small ravine from the terrace above. Altitude 7,494 feet.

April 10.—A light snow begun to fall during last night, and continued all day, with a high, driving wind, which rendered our progress very disagreeable; and nearly one half the officers and men of the party were so snow-blind as to be unable to see beyond a few feet, and suffered intense pain from their inflamed eyes, the lids of which were swollen to a dropsical appearance, while their faces were quite as badly inflamed, skinned, and intensely sore. We crossed a small stream running into Bear river, four miles from our morning camp, and afterwards three small branches, which unite and form the Little Muddy, and encamped on the main creek of that name, after a march of only 11.20 miles. Our altitude on the divide, between Bear river and the Muddy, an affluent of Black's fork, which flows into Green river, and consequently upon what is called the eastern rim of the Great Basin, was 8,133 feet, and at our camp this evening 7,779 feet above the sea.

We encountered but little snow on the high surfaces and western slopes of the hills to-day, but invariably found large drifts just below the crests of the northeastern slopes, occasionally so compact as to bear our animals, but generally giving way under their feet.

April 11.—Thermometer at 5 a. m., 26°. Soon after leaving camp we crossed a small branch of the Muddy, and then ascended the ridge setting down from the Porcupine terrace, and nearly on a level with it, between the Muddy and Black's fork. This ridge preserves its elevation for several miles to the north, and then subsides abruptly into the valley of the fork. Upon this divide we encountered much more snow than upon any other part of the route, for the warmth of the season was not yet sufficient to affect it at all; and its average depth was from twelve to sixteen inches, while the drifts were broader and deeper than we had before encountered, varying from fifty and a hundred yards to a fourth of a mile in width. These banks, as before stated, are always found just below the northeastern crests of hills and ridges, and can only be avoided by passing either above or below them.

The view from this position is very extensive. Overlooking the immense valley of Green river, which sweeps off to the east, apparently in an almost uninterrupted plain, the Sweet Water mountains near the South Pass, with the positions of the Muddy and Bitter creeks descending from them, are plainly in sight; and to the south the sources of Black's, Smith's, and Henry's forks, in the Uinta mountains.

From the head of White Clay creek, eastward for 19 miles, a railroad should be carried on a gentle curve to the southward, (as indicated on the accompanying map) along the Porcupine terrace before described, crossing Bear river and the main branches of Muddy and Sulphur creeks, where they are narrow ravines, offering no serious obstacles in themselves to its easy construction, thus avoiding any

but a local descent in the passage of these streams, and turning all the smaller ravines and branches which must otherwise be crossed below.

The ascending grade upon this line will be 49.8 feet per mile for 12.90 miles, and 39.50 feet per mile for 6.10 miles; and the altitude of the point thus gained—the highest upon the line—8,373 feet above the sea. And in descending from this point, the road should follow the ridge or divide west of the main branch of Black's fork by a uniform grade, to which there is no obstruction, of 40.30 feet per mile for 12.25 miles, to the main open valley of the fork, to which we descended at 10'clock a. m. The level valley of this stream is here three miles in width, with pine, white cedar, and aspen growing upon the stream, and extending to and uniting with that on the base of the Uinta mountains. We found considerable grass in this valley, and mud in place of snow. The stream in the present low stage of the water, the snow not having commenced to melt in the high mountains, is but 12 feet wide and eight inches deep, flowing rapidly over a bed of stones. In crossing its bottom we rode for some distance on the remains of a beaver dam, precisely resembling a small embankment 18 inches high, thrown up in making a common ditch. It is several hundred yards long. Travelling partly parallel to the stream, we crossed over to Smith's fork, which is separated from Black's only by a plain common to them both, passing near a settlement called Fort Supply, commenced on Smith's fork last autumn. It consists of only a half dozen log-houses, and although the margins of the stream are finely grassed—upon which considerable herds of cattle have been successfully grazed during the past winter, with no other food or shelter than they could themselves procure—it must be regarded as a doubtful experiment, until experience shall have established the practicability, in this latitude upon our continent, of producing crops during the cold summers, and grazing cattle during the severe winters, incident to so great an elevation—7,254 feet, that of our camp on the stream, two or three miles below the fort. Our descent from where we came upon Black's fork to camp, nine miles, was 69.50 feet per mile.

We were here in the immediate vicinity of Fort Bridger, the position of which a few miles to the north, on Black's fork of Green river, was plainly in sight across the open plain. In descending from the head of the Muddy I have given the preference to the line indicated, over that which follows that stream, as it is entirely free from short curves; and the valley of Black's fork, above the junction of the Muddy, is much more broad, open and direct than that of the latter stream. The line eastward from our present camp should be continued directly to where it should cross Green river, near the mouth of Black's fork, and be continued thence eastward by the line followed by Captain Stansbury from Green river, by way of Bridger's Pass, to the Great Plains, in 1850, as reported by him in his expedition to the Great Salt lake, and thence descend by the South fork and main Platte, or pass over to the Republican fork of the Kansas, and descend it to connect at a suitable point with eastern lines of commerce.

April 12.—It began to snow at dark last evening, and continued without intermission until late this afternoon. Several of the party were still suffering severely from snow-blindness, and many of our animals were becoming weak and exhausted for want of sufficient nourishment. I determined, therefore, to leave a portion of the party in camp on Smith's fork with the weakest animals, and to proceed with the balance to Henry's fork of Green river, a route represented to possess superior advantages to that before indicated for a railroad to the east from Smith's fork. With Captain Morris, Mr. Egloffstein and Mr. Snyder, and a small escort, and with our Delaware guide, I started—the snow being four inches deep as we left camp, and falling so fast that we could not see beyond a few hundred yards, but fortunately the storm was in our backs—bearing a little to the southeast to avoid the mud of the plains, which were very slippery and soft. We travelled over a succession of low hills, and crossed two or three small branches of Smith's fork, coming to Cottonwood creek at 1 o'clock, p. m., where our altitude varied but nine feet from our morning camp. We here came upon a wagon road leading from Fort Bridger to Henry's fork by a low pass in the small mountain spur dividing the waters of that stream and of Cottonwood creek. It is six miles from the creek to the summit of the pass, and the difference of level 266 feet. Entered from the north it is narrow and direct, and is formed of horizontal strata of clay, from six to fifty feet thick, often separated by thin strata of sandstone; and the clay itself in some parts is indurated to an argillaceous stone containing considerable sand. It is washed into a thousand gullies and ravines, and its slopes are barren. The spur itself is level upon its summit, and preserved from washing by a capping of stone.

Notwithstanding the storm, our guide related an incident which occurred to him a few years since in this pass, characteristic of the adventurism of his own tribe, and of the war habits of his race.

He was travelling this pass at midnight, accompanied by his squaw only, both mounted upon the same horse, and the night so dark that he could neither see the outlines of the hills nor the ground at his horse's feet, when he heard a sound, (which he imitated) so slight as scarcely to be perceptible to an Indian's ear, of an arrow carried in the hand striking once only with a slight tick against a bow. Stopping, he could hear nothing, but instantly dismounted, his squaw leaning down upon the horse that she might by no possibility be seen, and placed his ear to the ground, when he heard the same sound repeated, but a few feet distant, and was therefore satisfied that, however imminent the danger, he had not yet been heard or seen, for no Indian would make such a noise at night in approaching his foe; he therefore instantly arose and took his horse by the bridle close to his mouth, to lessen the chances of his moving or whinnying, and one hundred and seventy of his deadly enemies, the Sioux, on a war party, filed past him within arm's reach, while he remained unobserved.

We encamped on Henry's fork after a ride of 23.50 miles, descending for 3.20 miles, from the summit of the pass, 122 feet to the mile. The valley of this stream is of the park-form, ten miles in diameter at our camp, with bottom lands from one to three miles in width,

narrowing rapidly as it descends. The bottom is finely grassed, while the hills about it are barren or covered with artemisia; but the mountains to the south are quite covered with pine. The water of the stream flows in several channels through the meadow, which might be easily irrigated, and support a small settlement, if not too cold for cereals.

April 13.—Leaving half of our men in camp, we descended the valley, crossing several little streams, the largest of which is called Dry Timber creek, and seven miles below camp bore off to the right, and ascended a high point of the adjacent mountain to obtain an extensive view of Green river and of the surrounding country. The snow, scarcely two inches deep in the valley, soon increased to a foot and more, and our animals waded heavily through the deep drifts and gullies. We were rewarded, however, for the labor of the ascent by the excellent view obtained.

The valley of Henry's fork continued its uniform descent to its junction with Green river, fifteen miles distant, and immediately to the south of it two other small streams enter Green river from the west, separated by a pile of rocks called the Beaver Lodge, which is also the name of the northern stream; the southern being known as Medicine Spring creek by the Indians, and Blue by the trappers, from a fine spring somewhere near its source. Fifty miles distant the Uinta mountains were seen, terminated to the east by the passage of Green river, and through a large gap in an intervening range the pine-covered sides of Brown's Hole were distinctly visible. Above the mouth of Henry's fork stand two isolated buttes of the same altitude as the low range, to the north of this stream, which we crossed yesterday, and of which they once formed a part. Green river descends from the north just to the east of these buttes. Beyond this river, to the north and east of Brown's Hole, high ranges of mountains, covered with snow, extend far to the east and south of the line indicated for the railroad from our camp on Smith's fork. So far as this proposed line can be seen from this point—which it can be far east of Green river—it appears very level. But the wind whistled cold and piercing about our heads, and, standing knee-deep in snow, we were soon chilled through, and, hastening our notes and observations to a close, descended in an hour and a half to Henry's fork, to a comparative summer climate—a change from 34° to 50° —the snow having entirely disappeared from the valley during our short absence.

Notwithstanding the severe snow-storm yesterday, the party suffered quite as much from blindness as during a bright sunny day, my own face becoming somewhat inflamed for the first time, and "Ring," a bulldog which accompanied us, became so much affected that he could not be induced, in camp, to open his eyes, from which tears were constantly falling. We returned at evening to our morning camp.

April 14.—We repassed the divide by which we entered the valley of Henry's fork. From Cottonwood creek, we followed a line across the artemisia plains or mesas, a little to the north of that followed in our outward journey. The light and friable soil of these plains is now saturated with water, from melting snow, and is miry and slippery. They are terminated to the west by abrupt bluffs of clay, so steep and

slippery, that, in descending them, we were obliged to dismount, and let our mules slide down as they best could—ten and twenty feet at a time. They decline rapidly to the north, and, apparently, soon entirely disappear in that direction. Grass is confined to the borders of the water-courses, the intermediate spurs being occupied by fields of artemisia. We encamped at evening on Smith's fork, a short distance below our camp of the 11th instant, and on the following morning (April 15) continued our western course, recrossing Black's fork and the ridge separating it from the Muddy, on which we encamped a little above the emigrant road to Great Salt lake. Although the valley of this stream is not so broad and direct as that of Black's fork, a railroad could readily ascend it to intersect our outward line at its crossing; but, as before stated, the line then indicated would probably be preferable.

April 16.—The country over which we passed to-day is very elevated and dry, and the vegetation principally confined to artemisia. It overlooks our outward path to the south, which preserves its superior appearance even from this distance. We encamped on Bear river, about which the snow had nearly disappeared. The grass has not yet sprouted, however, for a new growth, and our animals fare badly on that which has been buried under the snow from last year, and is now soaked from its melting.

April 17.—We returned to the head of White Clay creek this morning, and descended it, encamping two miles below its Beaver branch junction, when we again returned to fields of fresh grass. High upon the sheltered faces of a few bluff rocks, cropping out on the southern bank of the creek, as we descended it, large numbers of nests of clay, in clusters of pine-apple size and form, were seen, which our Delaware guide says are built by a dark-colored bug, which is good to eat when boiled. I could obtain no specimens of them. The guide killed a fine elk near camp.

April 18.—We attempted to-day to find a more direct route to the Kamas prairie and Timpanogos river than that by the mouth of White Clay creek and Weber river. In leaving camp, we ascended a narrow ridge, and again almost immediately descended its opposite slope, and crossed a small creek, beyond which, in ascending the succeeding hill, we entered upon a field of snow, two feet in depth, which was too soft to bear our animals, and was filled with brush and concealed fallen-timber, rendering its passage for a mile a severe labor; and several smaller fields were passed in crossing a broken country, until 11 o'clock, when we were rising a high ridge, and expected, at its summit, to find an end to our snowy labors, and to descend with comparative comfort to the prairie; but the snow had driven us off the summer trail, and, as we rose to the summit, we were greeted by the sight of another formidable ridge, everywhere presenting one immense field of snow apparently impassable, and the guide came to a stand—his last horse had failed. I, however, examined the country attentively, mounted the guide on a mule, and determined to go on, and in two hours, by severe labor, reached the succeeding summit; but, instead of seeing an end to our labors, and refreshing fields of grass at our feet for our exhausted stock, we saw before us only a pre-

cipitous descent of half a mile, followed by an ascent still steeper and higher than the former, which we accomplished, with increased labor, however, only to find before us an impassable field of snow, extending down the face of the mountain for several miles to Weber river. Our altitude was here 8,619 feet above the sea, and a magnificent view of the country in some degree rewarded the labor of the ascent. North, south, east, and west, the country presented only one extensive field of broken mountains. The opening made in the Wahsatch mountains by the Timpanogos cañon, with a high intervening peak or two between us and Kamas prairie, looked favorable for our passage; the high, snowy range between us and Great Salt lake, as far north as Weber cañon and Ogden Hole, was also before us, with those to the east crossed by the emigrant road. Above us, the Weber descends through an extensive mountain district, at present covered with impassable snows, and surmounted to the south by the higher and still more snowy peaks of the Uinta range.

Pine covers the steep mountain sides south of the Weber. We encamped on this summit, and sent out the guide with a party on foot to find, if possible, a practicable descent; he returned at dark with an unfavorable report, however, unless the snow should freeze during the night strong enough to bear our animals, of which there is no prospect.

April 19.—It began to rain during the latter part of last night, and the mountain sides at daylight were sending down rivulets of snow-water from every point. We were, therefore, reluctantly obliged to turn back, following, through banks of snow for two miles, the course of a small branch of White Clay creek, lying between high, steep hills and spurs of mountains. The heavy, cold rain from the southwest increased as the morning advanced, falling uninterruptedly for five or six hours, until we had gained a more open country as we approached White Clay creek. At every step, after leaving the snow, in this rapid descent, we were passing fine fields of grass, extending from the ravines to the mountain tops. We had certainly been driven higher up the mountains in our attempt to effect this passage than would have been necessary but for the snow; but it is not too much to say that there is no practicable route for a wagon-road, and much less for a railroad, by this Indian trail from White Clay creek to Kamas prairie, although it is the best in the vicinity, except that to which we returned. Soon after reaching White Clay creek, we passed our camp of the 7th instant, and again entered the valley of Weber river, in which we encamped, in the midst of luxuriant fields of fresh grass, 5.25 miles from the camp of the 7th.

In descending the mountain to-day, we passed a few out-cropping ledges of conglomerate rocks and sandstone, but soil and earth covered almost the entire surface of the mountains and ravines. The sun shone bright and clear during the afternoon, and dried our drenched clothes. The accompanying sections of the routes explored by the Weber and Timpanogos cañones, branch at our camp of the 7th instant on White Clay creek, the former descending the Weber, and the latter ascending it.

April 20.—The wind, which had changed to northwest during the

afternoon yesterday, returned to southwest last night, and the morning came in with a gentle cold rain, which increased during the day to heavy showers at short intervals. The width of the Weber valley, within the low hills, between our morning camp and Kamas prairie, varies from two or three miles to a few hundred yards; but we soon passed above the altitude of green grass, although the whole face of the country was covered with the growth of last year. It was 12 miles to Kamas prairie, which is five or six miles wide by eight and seven-tenths miles in length, and, to the eye, is as level as a sheet of water. The Weber river descends to it from the east, flows across its northern end, and thence descends to Great Salt lake, by our ascending path. A stream, ten or 12 feet wide, winds through the prairie entering Weber river at the northwest angle of the meadow. It is seen descending from a mountain ravine on the east side of the plain, six miles distant. A mile to the south of this ravine is the divide between the Weber and Timpanogos rivers—if so slight a change of level deserves the name of divide—the latter flowing at the base of a snowy range of mountains terminating the prairie to the south. We attempted to ride directly across the prairie, but found it so miry that we were obliged to turn back and keep along the base of the hills to the west, reaching the Timpanogos where it leaves the prairie. The average grade from our camp of April 7, on White Clay creek, to our morning's camp, 5.25 miles, was 3.80 feet per mile; and 53.90 feet per mile for 12 miles thence to Kamas prairie; and across the prairie to Timpanogos river, 8.70 miles, 8.80 feet per mile—the altitude of the prairie at Weber river being 6,319 feet above the sea. Below the prairie the Timpanogos river descends in a bottom varying from 100 to 250 yards in width, covered by cottonwood. It is enclosed on the south by mountains, and on the north by high walls of a coarse feldspathic granite, from one to two hundred feet high. The stream is twenty-five feet wide, with a rapid current. This bottom is entirely free from snow and sufficiently wide and elevated above the river to admit of an easy construction of a railroad.

We encamped some two miles from the prairie and river, on its right bank, among the hills.

April 21.—It continued to rain during the whole of last night, and this morning snow was mixed with the falling rain; but after being two or three hours on the road, we passed below the storm, which continued about the higher mountain peaks throughout the day. We returned to the Timpanogos river at the lowest point on it visible to us from Kamas prairie last evening, its valley being here half a mile wide, and, for three miles, very miry from the great amount of rain recently fallen upon it, and covered with willows. We therefore kept along the base of the hills, and occasionally passed over considerable spurs extending into the valley. Below this the stream enters a broad open valley, several miles in diameter, called Round prairie, in which it receives small tributaries from the east and south. In this prairie the grazing is very fine; and the valleys and mountain sides along our path, throughout the day, were covered with the finest fresh grass from an inch in height at our morning camp, to eight inches at that of this evening. In the prairie the stream bends

more to the west, and preserves this course, as the valley narrows to a few hundred yards in width as we approached the eastern base of the narrow Wahsatch chain. Entering the mountain, the valley becomes still more narrow, and in a short distance quite disappears, and the passage becomes a formidable cañon, in which the general course of the river is very direct; but the hills or mountain spurs, which extend down to it, slightly overlap each other, giving it a zigzag line upon a small scale, the projecting points overlapping but a few feet, and are generally not high. The southern bank is much the most abrupt, the wall becoming so nearly vertical as to be inaccessible. The rock at the base is chiefly a hard blue limestone, capped towards the summit of the mountain, with a stratum of argillaceous sandstone of great thickness. On the north side of the river, the mountain is terminated more in stages; yet it is very abrupt, and we had some difficulty at times in following the Indian trail along its face, in its natural state. These rocky precipices, rising one above the other, soon gain an elevation of two and three thousand feet, and the highest points finally attain an altitude of 4,000 feet above the river. The dip of the stratified rocks, wherever they are exposed, is from the river, and consequently there is little danger of land-slides in this gorge. The river as it enters the cañon is thirty yards wide, flowing with a strong current; but towards the foot it becomes still more rapid, breaking with considerable noise over the rocks in its bed. The pass, which is ten miles in length, varies in width from one hundred to three hundred yards, and in constructing a railroad through it it would be necessary to cross the stream several times, to avoid short curves, which could be done as easily as bridges are usually built; and considerable blasting of rocks would be requisite at various points, but amounting to no large aggregate. A little pine grows on the mountain sides quite down to the river, but it seldom exceeds 8 or 10 inches in diameter.

The descent per mile for the first 5.70 miles from Kamas prairie, is 32.90 feet, and 60.90 feet to the mile for the next 5.20 miles; for the succeeding five miles it is 44.40 feet per mile, and six feet to the mile for the succeeding 5.40 miles; and for three miles from the head of the cañon the average descent is 30.10 feet per mile; and for the succeeding eight miles, to our camp below the cañon, 39.60 feet per mile. Our altitude at this camp was 5,077 feet above the sea, and on a plain 150 feet above the river.

April 22.—We descended the river a short distance this morning, and then turned around the base of the mountain northward into the valley of Utah lake, which lay beautifully bright below us. A railroad from the Timpanogos cañon should follow the same line, gradually descending into the valley and passing through its numerous Mormon settlements to the foot of Utah lake, where it should cross the Jordan, and, if practicable, cross the Oquirrh mountain through Cedar valley to the west of Lake Utah—the appearance of this part of the mountain, seen at considerable distances both from the east and the west, rendering it worthy of examination, if at any time a railway should be constructed west from Timpanogos river; but if this route should be impracticable, then it should descend the valley of Great

Salt lake to the north end of Oquirrh mountain. The descending grades by the latter line will be 33.80 feet per mile for 14.20 miles, from the foot of the cañon to the American fork; and 3.50 feet per mile for 39.60 miles thence to our camp of the 6th of May, at the northwestern angle of the valley of the Jordan. This unobstructed valley, of 20 miles in width by 30 in length, is largely susceptible of irrigation and cultivation, and already contains many Mormon settlements, of which Great Salt Lake City is the principal.

It began to rain violently at 2 o'clock p. m., and continued until dark, soon after which I arrived at Great Salt Lake City after a ride of fifty miles. Latitude $40^{\circ} 45' 37''$.

CHAPTER II.

From Great Salt Lake City to the valley of Humboldt river—May 1 to 23, 1854.

May 1.—I received on the first of May, at Great Salt Lake City, your orders of the 21st of February preceding, directing me to make the explorations and surveys of the passes eastward from the Great Basin embraced in the preceding part of this report—these surveys having been made in anticipation of the receipt of the instructions referred to, or, in case of their non-arrival, to facilitate the completion of the explorations already ordered—and then to retrace my steps and survey the route which I had proposed, “passing to the south of Great Salt lake in the direction of the ‘Sink’ of Humboldt or Mary’s river, thence towards Mud lake and across to the tributaries of Feather river, and thence by the most practicable route to the valley of the Sacramento river.”

May 5.—Leaving Great Salt Lake City, we encamped on the west side of the Jordan, which is now flowing with a muddy, turbid current, considerably swelled by melting snow.

May 6.—The wind blew heavily during the latter part of last night, and a slight fall of rain renewed with vigorous freshness our previous realizations of camp life; and slight showers rapidly succeeded each other, crossing the valley of the Jordan from southwest to northeast during the day. At this season this valley is supplied with a growth of green grass which occasionally forms a sward, but is generally thinly scattered over the surface among the varieties of artemisia known as sage and greasewood. In crossing the level valley from the Jordan, the road is now very good; but during the rainy seasons there are a few miry alkaline beds, which are for the most part, however, easily avoided by making a short circuit to the right or left. We ascended slightly the base of the Oquirrh mountain, and encamped in abundant fields of grass. Large springs burst out along the northern base of this mountain near the Great Salt lake, but are generally more or less brackish; yet the water is used by the few Mormon families settled about them. Day’s march, 12.98 miles; altitude, 306 feet above Great Salt Lake City. In constructing a railroad, however,

this altitude is entirely unnecessary, as the road can be carried nearly on a level with the water of the lake, without a material change of grade while in its vicinity. It is at this point that a road descending the Timpanogos river, and passing by the north end of Lake Utah, should intersect one descending by the Weber, and passing to the south of Great Salt lake, unless it shall be found practicable by the former line to pass the Oquirrh mountain through Cedar valley.

May 7.—A disagreeable night was followed by a high wind and a heavy snow-storm from the northwest, which drove in our faces for two hours while we were passing around the north end of Oquirrh mountain to Tuilla valley. The scenery in turning this point, in the storm, where we came directly upon the shore of the lake, with several islands rising abruptly from its waters, with high mountain shores and extensive mountain ranges in every direction, was very beautiful, and caused regret at the taste displayed in the selection of the site for the neighboring city, from which this beautiful sheet of water is seldom visible, and never appears picturesque. But as it is a city of farms, necessity doubtless dictated its own terms.

The Mormons have several small settlements in Tuilla valley, which is ten or twelve miles in width, and extends south from the lake for some twenty miles, where it is crossed by a cross-range with low depressions at either end; the eastern leading into Cedar valley, and the western along the eastern base of the high range forming the western limit of this valley. The eastern side of this valley is finely grassed, but in crossing it the road lies through a continuous artemisia field, more or less interspersed with grass. For five or six miles in crossing, our road lay along an old shore-line of the lake, elevated some twenty feet above the general level of the valley, into which it gently subsides near a fine spring of water, flowing off in a bold little stream towards the lake. We encamped, after a march of 20.59 miles, on Willow creek, three and a half miles above or south of the most western Mormon settlement upon this line, and directly at the foot of what had been favorably represented to us as a pass by which to cross the mountain. But its appearance as we approached it was too formidable to require further examination; and the Indians who came to our camp informed us, that it is with the greatest difficulty that a horse when led can ascend by this trail when free from snow—which it is not now—and that with a rider it is impassable. Altitude of camp, 4,487 feet above the sea, and 170 feet less than at our morning camp.

Sho-ish, a Utah chief, had sent a runner to his neighboring band, the Goshoots, upon whose territory we were just entering, to say that I was his friend and made very fine presents to his Indian brethren, who accordingly presented themselves at our camp, and were delighted with the trinkets which they received; and I employed two or three of them to accompany me across their own deserts and mountains, no reward being large enough to tempt them to introduce us to their western neighbors, of whom they stand in great fear. Snow-squalls continued during the day, whitening the valleys to the water-level of the lake, and ice formed during the night.

May 8.—After some slight examinations of the mountains to the south, we turned down Willow creek, and passed north along the

base of the mountain towards Great Salt lake, passing several saltish springs and one warm spring, and encamped opposite Stansbury's island, 13.70 miles from our morning camp, and 4.238 feet above the sea. The rocks of the Oquirrh mountain, near Black Rock, and those near our present camp, are conglomerate and sandstone, with others changed (metamorphic) by igneous action, standing in nearly vertical plains. Ducks, gulls, and snipe of a large species, were killed in considerable numbers about our camp, and mosquitoes and gnats were very troublesome. The driving of the water, by the wind, upon the nearly level marshes which border Great Salt lake, presents a marked resemblance to a flowing tide, which has its counterpart in the ebb at the falling wind.

May 9.—Before passing around the north point of the mountain, three miles from camp, into Spring or Lone Rock valley, we passed several salt springs, one of which was blood-warm, sending out a fine stream of water beautifully clear at its source, at which gas was constantly bubbling out; and, as we entered the valley, these springs became more numerous—the finest of which sent out a volume of water two feet in width by three inches in depth. This spring issues through a mass of conglomerate rock, and is inhabited by a multitude of small fish two or three inches in length, which retreated into the spring under the rocks at my approach. Several other springs, as we passed on, were far less salt, but our horses drank of them reluctantly. Our path led all day through fine fields of grass, which sometimes occupied the surface unopposed by more hardy plants, but at others was thickly interspersed with artemisia, of the greasewood and rabbid-bush varieties. The large central portion of this valley towards the lake, is an alkaline plain, too soft and miry to be conveniently crossed. It is terminated to the west by Cedar mountains, a range parallel with, but not so elevated as that to the east of the valley, which is twenty miles wide. We encamped, after a march of 21.45 miles, on a fine little creek a foot in width, descending clear and cold from the highest snow-peaks of the range to the east. It would serve to irrigate a few farms before reaching the alkaline bed just mentioned, in which it sinks. High up the mountain peaks above our camp a few dark masses of pine are seen, and cedar extends nearly down to the valley. Our camp is a short distance south of the line by which Colonel Fremont crossed this valley in 1845, and Captain Stansbury in 1849, and by which it should be crossed by a railway to Cedar mountain, which should be crossed by the route followed by Fremont, where the altitude of its summit is given on the map “drawn by Mr. Charles Preuss from the surveys of Colonel Fremont and other authorities, under an order of the Senate, in 1848,” at 5,009 feet above the sea, or about 800 feet above Great Salt lake, or by lower depressions still further to the north, if it should be found desirable. In its course west from this mountain, it should be carried as far as practicable to the south, without unduly increasing its length, to avoid the miry plains nearer the lake—these plains becoming firm in proportion to their distance from it—passing by one of the open spaces to the south of Pilot peak, by which the succeeding chain of mountains to the west is terminated to the south, and thence be continued by the north end of the succeeding western range

towards the head of Humboldt river. For a faithful and lucid description of this part of the line, I beg to refer you to Captain Stansbury's report of his expedition to the Great Salt lake, chapter vi, pages 111 to 116; and for its delineations, to the map before referred to, made by Mr. Preuss. The passes and the country delineated by him in that vicinity were observed with much attention by us from the line which we explored a little to the south of it, our observations confirming the general character of the country as represented on this map, but materially adding to the positive knowledge of it, as will be seen by reference to the accompanying map. We crossed this desert on the 12th and 13th instants, under which dates its description will be found.

May 10.—By the advice of our Indian guides, we crossed Lone Rock valley by a very direct course to the pass in Cedar mountains, which they represent as leading to the best route by which the desert west of it can be crossed—the pass itself, in their estimation, being superior. The rise from the centre of the valley to the foot of the pass is very gradual, and its whole surface is covered with small varieties of artemisia, neither grass nor water being found near the road. The valley southward trends considerably to the east, and is uninterrupted as far as our vision could reach, although a low mountain extends into it for a considerable distance from the west, but eventually terminates in the plain. A small growth of cedar is scattered uniformly over the mountain in the vicinity of the pass, in which we encamped at a small spring of very bitter water, after a march of 15.18 miles, grass being abundant on the mountain sides. We met three Goshoot Indians during the morning, who accompanied us to camp. They were armed with flint-lock rifles and powerful elastic bows, made from the horns of the mountain sheep. Our most intelligent guide, Shippah, pointed out to me a small variety of ground-rat or gopher, and a black beetle-like cricket, which furnish a very large proportion of the food of his people. The grass also, on the seed of which they feed, he thinks of interest, and points out every tuft which we pass.

May 11.—The ascent became more steep as we approached the summit of the pass; the ravine narrow, and covered with a thick growth of stunted cedar, through which we were obliged to cut a road; and the descent still more abrupt and narrow, forced us to cut a road along its sides for a hundred yards—a considerable labor, as the ground was hard and rocky. Fortunately, just below the summit, we came to a small rivulet of running water, which leaks from the indurated shale and dark-blue limestone, overlaid by igneous rocks, of which the mountain is composed, and is much purer than that at our morning camp, which did not afford a supply at all adequate to our wants. The Indians say, however, that when the sun is hot, (mid-summer,) there is no water in this pass. It is not suitable for a railway. Like many of the mountain ranges in the Basin, this terminates in the plain to the south, and can be passed around by a long circuit. It was late when we extricated ourselves from this pass and encamped, having accomplished the short march of only 3.68 miles. The day throughout was dark and cloudy, and at night camp-fires were necessary to comfort, fuel being abundantly supplied by sage.

May 12.—We mounted our Indian guides on mules to-day, and furnished them with scarlet cloth for blankets, greatly to their delight—a merrier set of thieves seldom being seen. The morning was dark and cloudy, and a slight rain which fell during last night had moistened the light friable soil of the hills, making our early ride cool and pleasant. Leaving the base of the mountain, (2.43 miles from camp,) we crossed a field of heavy sand, and a few spaces of hard, barren white clay, succeeded by another field of sand, and then entered upon a soft, moist bed of clay or stiff mud, more or less miry at short intervals for nine miles, in which our riding-animals sank to the top of their hoofs, and occasionally to their fetlocks, and over which our loaded wagons dragged heavily. Eleven miles from the base of the mountain, however, brought us to an extensive field of small artemisia, extending far to the right and left, and sweeping up to the base of Granite mountain, which we were approaching at its northern termination. In this field the soil was light but dry, and the travelling fine; and we encamped at the point just spoken of, where we found a fine permanent spring of pure cold water issuing in abundance from the granite rocks in the bed of the ravine three-fourths of a mile above our path; but we were not so fortunate in regard to grass, only a few scattered bunches being found on this part of the mountain, which is a large isolated mass of granitic rocks, rising from the desert in which it stands, like an island from the ocean, to an elevation of 2,000 feet. Its general appearance is that of white naked rock, with a few small cedar-bushes in its narrow ravines. It disintegrates considerably, and forms the surrounding soil, which is filled with quartz and mica. Day's march, 19.76 miles; altitude of camp, (considerably above the plain) 4,666 feet above the sea.

May 13.—We resumed our journey at 5 o'clock a. m., directly across the desert, (which is that crossed by Stansbury, further to the north, where it is 70 miles wide, to which I have before referred,) south 45° west, (magnetic,) to the nearest point of the Goshute mountains, which derive their name from the Indian band inhabiting them, although the name might better have been applied to the desert, which is characteristic of their utter wretchedness. Five miles from Granite mountain, we left the dry soil on which we terminated our march last evening, and passing over a narrow ridge of sand, entered upon a desert of stiff mud, as level as a sheet of water, which we found great difficulty in crossing with our wagons for 17.66 miles. For this entire distance there is not a sign of green vegetation, and only here and there a dry stalk of artemisia, where it has been transported by the wind. The lightest sheet of effloresced salt covered the moist earth at intervals, and the track of a single antelope or wolf could be seen crossing the desert for miles, by the line of dark mud thrown up by its feet, so level, white and soft was the plain; and the whole scene was as barren, desolate, and dreary as can be imagined. Fortunately the sun was partially obscured during most of the day; but even with the obscurity its reflection was very painful to the eyes, which were materially relieved, however, by one or two light passing showers, which dissolved the salt upon the plain, but greatly enhanced the fatigue and labor of crossing it. These storms, however, which

had been hanging about the high peaks of the mountains all day, accompanied by thunder, increased in number and violence in the plain as we approached camp, and were accompanied by heavy squalls of wind from the southwest, and we were brought to a stand by a hail-storm, to which our animals turned their backs and obstinately refused to move until it had passed. Every object, when it was not storming, was distorted by mirage, rendering it impossible to form correct estimates of objects seen at a little distance—trees dwindling to mere twigs, and extensive lakes to glistening surfaces of mud, as they were approached. Very irregular detached mountain masses lay a few miles to the south, and a single one to the north, conforming in their course to no general theory of parallel lines of crests. The passage to the south of Pilot Peak, and another south of it, looked open and level, and it is by one of these that a railroad should pass west from this desert; the plain of which sweeps entirely around Goshoot mountains, preserving the same level, or nearly so, of our path and of the Great Salt Lake shore, where a road is already graded, or nearly so, but upon which it will be expensive, however, to construct a firm foundation for the road; for which extensive piling will be necessary in crossing all the miry beds. Approaching the Goshoot mountains, we came to a more firm and dry soil, covered with artemisia, for 2.34 miles to the foot of the outlying hills, where we found fine large springs of fresh water, sending out considerable streams to the plain. They were surrounded by large meadows of excellent grass. These springs are filled with small fish, and the Indians, therefore, give them the name of Pangwich or Fish springs. In anticipation of meeting their friends here, our guides dismounted before leaving the desert and prepared their toilet, for which they removed the dark surface-mud of the desert for two or three inches in depth, when they came to a white-clay mud stratum, with which they painted (bedaubed) themselves, in stripes, to hideous ugliness, remounted their mules, and appeared before their friends in holyday costume. We were soon visited by a number of the expected guests, extremely filthy and very naked, and emaciated by starvation during the long winter, during which their supply of rats and bugs fail, and they are reduced to the greatest extreme of want, if their appearance truly indicates it; and they are doubtless among the lowest of the human race in intelligence and humanity. We fed them and made them happy with small presents. There is a little scattered salt grass without the oasis spoken of; but it only extends a short distance, and is succeeded in the hills by artemisia, and in the desert by utter, desolate barrenness.

The teams arrived at camp between 6 o'clock and dark, very much exhausted by a march of 25.32 miles, in thirteen hours of incessant labor after a night of fasting. This desert, by the line by which we have crossed it, is forty miles wide, but less than thirty miles of it particularly deserves the description given of it where it is 70 miles in width further to the north, and the fine water in Granite mountain greatly relieves the hardship of crossing it by the southern line. Altitude of camp, 4,659 feet.

May 14.—It rained heavily during last night, and showers continued to fall in the mountains throughout the day, during which Captain Morris and Mr. Egloffstein made a reconnoissance of the

mountains, and found them very practical for the passage of wagons. Camp was not moved.

May 15.—A heavy fall of rain at camp during last night, covered the mountains well down towards the desert with snow. Accompanied by Lieutenant Baker, Messrs. Egloffstein and Snyder, and a man, I ascended to the summit of the mountain, and proceeded northeast along it, seeking for the best pass, and to determine with more certainty the practicability of turning its northern base. It is covered with fine grass and a low growth of cedar. The rocks were metamorphic, shale, and limestone. At 3 o'clock p. m. we descended to a fine creek six feet in width, descending from high snow-peaks to the south, and running along the western base of the first range of the Goshoot mountains, and breaking through it by a broad passage into the desert, where it disappears. The accompanying profile of the country explored crosses the desert from Granite mountain to the mouth of this creek, which it ascends to our evening camp. But it is still to the north of this line that the railroad should be carried by the line already indicated, and to which I should have immediately proceeded, had I not been led to suppose, by the Senate map of 1848, that the material from which it was constructed was in the possession of the government, and that the re-examination of the country was therefore entirely unnecessary. But, as I have already stated, our observation of that line was quite sufficient to determine its entire practicability and excellence as a railroad line. We now turned south, following Fish Creek valley, which is from 250 to 300 yards wide where we entered it, but soon opens to a much greater width, and sweeps off to the south and southwest. Ten miles brought us to camp, the main body of the party having crossed the mountains, under Captain Morris's direction, by a superior wagon-road measuring 18.63 miles. The valley is here several miles wide, and the stream lined with grass, which is not all, however, of a superior quality. Many of the small settlements of Utah are not so well supplied with the requisites for successful cultivation as those found on this stream, on which we found a band of twenty Shoshonee Indians encamped, besides women and children. They are mounted, and contrast strikingly with their Goshoot neighbors in the plump condition of their persons, although they complain of hunger, and in clothing, blankets and buffalo-ropes being common among them. Our Indian guides left us here, having reached the western line of their territory, and we endeavored, unsuccessfully, to obtain one from the Shoshonees to accompany us—their perfect knowledge of the country being of great service in designating the only points at which water and grass can be found.

May 16.—Leaving camp, we took a nearly west course by the shortest route we could discover, leading to a favorable passage of the low mountains in that direction. The country was at first gently rolling, but soon became more broken and hilly, and covered with an unusual growth of cedar—artemisia covering the whole face of the country, and the soil light and dusty. The rocks of the lower hills were an indurated clay, and a sandstone, easily crumbled; but the higher hills were metamorphic, surmounted by granite. I rode to the summit of several high peaks to the north of our path, to obtain a

better view of the country, and, if possible, to discover more favorable passes in this range, but without success. We therefore descended to the west to a valley but three or four miles in width—which extends northwest to the proposed railroad line, as we subsequently ascertained, and southeast to the head of Fish Creek valley, by which this mountain range can, therefore, be turned to the south, fifteen miles above our morning camp—and crossed to a pass marked by a high peak, at the southern base of which it ascends. The opening or gate to this pass, towards the valley, does not exceed 50 feet in width, the hills of metaphoric rocks being 200 feet high. The dry bed of the pass furnishes a fine road. It rained almost constantly on the mountains during the day, and a hail-storm and one or two showers swept over our path. We encamped a mile above the foot of the pass, and an equal distance below a small spring of fresh water, to which we did not proceed, as the fine grass of the mountain was saturated with rain, and we had provided ourselves with a supply in the morning, not knowing that it could be found at camp. Just before encamping, two or three Goshoots, who had declined to accompany us in the morning, came up with us, and others arrived during the night.

May 17.—We followed up the ravine, in which we had encamped, for three miles, to where a more broad and open passage to the north extends into the valley we crossed just below that camp, and, as we entered it, changed our course more to the south, and in three miles reached the divide, from which I rode two miles to the west to the summit of a high ridge, from which I obtained an extensive view of the valley to the west and of a large mountain-range beyond, extending considerably to the north and south, upon which there were still large fields of snow, and lying directly in the line I wished to explore. The intermediate valley was destitute of grass, and the distance too great, with an unfavorable light, to allow me to see any evidences of water on its western border. I returned, therefore, to the pass, and encamped a mile and a half to the west of its summit, at a fine spring, which sends out a fine stream watering a small field of grass, and again disappearing as suddenly as it rose. I made presents to the miserable, emaciated Indians who visited our last and present camps, and they were made happy not alone with cloths and knives, but pails-full of soup, on which I feed all who call on us. The morning was pleasant, turning cool towards noon, with light showers of rain in the evening. Near sundown, I again ascended the high western ridge to examine the country ahead with a more favorable light, by which I discovered a narrow lake extending along the base of the succeeding mountain-range for several miles, and indications, by the vegetation, of fine springs at the foot of the same mountain.

May 18.—Last night was cold, freezing the surface of the ground to the depth of a quarter of an inch. (Altitude, 6,550 feet.) Leaving camp at sunrise, we continued down the dry bed of the creek for a short distance, but leaving it as we entered the valley, in which our course changed more to the north, for the purpose of passing around the north end of the succeeding mountain. The road was dry and hard, and the artemisia, which covered the whole face of the country,

small. The water of the lake spoken of is shallow and bitter, and its banks miry. Crossing below its foot, which sometimes overflows, and sends out a small stream to the north, we encamped among numerous fine springs of fresh water, around which the fresh grass is just springing up, and the willows are just beginning to show their leaves. The day has been the finest we have enjoyed, and as yet (8 o'clock p. m.) we have seen no rain falling in the mountains. Day's march, 18.40 miles.

May 19.—We continued our northwest course this morning around the mountain, but, to avoid a long circuit in the plain, passed over the foot-hills of the range through a large growth of the cedar of the country. The range itself is terminated by a high round butte just north of the line of our trail. The valley of our last camp was seen to extend well to the north, and to connect to the east by other plains with the valley above Fish creek, just below our camp of the 16th, which would give an important line for a railroad from Great Salt lake, by a very uniform grade, but by a very circuitous route, were not the line by Pilot Peak, which was in sight, and with which this valley also connects, more direct, with equally favorable grades. To the north of the open passage, beyond the terminating butte above described, there is a remarkable peak, very broad at its base and sloping gradually up to its summit, upon which snow is still seen. This peak apparently terminates a short, isolated north and south range, of which it is the conspicuous feature, and a conspicuous land-mark. To the west of this peak we entered upon an extensive plain extending uninterruptedly so far to the north, that only the highest peaks of very distant mountains were visible above it. It also extends far to the south, but is much more broken by mountains. Turning a little south, we encamped, still on the mountain base, at fine springs, which send out small streams to the plain, watering small meadows of grass before they disappear in the absorbing soil. Day's march, 16.11 miles. As we approached camp we discovered near the springs the smoke of a Digger wick-ey-up, or lodge—that is, a smoke curling upwards from the sunny side of a cedar bush. Its inmates, or more properly occupants, were an old man and a young woman, the lowest beings in the scale of humanity I have any desire to see. They were greatly frightened when they discovered us, and the man escaped to the mountains; but the woman did not see us until too late to escape; and as she experienced no incivility, her companion afterwards returned, informing us, as he best could, that he fled taking us for Shoshonees. But he was still greatly in fear, and trembled from head to foot, and, with his companion, returned to the hills as often as curiosity or hunger induced them to come forth. They were filthy beyond description, and as ugly in features as in dirt. They had no shelter, no blankets—nothing but a deer-skin or two, a few ground-rats, a little grass-seed in grass baskets, food for themselves, and a variety of artemisia-seed, which the squaw ground between stones for food for two of the most emaciated and mean-looking dogs I ever saw. We could not discover the use they put these animals to in this condition, for they could barely stand, and the woman was constantly beating them with clubs to keep them from lapping the stones upon which their food was

ground; but they were very anxious to obtain the fat dogs in our train for food. I made them presents of knives and calico, which astonished them not less than our arrival, by which they were made as happy as they were miserable an hour before. We fed them also, but they were, although half-starved, afraid to eat until they saw us partake of the same dish, so little are they accustomed to kindness from strangers. Their dialect was a gibberish which none of us could in the least understand, except when they introduced a word or two of some adjacent tribe. The language of the Diggers, in general, is a corruption and intermingling of a few words from those of each of the surrounding tribes, from whom, in part, they come themselves, it is said, being the Botany Bay fellows of all the Indian tribes in the great mountain world around them. They live a family or two in a mountain, and know nothing beyond the rat-holes of their own hills, being afraid even of their next range neighbors.

May 20.—I despatched my assistant, Mr. Egloffstein, with a party this morning to the northeast, and to the east of the high peaks described yesterday, to make topographical sketches of the route, and determine with accuracy the continuousness and practicability of the railroad line by Pilot Peak, to which we were about to return, while with the main party I crossed the plain west of our morning camp, and passing between low hills on the right, which are easily passed around by the north by the line for the railroad, and a considerable mountain to the left, entered the large valley, twenty miles in width in its broadest part, by sixty in length, lying at the eastern base of Humboldt mountains. It connects directly with that seen to extend so far to the north yesterday—indeed it is here the main part of that valley, which could be followed by a railroad, passing by the north end of Great Salt lake, and crossing the Humboldt mountains by this line. It is the most fertile valley known to exist in the centre of the Basin. Numerous streams descend into it from the elevated range of the Humboldt mountains, all the crest of which for a thousand feet below its summit is still buried in snow. To the largest of these streams I gave the name of Franklin river. It rises, by the union of several small streams, in the pass by which it is proposed to cross the mountain with the railroad, descends to the east of the base of the mountain, and thence flows south for many miles, forming the most considerable lake in the valley, of which there are several, but none of great extent. The lakes are surrounded, and all the streams are lined, with extensive meadows of coarse, tall, luxuriant grass; and the water, so far as we could ascertain, at least at this season of the year, is fresh, but near the lakes has a strong taste of decaying vegetation. The richest of the lands are, unfortunately, too low and wet for cultivation to their full extent; otherwise it would furnish lands for a respectable settlement.

We passed directly along the shore of one of the numerous ponds soon after entering the plain. It is shallow and its water colored by the clay of the soil, and not more than a mile in length. The day was bright and clear, and we rode for several miles in a due west course from this pond, although this course would bring us directly to the base of the mountains, where there is no possibility of crossing

them; but the width of the plain is such—as we travel without any knowledge of the country in advance, not having been able to find a single person who had any knowledge of it by the line I wished to follow—that it is necessary to be sure of finding water and grass for our animals at night, which we could not fail to do at the foot of the snowy range we were approaching, although it increased the distance to travel beyond what it would otherwise have been. But in the middle of the plain we came upon Franklin river, the channel of which is thirty feet wide at present, and it has everywhere overflowed its banks; but in mid-summer it is doubtless a small stream. Turning north, towards the pass in the mountains, we encamped after a march of 21.52 miles, on the banks of the river, which are destitute of timber, but sage furnishes abundant fuel. I observed, in crossing the plain, a curved line crossing it in a general northeast and southwest direction, and elevated perhaps 20 feet above its general level, evidently the shore of a lake which has existed here within a moderate geological period.

May 21.—To avoid ponds and miry places, we were obliged to change our course more to the north, and in six miles crossed the wagon-road opened by Hudspeth and Hastings in 1846, in conducting a party of emigrants to California. It has been frequently followed since, but cattle are seldom in a suitable condition to cross the desert from Great Salt lake to Pilot Peak the same season that they leave Missouri. But it can be safely crossed by the line which we followed; but on arriving in this valley travellers should bear to the south, and intersect the line one day's journey to the north of the pass to which it leads in the Humboldt mountains. Packing parties can easily cross by the northern pass, however, to the valley of Humboldt river. Antelope, sage-cocks, and ducks were quite numerous in the plain and on the ponds to-day.

Mr. Egloffstein and party rejoined us at noon. His observations and topographical sketches conclusively establish the practicability of the railroad line crossing from Cedar mountain to the south of Pilot Peak, and thence to our present camp—and its consequent superiority to all others in this vicinity. The general grades upon it will be readily determined by a reference to the level of our camps of the twelfth and thirteenth of May, and those of yesterday and to-day. The same references will also exhibit a singular feature in the formation of what is called the Great Basin, analogous to that observed in approaching the Rocky mountains from the east, where the gradual and uniformly increasing ascent from the Mississippi or Missouri rivers, forms an immense trunk of table-land upon which these mountains are elevated. The altitudes referred to in the desert are 4,666 and 4,659 feet, respectively, above the sea; and of our last and present camps, on quite as extensive a plain, north and south, as the former, 6,004 and 6,061 feet above the sea. And upon this elevated plateau, as in the case of the Rocky mountains—the most extensive and remarkable range of mountains we have seen in the Basin—the Humboldt is elevated, its altitude being at least nine or ten thousand feet above the sea; and from the western base, as will be seen hereafter, a corresponding subsidence of plains takes place, extending

quite to the foot of the Sierra Nevada, where we again return to nearly the altitude of the Great Salt lake. Latitude of camp, $40^{\circ} 41' 50''$.

May 22.—To avoid the miry banks of numerous small creeks in the plain, we continued our course of yesterday until reaching the foot-hills of a mountain spur extending from the Humboldt mountains, from just north of the pass we were approaching, several miles into the plain, where it terminates, when we wound gently along its base, and crossed the main branch of Franklin river, (which descends from a high peak to the north of the pass,) a few yards above the plain. Though but twelve feet wide and three deep, we were obliged to bridge this stream on account of the miry character of the soil when moist, even on the mountain sides. From this creek, descending slightly, we passed over spurs of hills descending from the pass, and in 2.05 miles came upon a small rill descending from the lowest point in its summit, which was but 0.84 mile distant, 1.15 miles below which we encamped in a side ravine, finding it impracticable to descend with our wagons, on account of the miry character of the soil and of a rocky ravine, commencing 1.33 miles below camp, to the valley of Humboldt river, which lies directly west of this pass. Numerous small creeks descending from various parts of the pass unite, forming a stream five feet in depth, at present, above the head of the ravine, through which it descends with a rapid current to the valley below. Its banks in the ravine are lined with willows and a small growth of cotton-wood, and large fallen rocks obstruct its easy passage, did not the soft soil forbid it. The narrow part of the ravine is three miles in length, and its rocky sides very abrupt; and some parts, particularly near its head, rise vertically to the height of 40 and 60 feet. On the north side, immediately above these rocky walls, the mountain spurs are rolling, or intersected by ravines, and rise rapidly to a much greater height than they attain directly above the summit of the pass. They are easily ridden over, however, in any direction near the stream. On the south side these hills are more abrupt, both towards the stream and the east, and are more rocky and broken, the narrow ravines partaking slightly of the character of cañones. Below this the ravine opens and is easily accessible on horse-back, although the mountains are still high above it for three miles, whence they subside gradually into the Humboldt valley on the south side of the stream; but on the north side, are terminated quite abruptly by a remarkable round bald butte, standing directly in front of the pass in looking eastward from the Humboldt river. From the summit of this butte the country to the west is seen to great advantage. The Humboldt valley is broad and open for 30 miles between its main branches, which are seen descending from the north and south of this position; beyond which the mountain chains, which rapidly succeed each other, apparently rising from a common plain, overlap, and it is impossible to trace the course of the river without reference to maps. A few streams are seen descending towards it from the mountains in the immediate vicinity, but few of them, however, reach it, their waters being absorbed by the light soil of its valley. The whole landscape, except just above us, presents a sombre and even barren aspect, sage being the prevailing plant.

The main mountain depression of this pass exceeds two miles in width to the east, but at the head of the ravine, to the west, it does not exceed a half mile in its narrowest part, including the ravine which is only 100 or 150 feet wide. Snow covers the high peaks above it, and a few drifts extend in the ravines down to the level of its summit. The rocks are granite, quartz in masses, blue limestone, and slate, altered by igneous action. In approaching the pass from the east, advantage can be taken of the mountain spur which extends into the plain from its northern edge to the right of our path, to enter it and pass its summit by a longer and easier grade even than that given in the accompanying profile, which indicates the natural grade by which we ascended it; and in descending to the west, its width and the character of the mountain sides are such that some advantage can be taken of them to effect the descent by a line following the hills on the north side of the pass, but this advantage will be confined chiefly to that portion below the rocky ravine.

The ascending grades from our morning camp, as indicated by our barometers, are, for 7.65 miles, to the crossing of Franklin river, 58.10 feet per mile, and thence to the summit of the pass, 2.89 miles, 25.10 feet per mile, the altitude of the summit being 6,579 feet above the sea; and the descending grade to the west, for the first 0.80 of a mile, 78.30 to the mile; and thence to the base of the bald butte, 8.36 miles, 96.70 feet to the mile. Below this point we enter the valley of the Humboldt river between its north and south forks, their junction being, by the course of the creek descending from this pass and the north branch of the river, thirty-five miles distant, with an average descent of 28.50 feet per mile.*

The valley of the Humboldt river having been explored by Colonel Frémont, and so favorably represented for the line of a railroad, no further examination of it was deemed necessary; and being obliged to proceed sixty miles south to cross the Humboldt mountains with our wagons, I determined to proceed west from that pass across the Basin

*The Humboldt river "rises in two streams in mountains west of the Great Salt lake, which unite, after some fifty miles, and bears westwardly along the northern side of the basin, * * * The mountains in which it rises are round and handsome in their outline, capped with snow the greater part of the year, well clothed with grass and wood, and abundant in water. The stream is a narrow line, without affluents, losing by absorption and evaporation as it goes, and terminating in a marshy lake, with low shores, fringed with bulrushes, and whitened with saline incrustations. It has a moderate current, is from two to six feet deep in the dry season, and probably not fordable anywhere below the junction of the forks during the time of melting snows, when both lake and river are considerably enlarged. The country through which it passes (except its immediate valley) is a dry sandy plain, without grass, wood, or arable soil; from about 4,700 feet (at the forks) to 4,200 feet (at the lake) above the level of the sea, winding among broken ranges of mountains, and varying from a few miles to twenty in width. Its own immediate valley is a rich alluvion, beautifully covered with blue-grass, herd-grass, clover, and other nutritious grasses, and its course is marked through the plain by a line of willow, * * * serving for fuel.

"This river possesses qualities which, in the progress of events, may give it both value and fame. It lies on the line of travel to California and Oregon, and is the best route now known through the Great Basin, and the one travelled by emigrants. Its direction, mostly east and west, is the right course for that travel. It furnishes a level, unobstructed way for nearly three hundred miles, and a continuous supply of the indispensable articles of wood, water, and grass."—*Geographical Memoir addressed to the Senate of the United States in 1848, by Colonel Frémont—June, 1848.*

by a route not before explored, returning to the valley of the Humboldt near the point at which it is proposed for the railroad to leave it in its western course. The 23d of May having been passed in examining the pass described, we resumed our journey on the following morning.

CHAPTER III.

From the valley of the Franklin river, east base of Humboldt mountains, to the crossing of Humboldt river—May 24 to June 9, 1854.

May 24.—We travelled south along the eastern base of the Humboldt mountains, crossing numerous small creeks, and at our camp a mountain torrent, which we were obliged to bridge, although it did not exceed twelve feet in width by two in depth, but it poured by with great fury; yet we were but a few hundred feet above the plain, which we were obliged to avoid on account of the miry banks of its numerous creeks. The base of the mountain is finely covered with grass, but we occasionally passed fields of sage and thorny bushes, the latter covered with myriads of nesting caterpillars. Before leaving camp this morning, a few miserable Indians came in, but they were very wild and timid; and we met a naked, stalwart fellow during the day, whom I adorned with rings.

In the plain at the foot of the hills near our camp this evening there are some forty hot springs. Their orifices are in granite—the water boiling up as from a well into funnel-shaped basins, and a small pond is formed by their united waters, with vertical granite walls even with the surface of the plain. There is a slight odor of sulphuretted hydrogen about them, but the water, when cooled, tastes pure and fresh, and is limpid. They are more or less intermittent in their action, and the temperatures of the different springs vary from 120° to 170°, and the total amount of water which they discharge is small. The mountain above us and along our path to-day is almost entirely granitic—sometimes very fine, at others feldspathic and crumbling, or micaceous and disintegrating. The morning was very beautiful and pleasantly cool, and mid-day warm; but we were thoroughly drenched by rain before encamping. Day's march, 19.17 miles.

May 25.—It commenced raining soon after daylight this morning, and continued until night, making the soil very soft for travelling, and swelling every rivulet to a mountain torrent; so that, although we started at the usual hour, and did not encamp until late, we made but 7.99 miles; and, although we built several bridges in this short distance, several of the gentlemen were thrown into the swollen streams, their riding-animals being thrown down by the force of the water; but this bathing was of little consequence, as we were all thoroughly drenched from early morning until sundown. We remained in camp on the 26th, for the purpose of observing the eclipse of the sun for longitude, for which we were very anxious, all our previous efforts

having proved so abortive. But the morning was unfortunately very cloudy, and we failed in seeing its commencement, and were no more fortunate at its termination, the sun only occasionally breaking through the clouds during the day, and being too much clouded for the exact observation of its termination. The day was considerably darkened and chilled by the obscuration. Our camp is magnetic west from the point where we entered this valley, near a small lake, six days since.

May 27.—We continued along the base of the mountains, crossing several small streams, and encamping, after a march of 13.93 miles, at the mouth of a narrow ravine by which an Indian trail passes over the mountains. I ascended it quite to the summit, overlooking again the valley of the Humboldt river, towards which several small streams were seen flowing from mountains west of that on which I stood. On the peaks of two or three of these mountains, only, could I see snow, and on these in small quantities only. The country, except by the course of Humboldt river, looked very broken and difficult to pass. This pass is only fit for a mule-path, as the ascent by the most advantageous line is 1,200 feet in the first three miles.

The lake spoken of before, several miles in extent at high water, we passed to the east to-day. It is lined with grassy marshes on the west, and apparently by sage-plains on the east, and is very shallow, the shoals appearing here and there above its surface. From my position on the summit of the mountain I could see a high shore-line across its southern end, dry and easily crossed, but it is immediately succeeded to the south by ponds and marshes of considerable extent. Several Indians—Diggers—whom we met, collected a score of their friends, and accompanied us to camp. They are better clothed (in skins) and less afraid of us than those we have before seen. They are accompanied by but one squaw, who has a child a year old, of which she is very fond, and its father plays with it in its new finery—a sight I have never before seen among wild Indians. An equally strange sight was that of the only horse possessed by the party, packed with their effects, surmounted by the child, while the father walked and the mother carried no burden. Several of our men are quite ill with fevers.

May 28.—I engaged an Indian to accompany me to-day in order to gain from him such information of the country as he possessed; but he soon deserted and returned, with two companions who accompanied him, to his people. From the base of the Humboldt mountains a very large number of fine springs burst out and flow into the ponds and marshes to the left of our trail: all the water indeed—and it is a large amount—with the exception of one or two small creeks of this portion of these mountains, bursts in springs from their base. In a single mile I counted fifteen, any one of which would have been a remarkable spring in another locality; but one of them was, even here, remarkable, both in volume and beauty. It bursts from the base of a vertical rock of blue limestone, nearly 50 feet in height, in the face of the mountain, in a single stream like the escape of a subterranean river, and pours down in a foaming white sheet over detached rocks for 40 or 50 yards; and thence continues on in a rapid limpid stream, 15 feet in

width, and one in depth. The streams from several of the other springs were nearly as large, but none compared with this in beauty. The numerous ponds and marshes formed by them seem to have no outlets; at least we could discover no stream flowing from this valley, which receives a very large amount of water, all of which must be carried away by evaporation.

Twenty miles from our morning camp we turned west, and began the ascent of a pass which an Indian described to us by placing his open hands side by side, and gently separating and elevating them, indicating a broad open depression in the hill or ridge rising to high summits on either side. Its width is six or eight miles, and it is a very superior natural wagon-road, for which it has been used considerably in the early days of emigration to California, the Hastings road passing over it. It is 5.18 miles from the eastern plain to its summit, which is covered by a fine growth of cedar, and an equally fine growth of grass. The descent is also broad, and ten miles in length to the western base of Humboldt mountains to where the southern branch of Humboldt river flows past, which is followed by Hastings' road to the junction of the north fork. We encamped, after a march of 35.11 miles, at a late hour, our dinner not being served until 10 o'clock at night. The valley of this creek is uninterrupted to the eye from Humboldt river far to the south.

May 29.—We travelled four miles over a field of rank sage, and entered a dry, grassy ravine from fifty to one hundred and fifty yards wide, leading to the succeeding summit, 6.83 miles from our morning camp, whence we descended by the same cañon ravine to the succeeding plain, some fifteen miles in extent, enclosed by mountains to the east, south, and west, and by considerable hills to the north, and is therefore a "basin," in the centre of which, at times, if not permanently, there is a respectable-sized lake. We crossed the northern end of this plain, where it is covered with rank sage from three to five feet high, and proportionably large, our course being directed to the most favorable western depression in the succeeding range, which we ascended slightly, and encamped, after a march of but 16.02 miles, in fine fields of grass upon the banks of a small rivulet.

Last night was quite cold, snow falling on the mountains, and a few flakes in the valleys, and ice forming on the water; and at sunrise, the thermometer stood at 26°. The party were wrapped in their overcoats during the whole day, and fires are pleasant this evening. But, notwithstanding this indication of the climate, the blades of grass are eighteen inches long.

May 30.—We passed the low summit at the depression near which we had encamped, finding a small creek flowing west, which we followed towards the next valley until the hills confined it within too narrow limits to admit of our passing in its ravine; at the same time, the mountain rose high and abrupt to the west, covered with a thick growth of cedar, interspersed with a few small pines, through which we were obliged to cut a road to its summit. The western descent, for a thousand feet, was very steep, and intersected by vertical ledges of metamorphic rocks, broken and fallen at intervals, enabling us to descend with our wagons, when we again returned to the creek,

on which we encamped at the termination of the mountains, surrounded by an immense growth of sage interspersed with grass. Day's march, 10.44 miles. The night was cold, ice forming in our tents.

May 31.—We entered a large valley, extending north to Humboldt river and far to the south, and covered with sage, except in a few spots white with incrustations of salt. The chain of mountains to the west is not so elevated as those passed heretofore, but a high, snowy peak, and the sharp crest of a considerable range, are seen far to the south, dividing the valley. Several small creeks were crossed flowing into one main one, which descends towards the valley of the Humboldt. Reaching the western mountains, we came to a small stream of excellent water descending from the pass we were approaching, and ascended two miles, when we encamped, having travelled 21.94 miles. We saw but little grass during the day, but it is abundant among the sage on the hills about our camp.

A single Indian visited our camp this morning, and two or three were seen during the day industriously employed in catching small ground-squirrels or rats, upon which they subsist to so large an extent. They are very numerous, and in fine condition at this season of the year. The Indians shoot them with blunt arrows, catch them in ingeniously contrived "figure-four traps" set at the mouth of their burrows, and dig them out of the earth with their hands; and it is not unusual to see them carrying forty or fifty, the reward of a single day's hunt. Forty Indians (Diggers) were gathered at our camp at sundown this evening—all males, and generally unarmed. I ordered camp-kettles of soup for their supper, and made them presents of a few knives and other articles, which put them in such good humor with themselves and our party that they spent the entire night at the fire assigned them, under the eye of the guard, singing and rejoicing, and annoying us by their grunts and nasal sounds, of which all Indian singing is made up—sounds anything but agreeable to civilized ears. At daylight their number was increased to fifty; and as I arose, the arrival of a chief was announced by the oldest acquaintance we had in the band, and he was soon paraded before me to receive the lion's share of the bounty in which he had not participated the previous evening. I covered him and his son, a small boy, who stood by his father's side, in scarlet, greatly to their delight. The claims of those who had arrived during the night were next urged; but I had no time to attend to their wants, and informed them that they would receive no more—"Kay-wit," in their miserable language—when their importunities ceased. Their wigwams—wickeyups, as they call them—are superior to those we have recently seen. They are bee-hive shaped, four feet high, and partially covered with grass. The opening of every one that I have seen in the Basin is towards the northeast, an indication of the prevalent direction of the storms.

June 1.—Two miles and a half, by an easy ascent for wagons, brought us to the proper summit of this pass, to conduct us to which, one of the Indians constituted himself guide, running before my horse and pointing out every stone and bush that he was to avoid, while several others were occupied in catching rats along our path; but the

main body preceded us a short distance, and appeared in great haste, which excited my curiosity, and I rode forward to discover the cause of it, from which it appeared that, as a matter of policy, or a precaution to prevent being despoiled by robbery of their wardrobes, in visiting us the previous evening, they had, each for himself, made a cache of his effects under separate bushes, and for the same reasons they were now hastening to remove them from where we were about to pass. It was indeed a novel and ludicrous sight of wretchedness to see them approach their bush and attempt, slyly, (for they still tried to conceal from me what they were about,) to repossess themselves of their treasures, one bringing out a piece of an old buckskin, a couple of feet square, smoked, greasy, and torn; another a half dozen rabbit-skins in an equally filthy condition, sewed together, which he would swing over his shoulders by a string—his only blanket or clothing; while a third brought out a blue string, which he girded about him and walked away in full dress—one of the lords of the soil. With these simple wardrobes they were all soon reclothed, and we arrived at the same time at their lodges, deserted by their women, and upon the top of the pass—that is, to where a respectable stream rose and flowed to the west. But owing to the formation peculiar to so many of the mountains in the Basin, and upon our continent generally, we had but just commenced the ascent necessary to its passage in its natural state. For, though the streams continue to flow to the succeeding valleys, which are open and easily descended, frequently for miles, the mountains still continue to rise to the west, and the valleys are again closed up by their close proximity, and the streams break through the last and highest ridges in deep, narrow, rocky ravines and cañones, which terminate abruptly to the west. This was the case in this instance, and we were obliged to ascend a thousand feet higher before commencing the descent, and were then obliged to encamp, and put all our well men—for we had several sick with rheumatic fevers—to work to level down a roadway on the side of the ravine we were descending. From the top of the valley the view was extensive. To the west a small valley, containing small ponds of water, sweeps off to Humboldt river, and is succeeded by numerous mountain ranges of limited extent, and by two large ranges upon which there are still large banks of snow. This mountain is characterized by large masses of beautifully colored quartz, and we therefore gave it the name of Quartz mountain, although it is chiefly composed of dark metamorphic rocks. To the pass, Dr. Shiel, geologist, gave the name of Agate, that stone being profusely scattered about in large blocks. Day's march, 6.83 miles.

June 2.—Owing to sickness among the men, with new cases of rheumatic fever daily occurring, it was necessary to remain in camp to-day, during a heavy fall of snow, from 6 a. m. until noon, when we proceeded to the foot of the pass, 2.65 miles, and encamped; but during this short march we were thoroughly wet by a shower of rain, and a second swept over us after we had encamped. This pass, though easily ridden up, would be in some parts very difficult to ascend with wagons. The valley in which we encamped does not exceed nine miles in width where we entered it, but a little to the north the

mountains trend to the east and west, and it becomes broader, but again becomes narrow before joining the main Humboldt valley. Several small streams descend into it, forming the grassy ponds already described. Two or three varieties of artemisia constitute its chief vegetation. Its soil is very light and friable; the track of a single Indian crossing it being plain and distinct.

June 3.—A cool and pleasant morning. Crossing the valley of our morning camp, we ascended a range of low hills of altered rocks, which could be easily passed around to the south, and then crossed another small valley, from which a creek flows into the one first crossed, and passed over a second range of hills, as easily turned, and encamped on a creek which descends to a small pond two miles distant. Scattered over the hills there are a few bunches of wheat-grass, and on the stream a narrow margin of the broad-bladed grass of the country, and sage supplies us with fuel. We see daily a few varieties of wild flowers scattered along our path. The rocks in the vicinity of our present camp are a coarse, crumbling granite.

June 4.—It was again impossible to cross the mountain, (at the foot of which we had encamped,) by the lowest depression in it, on account of a narrow ravine with steep sides and rocky projections at short intervals, and large stones in the bed of the creek which trickled down it. We therefore turned north, following for some distance the ravine of a large stream coming from high peaks in that direction; but it became narrow and miry, obliging us to leave it and wind round from hill to hill until we reached the summit of the mountain, which was itself very springy and miry, and we passed a small pond on its narrow summit. There are no trees upon it, but a few scattered cedar-bushes and a luxuriant growth of bunch-grass. From the high peaks near the pass the valley of the Humboldt was seen, 25 or 30 miles distant, to which the valley to the west extends. The descent was more steep, springy, and miry, than the ascent, and filled with out-cropping strata of altered rocks, by which two or three of our wagons were broken. By the wagon path it was 8.44 miles from our morning camp to the top of this pass, with a difference of level of 2,019 feet, the altitude of the summit being 7,315 feet. We encamped near the succeeding valley, 3.04 miles from the summit, and 1,667 feet below it.

June 5.—In the valley which we crossed this morning there were numerous ranges of hills, and twelve miles to the west a low, bluff mountain, around the north end of which we passed, coming upon a small lake of brackish water surrounded by miry, desert plains, in all respects like those immediately west of Great Salt lake. Crossing the foot of this miry plain, from which the sun was reflected with great power, we encamped at the mouth of a ravine in the succeeding mountain, from which a fine stream of cold water descends. In the first valley crossed, no vegetation was seen except artemisia, and the soil was alternately light and dusty, and smooth hard clay. The mountain at camp is formed of altered rocks and of a hard, blue limestone. Day's march, 30.10 miles.

June 6.—We passed around the north end of the mountain of our last camp, through a broad depression two or three miles in width, in

which there were fine springs of water and a respectable growth of cedar. The ascent of our road was inconsiderable. On the north of the passage stands a small mountain, which sends out a high spur to the southwest, which I ascended, and from which the view was extensive. Mountains succeed mountains rapidly, and the valleys become small and irregular. The one which we were entering sends out a small stream to Humboldt valley, and is bounded by a high, snowy range to the northwest, which gradually subsides towards the south, where it trends to the eastward and unites with the one we were passing—the rocky strata of which dip from each side towards its centre. We encamped in fine fields of grass, with sage for fuel, at the foot of the mountain which trends eastward. Two or three Indians were seen during the day, which was fine with a pleasant breeze, with thunder-showers in the mountains. Day's march, 14.12 miles.

June 7.—Guided by the Digger Indians, who call themselves Pah-Utahs, however, we passed easily over the mountain at our last camp through luxuriant fields of grass and sage. The ascent from camp was narrow only for a hundred yards, the hills sloping easily upwards; and in the mountain there was a broad depression, followed by a descending plain 75 yards in width, at the foot of which there are fine springs of water which we passed as we entered the succeeding valley, which is ten miles broad, and extends to the north to Humboldt river, but is shut in to the south by mountains. The soil of the valley is friable and dry, supporting only a small variety of artemisia. Leaving the valley, we encamped well up a ravine in the succeeding mountain. This pass is grassy, well watered, and easy to ascend to the summit. There are a few small cedar-bushes only in the mountain, but sage covers all the hills. Indians were digging roots about us, which were of the size of ground-nuts, with a pleasant taste. A few presents made them happy. Distance, 20.57 miles.

June 8.—Leaving camp at 6 o'clock this morning, we passed the summit of the mountain, and descended the opposite slope on the banks of a fine creek which flows into a desert plain in the southern part of the succeeding valley. This valley is ten miles wide where we entered it, and extends to the south and west entirely around the next western mountain-range, which is elevated and quite snowy towards the north, where it is terminated by a high peak marking the southern border of Humboldt valley. The soil is light and covered with artemisia. In entering it we changed our course considerably northward, and passed over a low spur of the western mountain, where it descends to the valley of the Humboldt river. In entering this plain, we returned to the proposed line for the railroad. The valley of the Humboldt, as seen here, is from eighteen to twenty miles wide, its soil very light and friable, with extensive districts of sand, more or less covered with the several varieties of artemisia, which occupy so large a proportion—at least nine-tenths—of our territory between the Rocky and Sierra Nevada mountains, and characterize its vegetation. To the south of the river, and for a short distance to the north, the mountains are generally similar to those we have so recently crossed, which run out as they approach the valley. Many of them do not

exceed twenty or thirty miles in length, and are easily passed around upon the general level of the plain. They are generally very narrow, and, in their elevation, seem nowhere to have disturbed the strata of the plain above which they rise; or, more properly, the earth of the plains—for they are without rocks—seems to have been deposited since their elevation.

Four miles from the mountain we reached the river, and encamped. The river-bottom is a mile wide, the stream, just level with its banks, winding, from side to side, to where the second banks or bluffs, twenty feet high, rise to the level of the main plain of the valley. Willows line the stream in many parts, but trees are nowhere seen on the Humboldt. Its water, even at this season, is not superior, and becomes less so as you descend it, and as it subsides after the spring rise. It is now 40 yards wide when all collected in one channel, and eight feet deep, flowing with a moderate current. There are no fish in this part of it larger than minnows. The width and character of the valley as here given extends as far as we can see, many miles above and below, and is precisely like the portion we entered at the foot of the Humboldt mountains, and such is its general character. It is infested with mosquitoes and sand-flies. The day has been very pleasant. March, 30.26 miles. The altitude of camp above the sea, 4,141 feet.

June 9.—We moved camp but 6.80 miles down the river to a point selected for crossing it, where it has no bottom-land upon it. These low lands being very much overflowed at this season, and miry, are entirely impassable for horses or cattle; and many arriving here in a weak condition, are annually lost by emigrants from becoming mired. But one of the chief causes of the loss of cattle by emigrants upon this stream, is allowing them to eat the grass in the river-bottom, which is extremely unwholesome. The more experienced stock-drovers to California send their cattle back from the river to feed on the nutritious grass of the hills; but, as these are frequently distant from the road and from water, it is only by experience that men learn its importance.

CHAPTER IV.

From the crossing of Humboldt river across the Sierra Nevada, by the Madelin Pass, to the junction of Fall river with the Sacramento, and back to the eastern base of the Sierra Nevada and the shore of Honey lake.—June 10 to July 4, 1854.

June 10.—We crossed the river by a small wagon-boat brought with us for the purpose, and descended the stream 3.51 miles to camp. Fine droves of cattle, which had been wintered near Great Salt lake, passed to-day on their way to California, and one or two large flocks of sheep are but a few miles behind them. Latitude of camp, 40° 42' 03".

June 11.—Our last camp was in a large bottom of coarse grass—the last found on this river above its sink—known to emigrants as Lassen's Meadows, in which the river terminates its general western course, and turns south for 40 miles, where it reaches the marshy lake in which it disappears. Immediately north of the meadows there is a detached east and west mountain range, a few miles in length, behind which there is said to be a favorable passage to the west, leaving the river, of course, a few miles above where we returned to it, but in sight. The same passage is entered by the west end of the mountain by a northwest course from yesterday's camp. It is by this line that Noble's route to California, followed to some extent by emigrants, leads to Mud lake, and it is believed to be the most favorable route for reaching that lake from the river; but its eastern portion did not appear so favorable to us as one further to the south, which we followed after ascending the highest mountain in the vicinity, and examining the connections of the respective passes westward. By the one we followed we descended the course of the river for 9.64 miles, and then bore off to the southwest over the foot-hills of a mountain just west of this part of the river. Still further to the south, the country becomes more open, and no obstacle could be seen to approaching Pyramid lake on the general level of the Basin; but this would have taken us too far to the south for our present purposes, if it could be avoided, and we therefore followed what appeared the best route. The soil of the valley and foot-hills was of ash-heap friability; but as we ascended the broad open mountain depression it became firm, being formed from the disintegrations of granite rocks. The ascending grades to the summit of this pass are, for the first 9.64 miles from our morning camp, 16.20 feet per mile; but, from the formation of the hills, the distance can be increased to diminish the succeeding grades, which average 23.20 feet per mile for 7.86 miles; 64.30 feet per mile for 6.93 miles; and 97 feet per mile thence to the summit, 5.50 miles distant. The width of this depression, in its narrowest part, exceeds one and a half miles.

We were obliged to leave it, however, to find water and grass, encamping on a granite peak to the south, and several hundred feet above it, where the grass was abundant, and a small spring furnished a sufficient supply of water.

June 12.—The pass to the west is equally as broad and open as to the east, with a descending grade of 87.20 feet per mile for 10.55 miles, and of 30.50 feet to the mile for the next 4.68 miles; and thence to the succeeding valley, 1.85 miles, 73.50 feet per mile. This valley extends far to the south, and doubtless to the east to Humboldt river, passing to the south of this mountain, and west to Pyramid lake. It extends, however, only 12 or 15 miles to the west, opposite the point where we entered it. The western portion of it is entirely barren, and in the spring is doubtless covered with water. To the north the plain of the valley ascends considerably, and becomes narrow, not exceeding two miles in the narrowest portion. It was late in the afternoon when we entered it, and we could nowhere see any indications of water. We therefore turned northward, and were gradually approaching the west side of the valley when we discovered a bunch

of willow-bushes on its east side—an unfailing sign of water in this country—where we found a small spring, and scattered grass in the plain two miles below. The plain was level for 2.55 miles by the path we followed, and ascended 21 feet per mile for 8 miles to where we left it to encamp. The mountains about us are not elevated enough to retain snow at this season, and are very dry and destitute of timber. The rocks in the higher parts are coarse granite, but lower down are shale, and hard dark-red altered strata. The day has been cool, with a high southwest wind and slight showers. Day's march, 28.75 miles.

June 13.—From our morning camp our path lay west to a depression, two or three miles wide, in the succeeding ridge, from which we descended northward over the base of hills extending towards the western valley, directing our course to an open passage in the next western range, at the foot of Mud lake, or rather through which that lake extends, to the foot of the Sierra Nevada. Finding, however, that we should not be able to reach it before night, it was necessary to leave the barren sage plain, and ascend the mountain to the west, to find a camp. But although the grass was abundant, we were unable to find water. Several slight showers during the day, however, prevented great thirst, and one at evening moistened the grass for our animals. The most eastern of the miry plains, called Mud lakes, lies 11.75 miles directly north of the camp. Its southern border is followed by Noble's road, which follows one of the most favorable lines by which the passes we are approaching in the Sierra Nevada can be reached from the east, and in the event of future surveys being conducted in this part of the basin, it is worthy of examination. In crossing the valley which extends to this lake, in approaching camp, we passed over a high mass of rolling hills, which should have been avoided by extending our course to the west in the earlier part of the day; or in leaving the preceding pass, we should have maintained our level by travelling on the east side of the valley, and thus have avoided the descent and rise indicated by the profile, for though the grades are not heavy, they are to some extent unnecessary. As before stated, the depression crossed in the ridge this morning is broad, and can be ascended by a line at least twice as long as the direct one followed by us, which would make it entirely a practicable grade in its unimproved condition for a railroad. From the centre of the valley east of that pass, we ascended 69.80 feet to the mile; and thence to the summit, 1.37 miles, the ascent was 207 feet to the mile. For 2.55 miles west of the summit, the descent was 40.30 feet per mile; and the average ascent for the next 7.04 miles, 44.40 feet per mile; while the change of level indicated by the barometers in the succeeding 2.54 miles was but 43 feet. Day's march, 24.12 miles.

June 14.—We crossed the mountain on which we had encamped, immediately to the west, and descended to a branch of Mud lake. The soil of these plains is very light, and our animals sink quite as deep in many of the parts, dry upon the surface, as in the wet and miry portions. The name of *lake* is liable to mislead you in regard to the character of these mud-flats. It is true, there is a small sheet of water upon the surface of a small portion of the most eastern of them, and upon the most southwestern also; but their general character is precisely that of the desert west of Great Salt

lake—a plain of mud, more or less miry at intervals, destitute of vegetation, with a surface, especially when recently moistened by rain, presenting at a little distance a perfect resemblance to a sheet of water. It is here and there encrusted with salt, but not to the extent of the desert referred to. The first branch of these plains which we crossed was 6.90 miles in width. At this point we crossed Frémont's trail of 1844, leading from the Boiling springs to Pyramid lake. We then travelled along the north end of one of the ranges or spurs of mountains terminating in these plains. I experienced great difficulty in ascending it a few hundred feet on horseback, its composition being in many parts precisely that of the plain, into which, of course, it is washed by every shower. Granite is, however, found in the same mountain, and vegetation in some parts, but there is none upon the friable surface. It was late in the day when we arrived on the eastern border of the second branch of the plain, and it was very doubtful whether we could cross it. There was no alternative but to try it, however, and sleep in the mud if we failed; for, although on a lake, we were without water, nor could any sign of it be discovered, or of grass. Taking a few men with me, therefore, I at once set off, leaving the party to follow with Captain Morris, if I should not turn back in a short time. But although the road was heavy, we experienced no difficulty in crossing this branch of the lake for ten miles to the foot of the Sierra Nevada. The sun was bright, although the day was very smoky, and the reflection severe upon our faces and eyes. When in the centre of the plain, we were gratified by the sight of bushes and of green vegetation in the mountain we were approaching, indicating the position of springs and of small streams; but the streams did not reach the lake, and we experienced much difficulty in ascending to them, as they were upon a terrace, in front of which the ascent was very steep, and so covered with blocks of altered rocks, that it was only after great exertion that our animals were driven over them to water and grass. We were here upon the Noble road, which follows the north shore of the lake by the Boiling springs. In descending to Mud lake north, from the valley east of our morning camp, the grade is 76.60 feet per mile for 11.75 miles, and thence to our present camp, or indeed to any point upon the borders of these plains, the change of level is merely nominal. Day's march, 25.27 miles; altitude above the sea, 4,118 feet.

June 15.—I remained in camp to-day to refresh our animals and give the party rest, its severe labors from sunrise until sunset every day, and frequently until midnight, with the men on guard every third or fourth night, requiring relaxation.

June 16.—In order to discover a practicable railroad pass, if possible, in the Sierra Nevada—this portion of which had never been explored—I determined to examine every opening and depression which could be seen to the east, commencing with the northern, and proceeding towards the south—determining not only the merits of each, but establishing their comparative value. The first of these openings we reached by turning gradually westward three miles south of our last camp, and crossing a branch of Mud Lake valley, 8.85 miles to its foot. I there entered a level, narrow ravine, varying from 50

to 200 yards in width, and more or less winding for six miles. Its walls are precipitous, and at a few points vertical. Large rocks lay scattered about its bed, preventing its use by wagons, and ours were sent further to the north over the hills, but descended to the creek to encamp, having marched but 15.20 miles; our ascent by the course of the stream being but about 200 feet above Mud lake. The mountains here are thoroughly metamorphic, and many of the rocks partake of a volcanic character—black, red, and white in color, and porous in their formation.

June 17.—Fallen rocks, thick willows, and a miry soil prevented us from following the ravine, the sides of which were also difficult to follow, being constantly broken by side ravines, as deep and nearly as large as the main branch—the rocky sides of which vary from 50 to 200 feet in height, and are too steep to ascend on horseback. But as its course was sufficiently direct and its ascent gradual, it was necessary to examine it still further; but it began to rain at an early hour of the day, and we encamped, having advanced but 3.78 miles.

June 18.—From our last camp we left the ravine with the train, and, by a rapid ascent and winding course on its southern side, in two miles reached one of the broad terraces which characterize the formation of this portion of the Sierra Nevada. Crossing this terrace for 1.50 miles, we again rose to a terrace elevated considerably above the first, and then continued to the summit of this part of the mountain by ascending to successive terraces, approached by steep ascents of but a few yards in length. These terraces are more or less broken by deep rocky ravines. To the north of the one we were examining the terraces rise still higher and more broken. The character of the summit of the mountain is, however, broad and massive, and, when once gained, easily traversed in any desired direction.

The ravine itself above our last camp soon became divided into several branches, and the ascent towards its termination, for considerable distances, exceeded 190 feet to the mile—a grade that could not be diminished by any line that we could discover, to which the labor of several days was devoted. We encamped six miles west of the point at which we reached the broad summit of the mountain, and a short distance west of the termination of the ravine examined, on the borders of a marshy, grassy pond, into which a few springs and small rills are discharged from neighboring hills. This grassy marsh and the Sierra Nevada is covered with similar ponds—is a mile in width by two or three in length, from which we could nowhere discover water discharging. The whole mountain surface is covered with small angular stones, which in some places are packed in drifts and heaps, over which it is difficult to ride; and the steep edges of the terraces are formed by the outcropping strata which underlie the plains above. Bunch-grass is abundantly scattered over the hills, and a few branching cedar-bushes are seen. There is in no direction more than a handful of snow visible.

Several Indians, calling themselves Pah-Utahs, visited us and received small presents.

June 19.—The examination of the country already described was continued to-day, while the train and main party, under Captain

Morris, moved south and west, crossing the marsh spoken of yesterday, and passing over a ridge of low rocky hills, entered Madelin Pass, the broad valley of which sweeps off to the east, encamping after a march of 9.30 miles. Smoky creek, a small stream, descends to Mud lake through the valley, which is covered with sage, grass, and stones—the soil being as light as upon the miry portions of the basin. Latitude of camp, $40^{\circ} 44' 12''$.

June 20.—We descended 7.25 miles towards Mud lake and encamped where the valley, which is ten miles wide in its broadest part above, becomes narrowed again to a mile in width, whence it continues to the eastward between hills rising and sloping back to the height of a few hundred feet. Our camp is upon one of the great terraces of the mountain. This terrace is broken in the centre to the east by deep ravines, with steep rocky walls. It is only with the greatest difficulty that our animals can travel over the light soil and rocky surface of the valley. The day has been delightful. Altitude above the sea, 4,914 feet.

June 21.—Captain Morris, Mr. Egloffstein, Mr. Snyder and myself examined the lower portion of this pass to-day. It was 13 miles to the eastern base of the Sierra Nevada, in the plain of Mud lake, to which we approached within six miles—obtaining an unobstructed view back to the point at which we turned west to leave its shore on the 16th instant. Immediately above the plain Smoky creek breaks through a mountain ridge, three miles in width at the base, in a pass varying in width from 100 to 150 yards, and at one or two narrow points not exceeding 50 yards. Its walls are of coarse, crumbling, metamorphic rocks, greatly cut and broken by small rents and side ravines. They rise, not vertically, but at points very steep, from 50 to 200 feet on the south side, and still higher on the north, swelling up, two miles back, into an elevated mountain ridge. Thick willows are in the way of passing easily up the stream, which is followed, however, by a wagon-road for a mile, which then leaves it and passes over the hills on the south side to the head of the gorge. For two miles above this point the wagon-road ascends a gently opening valley. It then leaves it, ascending a branch of Smoky creek to the southwest. The valley of the Madelin Pass at this point is half a mile in width; and a short distance above, it is a mile, but afterwards becomes a narrow ravine, with rocky walls, often vertical. On the south side the wall at once rises to the level of the terrace extending to our camp, and a railroad could only ascend that side of the pass by being cut along it; but on the north side, for seven miles above the gorge, there are no terrace walls, but the hills which set down into the valley afford a favorable site for ascending the pass. Above this point the terrace wall is found on the north side of the little valley also, but can easily be avoided in the construction of a road for which nature has already done much of the grading.

June 22.—A cool, bright day, with a gentle breeze from the southwest. The general width of the pass above our morning camp varies from four to six miles, but becomes more narrow as we approach its summit, where it does not exceed two hundred yards in width. But the hills and mountains rise gently and gradually in all parts

above it, and advantage can be taken of them to increase the distance and diminish the grade of a road to a very considerable extent. It was 9.89 miles to the summit by the direct route we followed. It is broad and rocky at the summit for three-fourths of a mile, and then gradually descends for three or four miles to a broad open plain, too level for the eye to detect its inclination. Large mountain ridges and peaks rise above this plain in all directions, but are nowhere snowy. A single snowy peak and a snowy ridge, however, are seen to the northwest, considerably elevated above the intermediate range. The extensive level plain (at the head of this pass) is ten or twelve miles wide, north and south, by forty in length, east and west. The most remarkable feature in this part of the Sierra Nevada, and a conspicuous landmark, is an elevated conical peak, standing immediately on the eastern limit of this plain, and directly in the line of the Madelin Pass in ascending it from the east. The pass winds immediately around its northern base. Some of the gentlemen of the party ascended it, and were gratified with the magnificent view it afforded of which the snowy Mount Shasta, to the west of the Sacramento, was the striking feature. Its elevation is from 2,500 to 3,000 feet above that of the summit of the pass. We encamped at the western base of this peak, at springs and meadows of grass.

The grades indicated by our barometers for the ascent of this pass from the valley of Mud lake are as follows: To the head of the gorge, 3 miles, 41.60 feet per mile; and for the succeeding 3 miles, 61.30 feet per mile; and 59.20 feet per mile for the next 2.50 miles, followed for an equal distance by a grade of 74.80 feet to the mile. The ascent for 3.56 miles above this point is but 31 feet, followed by a grade averaging 76.10 feet to the mile for 1.55 miles, and of 78.20 feet per mile for 1.56 miles; and for the succeeding 1.55 miles, 94.80 feet per mile; then for 1.56 miles, the grade is 50.60 feet per mile, followed by one of 100 feet to the mile for 1.32 miles, and of 30.30 feet per mile for 0.79 mile to the summit of the pass, the altitude of which above the sea is 5,667 feet, and the entire length of the ascent 22.89 miles; and the total difference of level between the extreme points, 1,172 feet. From the summit of the pass westward, the descent in the first two miles averages 23.50 feet per mile, and 31.80 feet per mile for the next 1.98 miles; and for 1.94 miles, 67 feet to the mile; and thence to camp, 3.85 miles, the descent averages 46 feet per mile. Day's march, 19.66 miles. Latitude of camp, 40° 48' 46" north.

June 23.—The train proceeded a little south of west, skirting the base of the mountains to avoid the miry banks of creeks descending into the plain, forming small grass-fields and miry marshes. Passing an isolated butte to the right, it crossed a small plain extending to the southeast and encamped, having travelled but 10.37 miles. I proceeded, at the same time, with Lieutenant Baker, Messrs. Egloffstein and Snyder, to the southeast from our morning camp to the plain just mentioned, which appeared to lead to a favorable descent to the valley of Mud lake, near its connection with Pyramid lake. Our altitude on the summit of the Sierra was 100 feet less than at the top of Madelin Pass; and for several miles below, the descent was

broad and unobstructed, except by surface-rocks and stones; but the labor of riding over the miry (dry) soil so often mentioned, was severe, not only for our animals, but for ourselves. Five miles below the crest, the country became much cut up by ravines, and was falling off so rapidly, 250 feet to the mile, that we did not deem it necessary to proceed further, but ascended a rocky mass and obtained a favorable view of a route leading from the south end of Mud lake to the west, which had attracted attention when we were approaching the Sierra from the east. Descending from the mountain near us were several small streams, forming a grassy pond at the foot of the descent; and beyond this a broken ridge was followed by the pass just mentioned; still to the south of this, a high range was seen, upon which there was considerable snow.

In our outward trip we surprised several Indian families. They were much frightened at our appearance, especially the women. I invited the men to accompany us, and made them presents. On our return the women had all disappeared, but the men accompanied us to camp, where we arrived at sundown, after a ride of thirteen hours. South from our camp the mountains rise gradually, but to no considerable height. Cedar was scattered along our path to-day, rising to the height of only 40 or 50 feet, but the largest of the trees were two feet in diameter.

June 24.—I determined to cross to the west the broad plain upon which we came at the head of the Madelin Pass, and which would be followed by a railroad crossing this part of the Sierra Nevada. As before stated, this plain to the eye is entirely level, and although several small creeks flow into it and sink, no water is or can be discharged from it without (first forming a lake) overflowing at one of the numerous low gaps in the surrounding mountains. At the time of melting snows, there are many little sheets of water standing upon it for a short time, and even now it is not free from them towards the west. Its vegetation is generally sage, but a few limited meadows of grass exist on its borders. A variety of large snipe and sage-cocks are common, but we saw no evidences of larger game. On the best authenticated maps in our possession, Feather river is laid down as rising far to the north of our present position, and, in its southern course, draining the country which we are passing; and, however well we were satisfied from the formation of the country that this could not be the case, it still indicated the probability of finding a practicable descent, in the direction we were travelling, to the waters of the Sacramento; which is laid down on the maps referred to as having one of its chief sources in a snowy range of no great extent, which has been several days in sight to the northwest.

The day was bright and clear—after the passage of a storm at a distance in the morning—with the usual very high wind from the southwest. The entire march was upon the plain, passing occasionally between low hills; and we encamped near the base of more connected low ranges near the mountains surmounting the plain to the west, which are low and beautifully dark with *forests* of timber—the first we have seen in twelve months really worthy of the name. Day's march, 19.53 miles. The line of profile is direct from our camp of the

22d instant to this point ; the distance (across the plain) being 21.9 miles, with but a nominal grade.

June 25.—Taking the most favorable course we could discover, we were forced still to the northwest, passing (upon the plain of yesterday) between two low spurs at first, and afterwards leaving a small lake to the left. We then entered a pass, or ravine valley, a quarter of a mile wide, smooth and gradually ascending for a mile. It then expanded to the width of a mile, and was grassy and smooth, and still rising easily ; but it became narrowed to a quarter of a mile in width and rose more considerably for the last half mile as we approached the summit. The hills or mountain ridges rise gently on either side of the ascent, and are finely rounded and grassy ; and that to the left, and the whole mountain at the top of the pass, is beautifully wooded with pine, two, three, and four feet in diameter, rising in fine trunks to great heights. By winding on the hills of the approach, it would be easy to increase the length of the approach somewhat, and to transfer the grade towards the lower part of the ascent, and equalize it ; and the summit can easily be cut to the depth of 100 or 120 feet, diminishing the altitude to be overcome. The descent to the west is at first rapid, and the ravine narrow ; but it soon opens to a much greater width, through which a creek descends, at first lazily, but afterwards, as the water increases, with a free but not rapid current. We passed with our wagons without difficulty down the slopes of spurs of the mountains projecting into the pass, having to ascend and descend these spurs in passing side ravines. The last of these spurs only deserves a remark, as it brought us nearly to the level of the top of the pass, and narrowed the valley of the creek to the width of fifty or sixty yards ; but, as it was filled with bushes, it was preferable to avoid it by passing over the hill. Opposite this hill, a deep cañon from the southwest enters, with steep rocky walls. As we descended from it, we entered a valley of a mile in width, still descending considerably as we progressed.

From the summit of the pass it would be easy, for some miles, to carry a railway on the hill-sides, descending at pleasure ; but further down, this would become more difficult, on account of the curves which the hill ravines would require, but it is still practicable. For this purpose the northeast side is the most favorable ; for, although containing the largest number of ravines, they are the smallest, and it is unbroken by cañones. The western descent of the pass is heavily timbered to near our present camp, and there is a fine warm spring in a basin of rocks, just where we ascended the high spur to avoid the creek. We encamped before leaving the pass, after a march of 21.67 miles.

June 26.—Last night was clear and beautiful, but cool, making overcoats and fires comfortable in the evening. The morning was also bright and clear, with the thermometer at sunrise at 19° Fahrenheit—ice having formed an eighth of an inch thick. The pass again became narrow below camp, and heavily wooded for five miles, to where it opens into a broad plain called Round valley. This valley is twenty miles or more in length, and ten or twelve in width ; and several creeks flow into it, and overflowing form marshy lands of

large extent. It is everywhere luxuriant in grass, and the mountains around it are heavily timbered. They are not high, but gradually swelling and rolling. High mountains are seen, however, far to the north, upon which there is some snow. In the west, Mount Shasta is a beautiful feature in the landscape; and to the southwest, other beautiful snow-peaks mark the western line of the Sierra Nevada. As we entered the valley, unusually large Indian smokes curled gracefully here and there, announcing the arrival of strangers.

Turning southward, we followed the base of the hills to our evening camp. Indians were seen at some distance as we were encamping, and Captain Morris rode to them and invited them to accompany him to camp. They are short, but muscular and well-made men, calling themselves Pah-Utahs. They were naked and wild, and we could comprehend but few of their signs. Their noses were bored and ornamented with a horizontal bar of shell or bone. Just above our camp was a newly-made grave, from which the earth had been removed, and the clothes stripped from the body of a young man, doubtless by the Indians, who told us that he had died but two days previously and was buried by his friends; which we subsequently learned was true, the party having been here in search of gold.

June 27.—It was 4.76 miles to the south end of Round valley, where we came upon an old emigrant road, which is said to leave the Humboldt river above the point at which we crossed it, and to cross the Sierra Nevada near the southern line of Oregon, in the vicinity of Goose lake. This part of the road has also been used in travelling from Oregon to California. Its trail is well worn, but at present seldom used.

One of the main sources of the Sacramento river is in the snowy range referred to in crossing the Sierra Nevada, to the north of our path, whence it descends and enters the northeastern part of Round valley, and leaves it at our present station, where it enters a rocky cañon 100 yards wide. The river is from 30 to 40 feet wide as it enters the cañon, flowing with a free current over a bed of rocks. The walls of the cañon at its head are 80 feet high, vertical metamorphic rocks at top, with a large talus at the foot.

From our camp of the 24th instant, the ascending grades upon the line explored, average for the first 10.57 miles leaving that camp, 32.70 feet per mile; and for 1.63 miles thence to the western summit of the Sierra Nevada, 92.60 feet per mile, or 26.30 feet if the deep-cut of 120 feet be deducted from the altitude of the pass, which is 5,736 feet above the sea. With the same deduction for a deep-cut, the descending grades will average, for the first 2.42 miles, 124.30 feet to the mile by the fall of the stream, or 173.4 feet per mile for the same distance to the west, if the summit be passed without any cut or tunnel; succeeded, for 4.93 miles, by 55.90 feet per mile, and 125.30 feet to the mile for the next 3.67 miles, and 25.30 feet per mile for the following 2.25 miles; while the descent is but 25 feet in the succeeding 2.08 miles, but averages, for the next 1.25 miles, 76 feet per mile, and 19.70 feet per mile thence to our last camp, 8.81 miles; and from that camp to the head of the cañon, 4.76 miles, there is an ascent, by the foot-hills which we followed, to avoid soft grounds, of 27 feet. In this valley our altitude has returned

very nearly to that of Great Salt lake, of the lower part of Humboldt river, and of Mud lake; being 4,154 feet, above the sea, at the head of the cañon.

Rising the table in which the cañon is formed, we came upon an open plain, without timber, six miles in length, by a variable width of from one to three miles, so covered with stones on the east side of the cañon that we passed over considerable mountain spurs to avoid them, and again returned to the plain near our camp. On the west side of the cañon the ground of the plain is wet, and a sheet of water stands upon it, beyond which the mountains rise a few hundred feet; while above our camp, to the east, they rise much higher, and are everywhere fertile and timbered. A single Indian, only, ventured to come to camp; but as I was anxious to learn something of the water-courses of the country from them, I made him presents, and sent him to invite others in, for the hills and plains on the opposite side of the cañon were covered by them. The women were engaged in digging roots, of which they brought us large numbers on the return of the messenger with a dozen of his comrades, who were entirely destitute of clothing, and armed with superior bows of cedar and long reed-arrows, strengthened by inserting strong pieces of wood in their centres. They were short, muscular, and well-formed men, but were seriously afflicted with trembling, which they were unable to overcome entirely for several hours. This part of the Sacramento river has been heretofore termed Pitt river; and these Indians, and the bands lower down on it, are called, in California, Pitt River Indians, although they claim to be Pah-Utahs. One of them seated himself near me, and made from a fragment of quartz, with a simple piece of round bone, one end of which was semi-spherical, with a small crease in it (as if worn by a thread) the sixteenth of an inch in depth, an arrow-head, which was very sharp and piercing, and such as they use on all their arrows. The skill and rapidity with which it was made, without a blow, but by simply breaking the sharp edges with the creased bone by the strength of his hands—for the crease merely served to prevent the instrument from slipping, affording no leverage, was remarkable. After completing his work, he performed a pantomime, to inform me of the cause of his cheeks and forehead being covered with tar. He represented a man falling, and, despite his efforts to save him, trembling, growing pale, (pointing from his face to mine,) and sinking to sleep, his spirit winging its way to the skies, which he indicated by imitating with his hands the flight of a bird upwards, his body sleeping still upon the river bank, to which he pointed. The tar upon his face was his dress of mourning.

It is not practicable to descend the Sacramento river with wagons, owing to the mountainous and rocky character of its banks. I determined, therefore, to proceed with a portion of my party to the mouth of Fall river, leaving the remainder in camp until our return, and to ascend the Sacramento from its main valley to that point, after having completed our survey of the Sierra Nevada.

June 28.—We could not travel in the cañon of the river with our animals, and, to avoid a large, rocky ravine entering it from the southeast, we were obliged to leave it for some distance; and to make our day's ride shorter, attempted to cross the country directly to the

mouth of Fall river, intending to return by the Sacramento. But almost immediately after leaving camp, the hills, which were not high, and all the small ravines, became so rocky and covered with loose surface-stones, that it was difficult to ride over them; and our progress was effectually arrested by coming upon extensive fields of volcanic rocks, so rough and full of holes that no horseman can cross them. The Indians clamber over small portions of them, but usually avoid them even on foot. We therefore turned in towards the river, and followed its valley to the mouth of Fall river, encamping just above it. Many Indians were seen during the day at considerable distances, but fled to their hiding-places to observe our movements, leaving their flag-roots where they were digging them. The Sacramento cañon preserves the character with which it begins (at Round valley) for six miles, its walls preserving nearly a uniform height above the river. The plain is then surmounted by high, sloping hills, rising five or six hundred feet above it, and the cañon becomes broader, and its walls also more elevated for two miles, to where the river makes a large bend to the north; below this the walls gradually decrease in height, and in two miles the cañon opens to half a mile in width, which it preserves for three miles to the open valley. This open part of the cañon is timbered with oak and pine, through which the river winds, and we rode several times down its rocky banks, from the hills two hundred feet above. Below, or north of the main bend in the cañon, there are two or three angles in it, but it is generally very direct in its course. The highest parts of the cañon walls are two hundred feet above the stream, with large masses of fallen rock sloping from the stream half way to the top. The passage of this cañon by a railroad, carried generally on the terrace on the north side of the river, and descending the side of the rocky hills which surmount it, which is the most favorable line, will be both expensive and difficult; for it will be necessary to blast and remove rocks to a very considerable extent, the amount of which can only be determined by accurate surveys. The average descent of the stream per mile, for 13.74 miles, from the head of the cañon to the open valley, is 39.30 feet; but by following the north side of the river, the descent can be made much longer and easier by descending to the valley several miles further down the river, which follows the base of the mountains until it turns west, when it is overlooked by a plain, elevated 30 or 40 feet above it, extending several miles to the north. A lake of several miles in extent is seen on this plain, from the hills near our morning camp, and Fall river descends it at the base of the mountains surmounting it to the west. Below the first cañon the valley of the Sacramento is three or four miles wide, easily traversed in any direction, and as easily followed by a railroad with a descent of 27.70 feet to the mile.

Just at our camp the Sacramento is twenty yards wide, and so deep that it can only be crossed by swimming; but its current is very sluggish. Fall river descends by a short rapid of foaming white water, from the plain north of the Sacramento, and discharges more water than the latter stream. At the junction, the Sacramento immediately enters a second cañon, very much resembling the first,

but is of less extent. The mountains rise above it also, as they do above the former cañon, and extend back on the north side to high mountains; but on the south side, after extending some distance into the plain, they diminish in height and sink away into broken rocky hills, and are followed by an extensive field of volcanic rocks, extending through the valley of Canoe creek, or Poinsett river, to Mount Saint Joseph.

The approximate length of this cañon is 8.95 miles, with an average descent of 34.80 feet per mile. Though not so long, it is as difficult and rocky as the former to pass with a railway, and the most favorable line by which to descend it can only be determined by minute surveys. But it is probable that by leaving the river a few miles above the head of the cañon, and crossing the rocky hills south of it, and returning to the river in the vicinity of the mouth of Canoe creek, (although the grades would not be as easy and uniform,) the least labor would be required in removing rocks for its construction, and the short curves avoided, which will be encountered in descending the cañon itself, and that this will consequently be found the most favorable site for the road.

June 29.—Large numbers of Indians were gathered on the opposite bank of the river this morning, but they were evidently afraid to approach us, unless they could take us at a disadvantage, for which they have a noted reputation. At sunrise the thermometer stood at 32°, and at 11 o'clock in the morning in the shade at 80° F. The day was pleasant, but the atmosphere too smoky to afford distinct views even at short distances. Completing our observations in the vicinity of Fall river, we retraced our steps, and rejoined our companions at a late hour of the day.

By referring to my journal from July 15th to July 21st, during which we ascended the Sacramento, from Fort Reading to the second cañon, the line just traced to the latter point will be found continued to the open valley of the Sacramento, and my northern line of survey complete.

June 30.—I had been so favorably impressed with the appearance of the broad opening in the Sierra Nevada, at the south end of Mud lake, as seen from several points, that I had determined, on leaving them, to return to the eastern base of the mountains and examine it. With this object, we therefore followed the old wagon road, near which we had encamped, in a general direction for several miles to the south. It led from camp immediately over a high ridge, affording an extensive view of the mountain country around us, and of a few peaks of the Coast range, seen through low openings in the western ridge of the Sierra Nevada. But the smoky state of the atmosphere was such that no distinctive features or outlines could be traced in the distant scenery. Seven miles from camp, we entered a forest of majestic pines and cedars, through which we travelled for the remainder of the day, but with occasional open, grassy spots, on one of which we encamped after a march of 15 miles. After the high ridge noticed in the morning, the country was still hilly but easily travelled.

July 1.—Following the road again, we ascended gradually for

fifteen miles over broad plains, the pine and cedar forests receiving the addition of the majestic redwood. Many of these trees were five feet in diameter, and rising to the height of 125 and 140 feet. Before encamping, we descended for three miles by a steep, rough road, to a broad, grassy plain five miles in diameter, into which several small creeks were flowing, but we could nowhere discover a certain outlet. The hills and mountains, ten or fifteen hundred feet high, surrounding this plain, with open spaces between them, are heavily timbered, with the exception of one, which is so covered with stones that no space is left for trees. Several graves near camp marked the resting-place of unfortunate emigrants. Day's march, 18.84 miles.

July 2.—We passed out by the south side of the plain to a succeeding one of less size. It was here, as before, impossible to determine which way the water flows, if, indeed, it flows at all from these plains. We have crossed them in every direction, and as yet have not seen an outlet from one of them, and some of them we have been entirely around. From the second we passed to a third of these plains, of the size of the first, in which Pine creek, a fine little stream, flows towards its northeastern part, forming a marshy pond, which can only have an outlet to Eagle lake, if at all. In this plain we also came upon a wagon-road which had been recently used, and which we subsequently learned was the Noble's Pass road, which descends to the east by the same line we were about to explore. We followed it, therefore, and leaving the plain without ascending more than a few feet, continued our course through a dense forest of pine and redwood, passing several grassy ponds, the largest of which we judged to be a mile in length. Many of the largest trees were eight feet in diameter and of great height. We descended a little before encamping, coming upon a small creek, to which emigrants have given the name of Summit, although there are points in the pass several hundred feet higher than this. In approaching camp through the woods, the road was very much obstructed by surface stones, which would have been avoided by following an open, level, grassy space, leading directly from Pine to Summit creeks, a mile north of the general line of the road, which enters it, however, at our camp. It was 10.57 miles from our morning camp to Pine creek, and 9.61 thence to Summit creek.

July 3.—The nights are cold in the mountains, but during the day the sun is hot, making the shade agreeable. Our path continued to-day through the same dense forest so often mentioned. In leaving camp we began almost immediately to descend, and continued to do so until encamping at the eastern base of the Sierra Nevada, after a march of 19.71 miles, in Honey Lake valley, which extends to Mud lake, forty miles to the east. The descending road was very stony, but we nowhere saw ledges or steep escarpments of rocks, until just as we were descending to encamp, when we passed over heaps of stones forming the edge or termination of a rising plain, upon which the higher masses and peaks of the mountain are elevated. This wall is vertical in many parts, to the height of thirty feet, but broken and fallen at others. The small stream known as Susan river follows the course of a low depression seen a short distance to the south of our

path throughout the day. It breaks through the rocky wall described in a broken cañon, and flows gently through the valley to Honey lake, receiving two or three small tributaries in its course. Soon after leaving our morning camp, the road led over a high rocky butte, (which it could more easily pass around,) from which we had a fine view of the lake, a few miles to the northeast. It is several miles in extent, and is set beautifully blue in the mountains which rise from 500 to 1,000 feet above it, covered with majestic pines. It has no outlet. We gave it the name of Eagle lake. From the foot of the butte a fine spring issued, and sent out a creek towards Susan river.

As we entered Honey Lake valley, we found two brothers by the name of Roop, busily engaged in erecting a log-house and planting a small field. They had been here but a month. The lands around them at the head of the valley are very susceptible of cultivation and are luxuriantly covered with grass and abundantly supplied with water by Susan river and other small streams.

Continuing our journey still to the eastward, we encamped on the evening of the 4th of July, after a march of 23 miles, on the shore of Honey lake.

CHAPTER V.

From the valley of Mud lake, via Honey lake and Noble's Pass of the Sierra Nevada, to Fort Reading, at the junction of Cow creek with the Sacramento river, California.—July 5 to 12, 1854.

July 5.—Messrs. Egloffstein and Snyder, escorted by Lieut. Baker and a detachment of riflemen, continued the exploration eastward to-day, to connect the survey from our camp of last night with the line previously explored to the entrance of Smoky creek in the valley of Mud lake. From a mile east of camp, Honey lake trends to the southeast for ten miles, to its most eastern point, and four miles from camp the party came to the foot of a spur setting down from the northern chain of mountains, affording them a view of the country eastward. From the vicinity of this spur in the open valley of the lake, there is, extending for several miles, an old shore-line raised a few feet above the present level of the lake, but to which it occasionally rises, perhaps, at stages of high water. To the eastward of this line the valley of Honey lake extends for 14 miles, and is generally of a dry, barren character. During rains and at the season of melting snows, small sheets of water stand at short intervals here and there upon it, and at present one is seen near the lowest passage to Pyramid lake. Beyond this plain, and forming its northeastern boundary, separating it from Mud lake, is a low mountain range, varying in height from 300 to 800 feet, with a general breadth of about nine miles. In this range several indications of favorable passages exist; but upon examination they proved to be worthless, and the party proceeded southward towards the main passage around this spur to Mud lake, at a point where Pyramid lake is also separated but slightly from the former, the three

being united at very high stages of water, by a small stream flowing into Pyramid lake. This passage is open and level, and in its narrowest part about a mile in width; and from the valley of Honey lake to that of Mud lake, from eight to nine miles in length, the passage to Pyramid lake branching to the south from it. From the position from which it was seen, the passage to Pyramid lake appears to cut through an elevated rocky range, with high peaks rising on either side above the vertical cañon walls. There was a line of green verdure in the cañon, but no indications could be seen of a permanent stream flowing through it. Three small islands in Pyramid lake stand opposite the mouth of the cañon, with Pyramid island in the distance. The water of this lake is remarkable for its deep-blue color, and contrasts strikingly with its yellow rocky islands.

From our camp of June 14, on the west side of Mud lake, our present camp is approached by travelling south, and crossing Smoky creek four miles below its gorge, at the entrance of the Madelin Pass, and thence continuing to the southwest end of Mud lake, and following the open passage, already described, to Honey Lake valley, and thence by the north shore of that lake by a direct line. In the accompanying profile of this pass of the Sierra Nevada, which is known as Noble's Pass, the line just indicated is followed. For three miles from the first point the descent is 13 feet to the mile; then ascends 3.60 feet to the mile for 42 miles, and 7.20 feet to the mile for the next 7.50 miles; with a descending grade thence to our present camp on Honey Lake shore, 8.50 miles, of 22.40 feet per mile—where our altitude is 4,094 feet above the sea.

In returning from their successful trip, Lieut. Baker and party halted a short time at warm springs, sixteen miles from camp; and at 10 o'clock at night, after a ride of 44 miles, encamped at a small spring of cold water, around which they found a little scattered grass. At 4 o'clock on the following morning they resumed their journey, and arrived at camp at 8 a. m.

Honey Lake valley is forty miles in length, east and west, and twenty in width. The extent of the lake itself we could not well determine, from its low shores; but it is about fifteen miles long, by eight or ten broad. It is shallow, and surrounded by low, marshy meadows, and extensive fields of tulare flags; but, outside of these marshes, the plain is firm and the travelling excellent. Its water has a disagreeable, alkaline taste. Towards the head of the valley a bold ridge rises from the plain, and extends back to a high, timbered range, rising 3,000 feet above the lake, and entirely enclosing the valley on the south. Its altitude, for many miles, is very uniform, not having a conspicuous peak upon it, nor a single break for a water-course. A few banks of snow still remain upon its summit. It extends to the east, falling off gradually to the cañon leading to Pyramid lake, and to the west of the summit of the Sierra Nevada, forming the southern chain overlooking the broad depression of Noble's Pass. To the north of Honey lake the mountains are broken, and destitute of timber; and, although connected in the eastern part, by ridges or spurs, with the Sierra Nevada, there are large depressions behind them; and the Noble's Pass road, which ascends Smoky creek for a

short distance, above Mud lake, passes behind them for a few miles to obtain water and grass, entering this valley over a low, broad ridge, near our camp. But the valley on the north side, towards the west, is enclosed by the main trunk of the Sierra Nevada, which rises into high peaks on the prolongation of the northern line of the valley, leaving a gradually ascending and very broad depression at its head—the line of the pass for many miles—with a few peaks rising above the general elevation, and the high, snowy peak of Mount Saint Joseph, standing a conspicuous landmark on the western line of the Sierra Nevada, and overlooking the valley of the Sacramento.

Near our present camp there are fine boiling springs, in one of which a column of water, twenty inches in diameter, boils up a foot or more, at a temperature of 205° Fahrenheit; and, in the large stream which flows from it, the temperature is 170° fifty yards from the spring. Besides this, there are numerous hot springs, varying in temperature from 170° to 190°, from which gas escapes freely with the water. The rocks in the springs have a dark, volcanic character, but the surrounding masses are gray.

We had now examined every favorable indication for a pass which we could discover on the eastern slope of the Sierra Nevada in the vicinity of Mud lake; and I determined to turn my course westward again, and extend my examination of this pass to the valley of the Sacramento. It was supposed before commencing this survey, that any pass in this vicinity, leading to the summit of the Sierra Nevada, would necessarily bring us upon the waters of Feather river; but, in our several passages across these mountains, it was conclusively established that no water does, or can, enter that stream from north of the fortieth degree of north latitude, and that no pass north of Pyramid lake approaches it.

July 6.—Turning westward, we followed the valley of Honey lake, which was swarming with ducks and pelicans, and crossed Willow creek after travelling 11.36 miles—our barometers indicating, in this distance, a change of level of but fourteen feet, with an ascending grade of 11.70 feet per mile, for 8.64 miles—thence to the foot of the pass at Roop's farm, where we encamped, after a short march, on the seventh of July.

July 8.—In reascending the Sierra Nevada to-day, I followed the course of Susan river, which descends in a broken, rocky ravine; and in its lower portion its walls frequently become vertical for considerable distances, partaking exclusively of the cañon character. Seven miles above the valley it is entered by a large ravine from the southeast, but it still preserves its general course, and eventually runs out. It is frequently broken, throughout its entire length, by small side ravines, and is generally narrow at the bottom and broad at the top; but, for short distances, it is alternately broad and narrow at the top and bottom. For the first three or four miles above the valley, the ravine is from two hundred to two hundred and fifty feet deep, but above that it seldom exceeds forty feet, except where small ridges, or spurs, approach it, when its walls become much higher, but are less vertical. After ascending it for eight miles, we crossed it, and ascended an elevated peak near it. The position of this peak was favorable for

observation; but we could nowhere discover a route superior, or at all equal, to the one we were following, for a railroad to ascend this pass. Continuing our examination, therefore, we ascended the stream for four miles on its southern bank, to where it again receives a considerable branch from the southwest, and two small ones from the opposite side. But it was here rapidly running out; and a short distance above, the main stream descends in a channel but slightly depressed below the surface of the broad mountain plain which we were approaching. Passing again to the north side of the stream, we ascended it a short distance, and then crossed over and encamped with the main party, which had followed the road, on Summit creek, at our former camp of July 2.

July 9.—In leaving camp this morning, I followed the open, grassy plain, lying between Summit and Pine creeks, while Mr. Egloffstein proceeded with a party down the former stream until it disappeared in the plain; and then crossed over, without any material change of level, to the head of Susan river; and thence continued our line of yesterday, from Susan river by the ascending plain to Pine creek. This portion of the mountain is unobstructed by any sudden rise or fall, and can be traversed for several miles in any desired direction without obstruction. It will require a minute survey of the lower portion of this pass, to determine the best line by which to effect its ascent by a railroad; whether by ascending the ravine of the river, by which the grade is comparatively small, or by rising as soon as possible to the top of the ravine, with a heavier grade, thereby avoiding, to a considerable extent, the expensive labor of removing rocks for its passage. It is believed to be practicable to accomplish either. The ascending grades by the river, from Roop's farm, are, for the first four miles, an average of 10.10 feet to the mile; and for the next four miles, 105.50 feet to the mile; then 59.10 feet to the mile for 4.50 miles; and for the next 7.25 miles, after leaving Susan river, 75.10 feet to the mile; followed by 31.10 feet to the mile for 7.25 miles, and 54.30 feet per mile for 2.25 miles; with a descending grade of 27.70 feet per mile for five miles, to the west side of Pine creek. From Pine creek we passed through the open pine woods by which we had first entered the plain, and, bearing to the left, followed a grassy plain, gradually descending for 4.73 miles, with a high ridge on our left, which we continued to pass around, changing our course more to the south as we progressed. This prairie was from one to three miles wide, and was marshy in the southwestern part, where it terminates. Leaving it, we again entered a heavily timbered district, descending considerably for 3.75 miles, when we came again into an open prairie, and encamped on Black Butte creek—a small stream, three feet wide, flowing a little to the west of north, and eventually disappearing in the plain. The characteristic feature of the country traversed to-day, is the broad trunk of the mountain—the plains which we are following—surmounted by elevated peaks and ridges, having no uniform direction, and with elevations varying from five hundred to three thousand feet above the plains, with drifts of snow only upon the most elevated peaks. From west of Pine creek to this camp the average natural grades, given by our barometers, are, for the first 2.89 miles, a descent of 63.20 feet to the mile;

and 19.50 feet per mile for the following 1.84 miles ; and 71.90 feet per mile for the next 1.70 miles ; and 64.90 feet per mile for 2.05 miles ; and 113 feet per mile for 1.55 miles thence to camp, where our altitude was 5,084 feet above the sea.

July 10.—From our last camp the road ascends Black Butte creek, which, for several miles, descends a broad valley, enclosed by high, rolling mountains to the northwest, and a more abrupt, but less elevated ridge, to the southeast. But to the west of that camp, passing north of the first-mentioned mountains, the view is unobstructed, except by timber. I therefore divided my party, examining the more southern route by the creek myself, and directing Mr. Egloffstein to pursue a general western course, by the most favorable route he could discover, to the most western ridge of the mountains. He proceeded through the dense pine forest, gradually ascending, but without obstruction, for five miles, but immediately afterwards came upon a precipitous rocky descent, increasing in height to the south, where it unites with the elevated mountain in that direction, and extending to the north far into the valley of the Sacramento towards Fall river, and nowhere presenting a practicable point for the descent of a wagon-road even, and much less of a railroad ; and it was only after the most persevering efforts, and repeated failures, that he succeeded in effecting the descent with his party—descending 967 feet at an angle of nearly forty-five degrees, into the large, rocky valley of Canoe creek. This valley extends north to the Sacramento, and in some parts is several miles broad, but in others narrow ; and is occupied, at intervals, by extensive beds of volcanic rocks, with intervening grassy spaces and pine forests, in which game is very abundant. Two considerable creeks enter it at its head, from the vicinity of Mount Saint Joseph, and unite to form Canoe creek ; but it is probable that this stream sinks and reappears several times in its rocky course before reaching the Sacramento. For three miles up Black Butte creek our route followed immediately upon the banks of the stream, and thence followed the open, rolling pine woods, for 5.90 miles, to where the creek descends from high hills to the south. For several miles of this ascent, the ground was covered with black, cindery sand, thin at first, but becoming very heavy as we progressed.

After leaving the creek we passed two or three small ponds, and entered one of the most recently formed and strongly marked volcanic fields we have seen in these mountains. It occupies a valley of three or four miles in length, by one or one and a half in width. The lavarocks are black, and about 100 feet high, occupying the valley in a confused mass, which it would be difficult to cross on foot. On the north side of this field stands the Black Butte, some 800 or 1,000 feet high. It is conical from its base upwards for several hundred feet, and is terminated in a peak with a semi-spherical outline ; and its whole surface as black as the darkest iron ore, is covered with a coarse, pebbly sand, formed from its crumbling mass, which has so smoothed its surface that a pebble would roll from its summit uninterruptedly to its base. The sand over which we approached this butte is uniformly distributed around it, as from a central crater, becoming thin towards the edges, and then disappearing. The width of the valley of Black Butte creek, and the broad, ascending base of the

range enclosing it to the northwest, are such, that, in the construction of a railway, they will admit of a uniform grade, which will necessarily be heavy until passing the Black Butte, or for twelve miles. The road should ascend by the line indicated, for nine miles, to the small ponds at the foot of the lava-field; and thence be continued to the south and west, passing around it, and, returning northward, pass a short distance to the west of Black Butte. This line will increase the distance and improve the grade given in the profile. The distance from our morning camp to this point, by the road, is 11.69 miles, and the average grade 101.80 feet to the mile; and the greatest distance which could be gained, would not probably diminish it below 80 feet to the mile. From the point thus gained, in a broad depression, west for 1.87 miles, the descent is 25.10 feet per mile; and 19 feet per mile thence 1.53 miles to the west to a small spring; with an ascent of 5.80 feet per mile for 3.75 miles, to where the road should cross Hat creek. This point is reached by following the present emigrant road, west of the little springs just mentioned, until it reaches the head of Canoe Creek valley, where, instead of descending into that valley, following the wagon road, a railroad can only be continued to the west by bearing a little to the south, and ascending the stream, to which there is no obstruction, for a mile, and crossing it at the point already designated, where the valley of the stream is on a level with the approach to it. Immediately west of this creek a spur from Mount Saint Joseph—which stands but a few miles to the south of this pass—extends a short distance into Canoe Creek valley; and is followed to the west by the narrow valley of Wolf creek, immediately beyond which the most western ridge of the Sierra Nevada rises. The spur between the streams is heavily timbered, but more or less rocky, and falls off rapidly to the north, affording the means of passing it by almost any desired line. It is, however, more or less broken by small ravines of an ordinary character. The valley, or ravine, of Wolf creek is narrow and deep, but can be readily passed by ascending its eastern side nearly to its head, and crossing a deep, dry ravine on the spur, and following it until reaching the creek, whence the road should be carried immediately along the side of the rocky, timbered ridge to the west, to the western crest of the Sierra Nevada. The average grades by this line from Hat creek, are, for 2.75 miles, 45.10 feet per mile; and 154.4 feet per mile for 0.50 miles; and 21.30 feet per mile for 1.50 miles, to Wolf creek; with an ascending grade of 45.50 feet per mile for two miles thence to the western summit of the pass. The side of the mountain, from Wolf creek to this summit, is broken by two or three large ravines, and, besides being covered with surface-rocks, large ledges crop out at various points upon it. The summit depression of the pass itself is three-fourths of a mile broad towards the east, and very soon expands to two miles—a high, round peak, destitute of timber, rising to the north to the height of 300 feet; and, to the south and east, steep, rocky peaks and masses rise towards Mount Saint Joseph, (sometimes called Lassen's Peak,) which is three or four miles distant, and covered with snow from its summit downwards for a thousand feet. We encamped on Wolf creek, two miles east of the summit. Day's march, 20.34 miles.

July 11.—We returned to the summit of the pass, which is covered with immense heaps of broken stones, covering miles of surface, like rubbish from a quarry, but so level that water stands upon it in various places for half a mile, and it is lightly timbered. Its approximate altitude is 6,074 feet above the sea. The descent from it to the valley of the Sacramento is unobstructed, and, unfortunately, very direct. For five miles from the summit about half of the descending plain or broad ridge is timbered, and the open portion covered with a dense thicket of mansanita bushes. Unfortunately for us, on both occasions on which we passed this summit, (we repassed here on the 25th of July,) the view of the mountains for any considerable distance below us was obscured by a smoky atmosphere, and the valley of the Sacramento entirely invisible from the dark cloud of smoke which hung over it, over which, however, as over a blue sea, peaks of the Coast range were occasionally visible. The plain of descent widened rapidly at first, as we descended, and four miles from the summit we judged it to be four miles in width, limited on the south by the deep ravine of Battle creek, (descending from Mount Saint Joseph,) which, however, soon runs out into the general level of the descent, and broken on the north by a formidable dry ravine commencing near the foot of the rubbish heaps at the summit, and extending several miles, and numerously intersected by ordinary ravines. Coming upon Battle creek, the road descends it for a short distance, and crosses it where it bends to the northwest, the road continuing its direct course, and entering a dense forest of pine, cedar and redwood. The mountain continued to fall off rapidly, and we made short, steep descents for a few hundred yards at a time, as from successive terraces. But after crossing the creek there is a deep ravine seen 3.50 miles to the southwest of the road, and nearly parallel with it, marking the southern slopes of the level intervening space between Battle creek and one of its tributaries, which descends from the south side of Mount Saint Joseph. This space is embraced in the general plain of descent, and considerably increases its width, affording the means, by its uniform character, for continuing the curves of a railway in any desired direction to the south of Deer Flat, nine miles from the summit, where a small farm is established on a few acres of open prairie, and thence to Hill's rancho, 3.69 miles below, on Battle creek, where the descent for much of the distance is imperceptible. Crossing the creek, we continued on through the same dense forest, interspersed with large branching oaks, across the most favorable and perfectly practicable section of the pass, and encamped near McCumber's mill, 8.72 miles below.

In the early part of the day the road was very much obstructed by loose stones, but for the last fifteen miles it was very fine. Many of the pines were from four to six feet in diameter, and from one hundred to one hundred and fifty feet high. Several mills are in successful operation in the vicinity, and others are being built. Day's march, 23 miles.

July 12.—For two and a quarter miles this morning—passing through Shingletown—the descent was scarcely perceptible; but the country there becomes more broken, and formidable hollows and

ravines extend from the road north to Bear creek—which before lay considerably to the north of the line of descent—rendering the winding of a road in that direction quite impossible. The country also became more broken to the south, towards Battle creek, leaving comparatively a narrow ridge upon which to effect a descent to the foot of the mountains. The distance between the streams themselves is about 4.25 miles at this point, and is not only broken by the large hollows referred to, but the remaining portion of it, 1.25 miles wide, the most favorable line and greatest width which we could discover for the construction of a railway on this part of the descent, falls off rapidly and is very broken, and intersected by broad and deep ravines, especially outside of the narrow ridge followed by the present wagon road. This narrow ridge continues for four miles, but the descent is still rapid for seven miles further, and the country broken into narrow ridges descending to the west, yet there is much greater room for increasing the distance and overcoming the descent. The country is here no longer a forest, but a broken and open oak prairie, dry and parched at this season of the year, but very soft and miry during the rainy season. Forty miles below the summit we were passing the lowest foot-hills of the mountains, and were fairly in the open valley of the Sacramento river. The heat increased with our descent, the thermometer standing, in the shade at 3 o'clock p. m., at 106° Fahrenheit. We continued on, however, and encamped, after a march of 23.72 miles, at Fort Reading, on the west side of Cow creek, a mile and a half above its junction with the Sacramento.

Table of approximate average grades, in descending by a very direct line from the western summit of Noble's Pass of the Sierra Nevada, to the Sacramento river.

Stations.	Intermediate distances.	Total distances.	Average descent per mile in feet.	Altitudes above the sea in feet.	Remarks.
Summit.....				6,074	
Battle creek.....	5.00	5.00	49.80	5,825	
	2.50	7.50	212.60		
	2.12	9.62	284.00		
Deer Flat.....	2.14	11.76	174.50	4,318	
	1.69	13.45	101.70		
Hill's rancho.....	2.00	15.45	7.35	4,131	
	4.14	19.59	47.60		
	3.58	23.17	136.60		
McCumber's mill.....	1.00	24.17	54.60	3,491	Camp.
	2.38	26.55	2.80		
	3.05	29.60	230.10		
	2.19	31.79	235.50		
	3.78	35.57	186.20		
	2.93	38.50	166.90		
	2.54	40.04	78.80		
	4.37	45.41	41.40		
Fort Reading.....	2.25	47.66	14.10	674	Total descent 5,400 feet.

In the preceding table and the profile of Noble's Pass, accompanying this report, for the first five miles from the summit I have given the longest line of descent which can be obtained (the direct line being but three miles) by winding from the summit of the pass south along the foot of the nearest peaks, and touching Battle creek. Below this, the distances and line of profile are those of the direct line of descent; for the total descent 5,400 feet—5,000 being confined to the first forty miles of the direct line—is so much more unequally distributed than was anticipated, when making the survey, that, at two points, it is not practicable, without a minute survey and actual location of the road, to indicate a continuous line upon which a railway can be successfully constructed to descend this pass; and I have, therefore, not deviated from the direct line. But it can only be carried below the point indicated on Battle creek by continuing the curve and crossing to the north the deep ravine before referred to, and again re-crossing it on a curve to the south, returning to and across Battle creek, and thence, by a continued series of similar curves, effecting the descent. The width of the descending ridge is so great, and its general character such, however, as to establish the strongest probability of the practicability of effecting the descent on large and practicable curves to Hill's rancho; and there is no difficulty in continuing it thence to McCumber's mill—24 miles (including the curve for the first five miles) from the summit. From this point the road should follow, for some distance, a branch of Battle creek to the south, relieving, as far as practicable, the difficult section below Shingletown; for the broken narrow ridge by which the descent must be continued for four miles below this point, is such, and the descent so great, as to render it doubtful whether it can be successfully descended without stationary power. A further survey and actual location of the road, as before indicated, is, however, necessary to determine this point. And if the general character and location of the route connecting with this pass is such as to render the determination of this point desirable, the survey should be continued to the summit of the pass.

The section immediately succeeding the one just indicated is that of the foot-hills of the mountains; and is rough, descending in narrow ridges, but a railway can readily be carried over it.

We were courteously received at Fort Reading by the commanding officer, Colonel Wright, and the other officers of the post, and hospitably entertained by them during the two days which we were detained in getting our animals shod and procuring necessary supplies for our trip up the Sacramento to the mouth of Fall river, to complete the line of exploration by the Madelin Pass.

CHAPTER VI.

Ascent of the Sacramento river from Fort Reading to the mouth of Fall river (line of the Madelin Pass,) and thence by the valley of Canoe creek to Noble's Pass, and return to Fort Reading.—July 15 to 26, 1854.

July 15.—Leaving Fort Reading, we ascended the valley of the Sacramento, by a general course a little west of north, passing over a hilly country of open oak prairie for sixteen miles, and encamped without reaching the river, which is a few miles to the west of our path. For several miles above the Fort the valley of the river is an open, rolling prairie, more or less timbered with oak and a small growth of pine. The general level of the country is, however, elevated above the immediate plain of the river banks, and is broken by dry ravines and hills, which continue to rise as they recede from the stream, and are eventually united to the great mountain masses which entirely enclose the head of the valley, and shut in the river from immediately west of our present camp upwards to the mouth of Fall river.

July 16.—Five miles from camp, this morning, we came to a small mining village called Churntown. It consists merely of a dozen miserable log-huts, and being badly supplied with water at this season of the year, is in a thriftless condition. The day, too, was intensely hot, and the men had everywhere thrown by their tools—not a man being seen at work. It was four miles from this village to the Sacramento river, directly north, and its mountainous position cannot better be illustrated, perhaps, than by the fact, that the stream or rivulet which supplies Churntown with water rises but a mile from it, but instead of flowing north towards it, it descends in the opposite direction, and enters it below our last night's camp. From the head of this creek we descended by a very steep Indian trail directly to the river, where it is two hundred feet wide, flowing with a very rapid, powerful current, and, with the exception of short distances here and there, breaking over a rocky bed. In seasons of high water it sends down immense volumes, the drift being ten and fifteen feet above the present stream. The mountains rise abruptly from the river banks to the height of eight and ten hundred feet. They are timbered with pine and oak near the river, but rocky ledges slope down to the water's edge; and it is, at intervals, impossible to ride along the Indian trails which lead over the water-washed drifts and heaps of rocks lying on the banks. At points where rocky strata crop out on the river banks, the Indians themselves are forced more or less to ascend the side of the mountain in travelling up and down the river, and in many instances, to avoid long bends of the stream, pass over the projecting spurs. In its mountain course the river is winding, but in its general direction in this part it descends from a little east of north, and continues it a short distance below our present position, when it changes more to the south and eventually a little to the east, as it enters the open valley below. We began its ascent by riding, when we could,

on the trails, but were frequently forced to leave them and pass over spurs, up which our animals could not carry us, and we suffered greatly from the intense heat of the day.

The river is followed on the opposite bank by a heavy pack-trail leading to Yreka; but it soon leaves the main river, and follows the course of an affluent from the north, which has been generally mistaken for the Sacramento itself. It is, however, but a small stream compared with the main river, to which the name of Pitt has been given. Six miles above the mouth of this stream we came to the mouth of McCloud's fork, a larger stream than the former, also entering the Sacramento from the north. Salmon abound in this stream, and in the Sacramento, but far more abundantly below this junction than above it. The stream was lined with Indians, many of whom were entirely naked, while others were provided with a single garment, or had their faces blackened with tar in mourning for their friends—the tribe having been recently severely punished by the neighboring miners and settlers, whose friends had been killed by them. From McCloud's fork, two of them accompanied us to our evening camp, 5.25 miles above, which we reached at dark, drenched with perspiration, our animals trembling with heat and fatigue. At this point there is, on the south side of the river, a small grassy prairie a few hundred yards wide, and a ferry is established by a Mr. Dribblesly for the use of a mining town, three miles to the north, called Pittsburg. The river, for a mile opposite this prairie, flows with a gentle, unbroken current; but at its foot makes a short bend, and descends rapidly over its rocky bed. I purchased from one of the Indian women, to-day, a girdle of the size of an ordinary rope, made entirely of human hair. Day's march, 24 miles.

July 17.—We rode on the bank of the river, this morning, for two miles to Silverthorn's ferry, and were then driven high up the mountain to avoid deep ravines, and to pass around ledges and masses of fallen rocks found at a few points—the mountains dividing the valley of Cow creek, which we occasionally overlooked at a distance, from the river immediately below us. The character of the river was the same to-day as yesterday, curving among the high hills and mountains. The timber of the forests was also the same, and the character of the hard, highly altered metamorphic rocks unchanged. Indian smokes curled upwards from every part of the mountains where they were engaged in burning the grass to catch grasshoppers, upon which they feed, regarding them as a great delicacy. We encamped on a small flat, 200 yards wide and a mile long, on the river bank, 10.50 miles above our morning camp. From the most reliable information we could gain from persons who have lived on the river for two or three years past, the amount of snow which falls upon the higher parts of the mountains is large; but upon the river itself it is small, never exceeding four or five inches in depth. They also state, that upon the river banks, which are completely sheltered from the winds, it never accumulates in drifts, being deposited on the sheltered sides of the mountains long before reaching the stream. They state, also, that the river is never choked up with ice, but that it rises ten feet above its general level in times of great freshets.

July 18.—Clambering along the mountain sides, we again returned to the river 4.70 miles above our morning camp; and in passing a rocky point several mules were crowded into it, and swam with their packs to the opposite bank. And in addition to previous difficulties encountered in following the river banks, it was obstructed by dense thickets of bushes and fallen trees lying at right angles to our path. But to ascend the mountain sides, and pass along where we could observe the character of the river, was also very difficult, and several of our animals repeatedly lost their footing and rolled back hundreds of feet, in passing the steepest points. We were constantly in positions to overlook the river, but did not again descend to it during the day, its character remaining entirely the same. The mountains, however, became higher, and the ravines longer. We encamped, after a march of but 11 miles, at the head of a ravine, where we found a small spring and a little grass in the open pine and oak forest.

July 19.—We returned again to the edge of the mountains overlooking the river, and at 9 o'clock a. m. again descended to it, hoping to be able to follow it; but we here found it more confined by rocky ledges than in any other part of its course, the strata being, at some points, quite vertical on alternate sides of the river. The ravines, too, were more rocky and precipitous than before, and we were forced, after examining it, to retrace our steps for nearly a mile, when we again turned up the river, and crossed two or three small streams, gaining a position from which we overlooked it for several miles, both above and below, but we could discover no improvement in its character. Our course, however, changed to nearly due north, parallel with the river, and but a short distance from it. The summit of the mountain was broad and level, and the timber unusually heavy, and a fine growth of raspberries reminded us of our boyish days. At the end of this direct course, we again descended to the river, and found it a foaming rapid for several miles above its change of course. Its fall here is twice as great as in its general descent. Just above its change of course there is a small boiling spring, the stream from which immediately falls into the river. Above this spring there is a rocky valley, half a mile wide, timbered with oak, in which we encamped after a march of 23.50 miles. The mountains passed to-day were more elevated than those crossed yesterday, but were not so difficult to traverse.

July 20.—We followed the rough bank of the river, this morning, for 7.50 miles. On the side of the trail there was something like a valley, uneven and rocky, but it soon became rough and broken; and the mountains, eventually shutting in close to the stream, were too steep, and too much obstructed by fallen timber and dense thickets of bushes, to admit of further progress along its shores. The opposite bank was, at the same time, more than usually steep and rocky, and at some points almost vertical. There was no alternative, therefore, for us but to re-ascend the mountains—for, with our force, we could not have progressed three miles a day, by cutting a road along the mountain base. The ascent was very steep and difficult, and we were occupied four hours and a half in effecting it. And when we had gained the summit, which we followed for some miles high above

the stream, which could be traced by its foaming current, not only where we were passing to-day, but at the foot of the long line of the heavily timbered summit followed yesterday, we encountered such a dense growth of mansanita and laurel bushes that it was only by the most persevering efforts that we could effect a passage through them. Steep ravines extend from the river quite to the summit of the mountains, and we were always forced to pass around them. Coming eventually, however, to an open woods, we pushed rapidly forward, and, at sundown, came upon an open, grassy prairie, abundantly supplied with water. This was the first grass we had seen during the day's march of 18.50 miles, and was a most welcome sight.

July 21.—We passed directly over the crest of the mountains towards the river, to points where we could overlook it immediately at our feet. For several miles below us its banks were as high and rocky as at any point below; but immediately in front of us, and for a short distance above, with one exception, the projecting ridges or angles were low, and for short distances one could ride comfortably along the base of the mountains. The river was, however, still shut in by mountains, and its current was as rapid as ever. But the mountains were so broken by ravines that we could not pass along them, and were obliged to recross the summit, where we at once came upon a more level country, but very rocky and dry. The mountains on the river also began immediately to fall off, and we easily returned to it a short distance below the mouth of Canoe creek, where there is a small valley extending for five miles along the river. This valley is a mile wide only, but the mountains above are low and retreating. Canoe creek is sixty feet wide, at its mouth, with a current as rapid as that of the Sacramento. The Indians have large fish-traps arranged in it, but the salmon season has not yet arrived. Crossing the creek we ascended to the head of this valley, passing several holes dug by parties searching for gold; and at the head of the valley reached the foot of the cañon, before described as the second cañon of the Sacramento, immediately below the mouth of Fall river. The walls at the lower end are higher, but much less vertical than at the upper end of this cañon; and the accumulated mass of fallen rocks extends from the water nearly to the top. It is much wider also at the lower than at the upper end; and the peaks rising on the terrace above, sloping gently back, are less elevated. It is, however, a formidable cañon, cut deep through strata of metamorphic rocks; and in descending the Sacramento with a railway, as before stated, it will be a point, which can only be determined by a minute survey, whether it will be easier to pass around it to the south, over the lava fields at the foot of the ridge or butte which rises on that side of the cañon, and return to the river at the mouth of Canoe creek, than to descend by the cañon itself.

Table of approximate average grades in descending the Sacramento river from the mouth of Fall river to the head of steamboat navigation at Fort Reading, California.

Stations.	Intermediate distances.	Total distances.	Average descent per mile in feet.	Altitude above the sea in feet.	Remarks.
Mouth of Fall river....	-----	-----	-----	3,249	Head of second cañon.
Foot of second cañon..	8.95	8.95	35.00		
Mouth of Canoe creek.	4.70	13.65	14.00		
Sacramento river.....	22.50	36.15	30.70		
Sacramento rapids....	7.50	43.65	59.60	1,730	
Sacramento river.....	26.50	70.15	21.70	1,156	
	4.70	74.85	16.60	1,078	
	10.50	85.30	11.80	954	
McCloud's Fork.....	5.25	90.55	6.10	922	
Sacramento river.....	11.75	102.30	7.20	837	
Fort Reading.....	22.90	125.20	7.10	674	

Having completed, by this connection, my exploration of the line of the Madelin Pass entirely through to the head of steamboat navigation on the Sacramento, we turned our course towards the south to explore the country drained by Canoe creek, and, if possible, discover a route connecting the Sacramento, at the mouth of that creek, with Noble's Pass at Black Butte creek, where the emigrant road first strikes it in crossing the mountains from the east, by which, if no better route could be found, the steep descent from that pass to the west would be avoided.

The ascent of this creek for the first mile led us over thorny bushes and rocky bluffs; and in their passage we were greatly aided by a heavy Indian trail, always serviceable when available, and here doubly acceptable, for our animals were both jaded and sore-footed from constantly travelling on the sharp angular fragments of rocks. For the first mile, also, the stream was full of foaming rapids at short intervals; but above that point we came to an open grassy prairie of small extent, through which the stream flows gently, and in its passage receives two or three respectable tributaries, one of which, from the southwest, falls with considerable noise into the main stream. We encamped under a wide branching pine in the centre of this prairie.

July 22.—Just above our morning camp we ascended a terrace wall, fifty or sixty feet high, to a nearly level plain, upon which we followed an Indian trail for two miles. This plain was covered in various parts with grassy ponds, but it was obstructed to the southeast and east by large fields and hills of volcanic rocks, with dark ledges and masses here and there, and it was apparently impassable. To the west there was an open pine woods and a low range of hills, apparently succeeded by another plain, upon which there is a lake called Frenar, the name of an unfortunate gentleman who is supposed to have been killed by the Indians in its vicinity. Many Indians were daily seen by us in every part of the mountains, but they invariably fled upon seeing us. Dismounting from our animals, we determined to attempt the passage of

the field of lava (pedrigo) to a high bluff beyond; but the path was so bad that many of them could not be led, and we were obliged to remount, and in two miles succeeded in extricating ourselves from it by the most difficult path I have ever seen. Ascending the bluff, the red soil of which was friable and dusty, we still found a stony path, but it afforded us an extensive view of the country for many miles, overlooking the Sacramento and Fall rivers, and the valley of Canoe creek. Here, as above, the valley of Canoe creek is but a few miles wide, and is almost entirely occupied by fields of volcanic rocks—the part we had crossed being but a small angle of it. The course of Hat creek, which enters it at its head, could nowhere be traced, and it is probable that it occasionally disappears among the open rocks of the valley, and again reappears when no longer finding a subterranean passage. Our course continued along the bluff, which is broken by deep ravines, and is the same that Mr. Egloffstein encountered in crossing to the west from Black Butte creek on the 10th instant, and by which we hoped to reach that stream, as it was supposed to be an affluent of Canoe creek, and it was near night when we reached the base of the mountains south and west of our former camp on that stream without finding it, or, indeed, any but the most trifling amounts of water in springy places; and as the country to the north, to the line we followed in our trip to the mouth of Fall river, was overlooked by us all day, and we could nowhere discover any indication of a stream, we came to the conclusion that, like most of the streams we have seen in these mountains, Black Butte creek sinks in some of the grassy plains before reaching the river. We were therefore obliged to turn eastward to find a suitable camp, and were soon overtaken by night in a dense forest, obstructed by a thick undergrowth, ledges of rocks, and fallen timber. But I determined, notwithstanding these difficulties, and that there was no trail—the stars being visible, however, through the pines—to proceed to our former camp on Black Butte creek. But as I could not see the ground, even when on foot, I owed my determination entirely to the confidence I had in my mule to conduct the party safely through. I gave her a loose rein, only occasionally bringing her back to the proper course when forced from it by insurmountable obstacles, and the men set up a merry song to enable them to follow each other; but it was not until 11 o'clock at night that we emerged safely from the forest at our former camp, after a most laborious ride of 35 miles upon which we were engaged for fifteen hours. We had failed, however, in finding a route by which to descend with a railroad from this point to the mouth of Canoe creek, having traversed a rough, broken country, and encountered abrupt descents, which we could discover no means of avoiding.

From this point we returned to Fort Reading, re-examining the most difficult parts of Noble's Pass to the west, the result of which is embraced in the report already given of that pass, where we arrived on the 26th of July, and were kindly received by our friends. Fort Reading is in latitude $40^{\circ} 30' 02''$, and by the course of the river about 300 miles from the sea, but only 200 or 220 by the direct course of the valley, and, as indicated by our barometers, 674 feet above it.

The valley of the Sacramento is here from ten to fifteen miles wide, but is more or less occupied by the foot-hills of the Sierra Nevada on the east, and of the Coast Range on the west, and these hills occasionally extend in bluffs, of sixty and a hundred feet in height, quite to the river banks; but they become much less frequent as we descend, and eventually entirely disappear near the river, and the valley becomes wider, more open, and level. It is occupied in various parts, throughout its whole extent, by extensive farms and flourishing settlements, and is well known to be finely adapted to the construction of a railway.

Having thus connected my line of survey with this valley by the most practicable route, as required by your instructions, I at once disbanded my party, and reported to you in person, in this city, on the 12th of September.

CHAPTER VII.

General summary of the line explored on the forty-first parallel of north latitude.

Having concluded the journal report of my explorations for the Pacific railroad, of what may, very properly, be designated the route of the forty-first parallel of north latitude, which is both central, as regards its geographical position and its connection with the general lines of commerce of all parts of our country, the general features of the route explored, and its adaptation to the particular object of its examination, will be succinctly presented.

This route is intended to connect, in the vicinity of Fort Bridger, in the valley of Green river, Utah, with that explored thence eastward by Bridger's Pass to the plains, by Captain Stansbury, in returning from his survey of Great Salt lake, in 1850; and it is only necessary that I should refer you to his report of that part of the route for its clear understanding, and connections thence eastward with the general lines of commerce of the country, either by descending Lodge Pole creek, the South fork, and main Platte, to the Missouri, or by keeping to the east of Crow creek and passing over to the Republican fork of the Kansas, and descending the former stream to its junction with the latter, and thence pursuing any desired route to the Missouri.

That part of the valley of Green river in which Fort Bridger is situated, and which is overlooked from the foot of the Uinta mountains by the line which we followed in our explorations eastward from Bear river, constitutes a remarkable feature upon this line. It has been variously designated as the valley of Green river, the Green River Basin, and the Coal Basin of Green river, from being abundantly supplied with that important article. It is more than two hundred miles in extent from east to west, and has a variable width, north and south, from twenty to over a hundred miles. It is enclosed on the east by the Rocky mountains, and on the northeast by the Sweet

Water and Wind River mountains—Green river entering it from the north—and on the northwest and west by the Bear River mountains; and on the south by the Uinta mountains, broken by the deep cañon by which Green river continues its course to the south. Its borders are occupied by spurs from the surrounding mountains, and a few detached buttes are seen east of Green river; but its general character is that of an elevated rolling plain or valley, easily traversed in any direction. It is drained by Green river, which passes southward through its centre, and by its tributaries. Its soil is light and dry, with a small scattered growth of cedar upon the mountains, and borders of grass are found upon its water-courses; but artemisia, with a little scattered grass, occupies the valley in every direction, and characterizes its vegetation. The trading post at Fort Bridger has been occupied constantly for the last ten years; but the district was much frequented before by traders and trappers, whose effects are always transported by cattle, which subsist themselves throughout the year by grazing—a fact remarkably significant of the winter climate, and depth of snow which falls in the district, the general elevation of which may be safely taken at 7,000 feet above the sea. And it is said, by these people, to be a well-established fact, that horned cattle, of which their stock largely consists, cannot so subsist where the snow is deep enough to bury their eyes and enter their ears as they feed. I have already stated, in this report, that the Mormons have commenced a settlement near Fort Bridger, and that large herds of cattle were grazed near it during the early part of the winter, and were subsequently driven over the mountains, and remained in the valley of the Weber river until spring.

Two ranges of mountains, more or less united, intervene between this valley and that of Great Salt lake. The first, or more eastern, is the Bear River range, which is broken and surmounted by elevated peaks towards the north, and more broad and open towards the south, where it unites with spurs of the Uinta and Wahsatch ranges. It is drained on the east by Black's fork and its tributaries, an affluent of Green river, and on the west by Bear river itself, which rises in the Uinta mountains and flows northward, breaking through the Wahsatch range and emptying into Great Salt lake.

The second, or western range, which stands immediately on the eastern border of the Basin, is the Wahsatch, extending from Little Salt lake, in a very direct line northward for 300 miles to Bear river. It is broken, towards the south, only by the passage of the Sevier river; but on our present line by the narrow passages of the Timpanogos and Weber rivers, by either of which, after crossing the first range, by ascending the divide between Black's fork and the Muddy, and crossing the heads of the latter stream and Bear river to the head of White Clay creek, (an affluent of the Weber) it is very practicable to descend to the valley of the Great Salt lake with a railroad. Looking westward, from the divide just indicated, the country presents a broad, level appearance, and it is difficult to realize its great elevation. It is, however, intersected by the valleys and ravines of the various water-courses by which it is drained, and which extend into the Porcupine terrace, lying at the northern foot of the Uinta mountains. The greatest elevation upon the line occurs upon this

terrace, between the sources of Black's fork and the Muddy, and, as indicated by our barometers, is 8,373 feet above the sea. By ascending the Muddy, two hundred feet of this elevation would be avoided; but the line would require more and smaller curves. It is here, also, that the greatest depth of snow is encountered, and it increases in depth as we approach the snowy Uinta range. When we crossed it, in April, the streams were not swollen, and we could not discover that it had diminished by the warmth of the season from its usual winter depth. On the northeast slopes of the hills and ravines it had accumulated in deep drifts, but its general depth varied, for a few miles, from twelve to sixteen inches; and in crossing Bear river, and on the head of White Clay creek, it was from eight to twelve inches; but below this we encountered no snow. The timber of this section is limited in quantity, the ridges being dotted with a scattered growth of small cedar, and the Porcupine terrace dark with a respectable growth of spruce, pine, and fir. The soil of the mountains is superior, and covered with a luxuriant growth of grass. The distance from Smith's fork, on which we encamped, near Fort Bridger, by the line of the Timpanogos river, to the northern point of Oquirrh mountains, at the south end of the Great Salt lake, and on the western side of the valley of the Jordan, is 182.55 miles; and the same point would be reached by descending the Weber from the mouth of White Clay creek and following the eastern and southern shore of the lake, by a line of equal length. The respective average grades and altitudes upon these lines, and throughout the lines of the survey, will be found in the accompanying table and upon the profiles submitted with this report. There are large cañones on both of these streams—one upon the Timpanogos, and two upon the Weber. The former is ten miles in length. It is narrow, from 100 to 300 yards, and very direct in its general course; but projecting masses or spurs on either side of the river overlap slightly, giving it a slightly sinuous course at the bottom. The great mass of the rock of which it is formed is blue limestone, on the south side often nearly vertical, but more inclined and open and covered with small stones and a luxuriant growth of vegetation on the north side, along which we rode. It will be necessary, in passing it with a railway, to bridge the river at several points to avoid curves, and to blast the rocks to a considerable extent at some points, amounting, however, to no large aggregate. The river is thirty yards wide, descending with a powerful current. The upper cañon on the Weber deserves the name only of a gorge or defile. It is eight and a half miles in length. The passage is more broad and open, and not so direct, as that of the cañon twelve miles below, on the border of the valley of Great Salt lake. The mountains rise to a great height above it, and are rocky and precipitous, and much broken by ravines. The river winds from side to side, frequently striking against the base of the mountains, and the path crosses it frequently; and in constructing a railroad it will be necessary to cross it several times. But it can be built by cutting and filling at the base of the mountains with the same facility that roads are carried elsewhere at mountain bases, where the formidable name of cañon is not encountered. The lower cañon, which is four miles long, in some parts well deserves the name. It is, however, very direct, with

an average width of 175 yards, the stream being 30 yards wide, and frequently impinging with great force against the base of the mountains. At a single point only, near the head of the cañon, the river is narrowed to one half its usual width, 30 yards, and has cut a passage 20 or 30 feet deep through the solid rock, which, on the north side, at this point, overhangs the stream, which is deflected from its course by a low projecting mass, for a few yards, but again immediately resumes it. The rocks are principally gneiss. The mountains are sufficiently retreating to admit of a practicable passage of the gorge by a railway, and it will require an amount of blasting no greater than is required in constructing a road on a rocky mountain side of similar extent elsewhere. Entering the valley of Great Salt lake from either this or the Timpanogos cañon, a railway meets with no obstruction in passing by the south end of the lake and crossing the Jordan, Tuilla Valley and Spring or Lone Rock valley, to its west side, the grades being merely nominal.

The settlement and cultivation of this valley by the twenty-seven thousand industrious people who inhabit it—the number at which the church authorities estimated their population when I was among them, and it did not seem to be an exaggeration—is so obviously a matter of great importance in connection with the construction of a continental railway, that only the simple statement of its being embraced in this line is necessary, and that its construction is an object which the Mormons are anxious to assist in accomplishing. From the western shore of Great Salt lake to the valley of Humboldt river, the country consists alternately of mountains, in more or less isolated ranges, and open level plains, rising gradually from the level of the lake on the east to the base of Humboldt mountains on the west, of from 4,200 feet to 6,000 feet above the sea. Cedar mountain lies immediately on the southwestern shore of the lake, and gradually subsides towards the north, terminating in Strong's Knob. But to pass entirely around it would unnecessarily increase the length of the line, for it can be crossed, not only by the line followed by Frémont in 1845, at an elevation of 800 feet above the lake, but apparently at a much lower elevation, a few miles north of this point. Immediately west of this range there occurs a desert plain of mud, about seventy miles in width from east to west, by its longest line, which becomes narrowed to forty as it extends southward—less than thirty of which is miry by this line—and it is firm in proportion to the distance from the lake. Two or three small isolated rocky ranges stand in it, but it appears otherwise to the eye, as level as a sheet of water. To the west this desert is succeeded by broken mountain ranges, one of which is terminated towards the south near Pilot Peak, affording the means of reaching and passing to the succeeding plain. To the south of this passage, however, an equally favorable passage exists to the north of Fish creek, connecting directly with passages to the west quite to the base of Humboldt mountains; and this will doubtless be the preferable line, as it will enable us to cross the desert by a shorter line and a more firm path. The ascending grades upon this section will be merely those of the ascent of the successive plains. The Humboldt mountains are a narrow but elevated ridge, containing much snow during most of the year. The length of the pass by which they will

be crossed is nine miles, about three of which are occupied by a narrow rocky ravine, above which the road should be carried on the sloping spurs of the mountains, on the western descent. The summit of the pass is five hundred feet above the extensive plain east of it, but considerably more above the valley of Humboldt river, which succeeds it to the west. This pass offers no serious obstacle to the passage of a railroad. Cedar only is found in these mountains, and in those to the east of it, sufficiently large for railroad ties; and although it will require transporting for long distances, it is believed to be sufficiently abundant for the construction of the road.

The open valley of Humboldt river immediately succeeds this section, and should be followed for about 180 miles. No other description is necessary of this direct and valuable passage across the Basin than that given in an extract from Colonel Frémont's Geographical Memoir addressed to the Senate, appended to the journal of the 22d of May, in the preceding part of this report.

The country to the south of this valley consists of an alternation of narrow mountains and valleys rapidly succeeding each other. The mountains have a general north and south course, but not unfrequently vary many degrees from that general course, and, occasionally, cross chains are seen, closing the valleys to the north and south; but large spurs more frequently extend out from succeeding chains, and unite to form cross ranges, or overlap and obstruct the view. They are sharp, rocky, and inaccessible in many parts, but are low and easily passed in others. Their general elevation varies from 1,500 to 3,000 feet above the valleys, and but few of them retain snow upon their highest peaks during the summer. They are liberally supplied with springs and small streams, but the latter seldom extend far into the plains. At the time of melting snows they form many small ponds and lakes, but at others are absorbed by the soil near the bases of the mountains. Grass is found in abundance upon nearly every range, but timber is very scarce, a small scattered growth of cedar only being seen upon a few ranges. The valleys rarely extend uninterruptedly east and west, to a greater width than five or ten miles, but often have a large extent north and south. They are very irregular in form, frequently extending around the ends of mountains, or are united to succeeding valleys by level passages. They are much less fertile than the mountains, but generally support several varieties of artemisia, relieving them from the character of barrenness or desert. There are, however, many barren spots in each of these valleys, and the soil is seldom one half covered with vegetation, even for a few acres, while the great mass of it is merely sprinkled by the sombre artemisia foliage, presenting the aspect of a dreary waste, unrelieved by inviting shades, grassy plats, and floral beauties, and is nowhere suitable for settlements and cultivation. The accompanying profile of the line which we traversed in this part of the Basin, will serve to convey a general idea of its formation. From Humboldt river, there are three lines which may be followed to the foot of the Sierra Nevada. That by the Noble's Pass road, leaving the river a few miles to the east of where we returned to it, is the most direct, and is believed to be the best, as it avoids the principal range of mountains which we crossed on the line followed a few miles to the south of this,

the two lines uniting on the shore of Mud lake. By the line followed, it is necessary to cross two ranges of the general character of the Basin mountains. The third line leads from the sink of the Humboldt to Pyramid lake without obstruction; but of the line passing thence by its shores to Honey Lake valley, little is known. It is 119 miles by the line followed from Humboldt river to the west shore of Mud lake, at the foot of Madelin Pass; but the northern line will diminish this distance at least one-fifth. The fertility of this section corresponds with that of the line south of Humboldt river. The northern route explored across the Sierra Nevada, to which I have given the name of Madelin Pass, ascends the eastern slope of the mountains from Mud lake through the valley of Smoky creek. In leaving the lake valley, the pass leads for three miles through a narrow gorge in an outlying range of the Sierra Nevada. The sides of this gorge are formed of coarse, crumbling metamorphic rocks, much broken by side ravines. They rise very abruptly to the height of from 50 to 200 feet above the stream on the south side, and to a much greater elevation on the north side, swelling up two miles back into the high mountain ridge. The course of the gorge is direct, and varies in width from 100 to 150 yards, and can be followed without difficulty by a railroad. Above the gorge the valley of the creek expands to the width of half a mile at first, and afterwards of a mile; but again becomes narrowed to a ravine seven miles from the gorge. This valley is enclosed on the south side, except at a single point broken by a creek and followed by Noble's road, by a precipitous rocky wall, rising at once to the level of the terrace above, which extends back to the foot of a high peak standing immediately at the summit of the pass. On the north side the valley is enclosed for seven miles by retreating mountain spurs, upon which a road can easily ascend to the terrace, which, in its eastern portion, is but a mile in width, with sloping ridges rising above it. Above this, however, it expands to the width of ten or twelve miles, but again becomes narrow as it approaches the summit of the mountain, where the grassy ascent is but 200 yards wide, with rocky hills rising gently two or three hundred feet above it. The soil of the pass is light, and the surface thickly covered with stones. Its width, and the character of the hills gradually rising above it in all parts, afford the means of ascending it by a very uniform grade. The length of the ascent is 22.89 miles by the direct line which we followed, and the difference of elevation of the extreme points 1,172 feet—the altitude of the summit being 5,667 feet above the sea. The latitude of our camp at the western base of the high peak was $40^{\circ} 48' 46''$. The pass leads around the elevated peak before referred to, and by a gentle descent for five miles enters upon the broad, level plain of the summit of the mountains, extending for forty miles to the west; its width, north and south, varying from ten miles to mere open passages of a few hundred yards. No water is discharged from this plain, which receives the waters of a few small streams and springs forming grassy ponds. The irregular spurs, ridges, and isolated buttes rise but a few hundred feet above it, and are sparsely covered with a growth of cedar to the east, but with heavy pine forests to the west. In leaving this plain to cross the low ridge enclosing it to the west, the line en-

ters a ravine valley a quarter of a mile wide, smooth and gradually ascending for a mile. It then expands to the width of a mile, and is grassy and smooth, and still ascends gently; but it again becomes narrowed to a quarter of a mile, and rises more considerably for the last half mile to the summit. The ridges rise gently on either side of the ascent, and are finely rounded and grassy, and it will be easy, by winding on these spurs, to increase the length of the approach somewhat, and to equalize the ascent; and the summit can readily be cut so as to diminish the altitude to be overcome 100 or 120 feet. The elevation of this point is 500 feet above that of the preceding plain, and 5,736 feet above the sea, and is the highest point in the pass, from which the descent is directly upon the waters of the Sacramento river. This descent is at first rapid and the ravine narrow; but it soon widens, and a creek descends from it with a free current. Spurs of the mountains, separated by ravines, project into the valley of this creek, leaving a direct and free passage, however, of fifty or sixty yards in width in the narrowest parts, and frequently expanding to half a mile. The descent is grassy and heavily timbered. For some miles from the summit, it will be easy to carry a road on the hill-sides, descending at pleasure; but lower down it will become more difficult on account of the curves required for passing the side ravines, but it is still practicable. For this purpose the northeast side is the most favorable; for, although it contains the largest number of ravines, it is free from cañones, while the opposite side is obstructed by a formidable one five miles below the summit, and a second three miles below this. The length of the descent to the broad open plain of Round valley, to which it leads, (on the Sacramento,) is fifteen miles, one half of which must be effected by following the mountain side. The total descent is 1,300 feet.

Round valley, through which the Sacramento river descends from the northeast, and through which a road can be carried at pleasure, extends for 15 miles below this point to the head of the first cañon of the Sacramento. This cañon is a formidable obstacle to be overcome. Its entire length is 13.74 miles, succeeded by an open valley of similar extent, which is followed by another cañon 8.95 miles in length, of the same character as the first. The river, as it enters the first cañon, is from 30 to 40 feet wide, flowing with a rapid current over a bed of rocks; and it is 60 feet wide as it enters the second cañon, just below the junction of Fall river, and flows over a similar bed with an equally swift current. At their heads these cañones are vertical, metamorphic rocks, 80 feet high, with large masses of fallen rocks accumulated at the bases of the walls. The first is cut through a high plain for six miles; the plain then rises somewhat, and is surmounted by high sloping ridges rising five or six hundred feet above it, and the cañon becomes much broader, and its walls more elevated for two miles, to where it makes a large bend to the north; below this the walls gradually decrease, and in two miles the cañon opens to the width of half a mile, which it preserves for three miles to the succeeding valley. The highest portions of the walls rise 200 feet above the stream, with an accumulation of fallen rocks extending half way to the top. For eight miles the course of the cañon is direct. It then makes a long bend to the north, and is followed by two or three short

curves, but with a generally direct course. Its open part is timbered, and its walls less abrupt; and on the right bank of the stream, the mountains, followed by the river, extend considerably into the plain of Fall river. The most favorable line for the passage of a railway leads along the plain on the north side of the river, and descends the sides of the rocky hills which surmount it, and continues on the side of the mountain until it enters the plain of Fall river. The second cañon is only less formidable than the first because of its less extent. Its character is entirely the same, except that it is surmounted near its head by sloping mountain ridges of a similar altitude to the former. But on the south side, a few miles distant, the ridge subsides into rocky volcanic hills and plains. It will require a minute survey to determine the most practicable line by which to pass it; but it is probable that the best line will be found to leave the river a few miles above Fall river, and to pass around the ridge extending southward, and again return to the Sacramento at the mouth of Canoe creek, four miles below the foot of the cañon, avoiding short curves, which must be encountered in it, and diminishing the amount of rocky cutting; for in the passage of each of these cañones, the expense will be very heavy from this cause, and can only be estimated after an extensive and complete survey.

For 96 miles below the mouth of Canoe creek, to 17 miles above Fort Reading, the course of the Sacramento lies entirely through heavily timbered mountains, which rise precipitously from the river banks to the height of from 1,500 to 2,000 feet above the stream. Its course is winding, with all varieties of curves greater than a right angle, and it is seldom entirely straight for two miles consecutively, but its general courses are more uniform.

The foot of the mountains along the stream is often obstructed by fallen rocks to such an extent as to prevent its passage on horseback, and it is also obstructed by fallen timber and dense thickets of bushes; but the obstructions from fallen rocks are favorable rather than otherwise, for the construction of a railroad, as they will serve to form its sub-structure. At many points, but for short distances only, the way is obstructed by rocks in place. The road will require to be carried on the side of the mountains, a few feet above the stream at high water, throughout this entire section to the open valley of the Sacramento, whence it can be continued on the open plain. The latitude of our camp, near the northwest angle of the river, was $41^{\circ} 03'$.

The southern or Noble's Pass of the Sierra Nevada (which I explored) branches from Madelin Pass, and the general line followed on the western shore of Mud lake, which it follows to its southwestern termination, where it approaches nearest to Pyramid lake. It then turns more to the west, and follows, for nine miles, an open passage of a mile in width, leading from Mud Lake valley to that of Honey lake. This valley extends 40 miles to the west, and is 20 miles wide in its broadest part, north and south. On the south it is enclosed by a high unbroken mountain range, and on the north by the outlying ranges, more or less broken, of the Sierra Nevada. The lake is about 15 miles in length and eight or ten in width. Its water is bitter. The head of the valley to the west is very fertile, and a settlement has been commenced in it, and will doubtless be continued. It is

situated upon Susan river, which descends through the broad mountain depression followed by Noble's road to the summit of the Sierra Nevada. For seven miles above the valley this stream descends through a deep rocky cañon, frequently with vertical walls towards its lower portion, but more or less fallen and open above. It is also much broken by side ravines, and spurs of mountain ridges occasionally extend to it. In leaving the valley, outside of this cañon, there is, at first, an abrupt terrace rise, followed by the road, which continues along the sides of the ridges to the right of the ascent by a much less gradual and uniform ascent than that of the stream.

Seven miles above the valley the cañon becomes an ordinary ravine, and disappears about five miles higher up, where the mountain becomes broad and undulating, with irregular ridges rising above the general level, but still continues to rise to the vicinity of Pine creek, whence it continues its rolling character to Black Butte creek. It is doubtless practicable to accomplish the ascent of the first section of this pass, either by following the river or by rising as soon as practicable above its rocky walls, and following its general course above its cañon. By following the river, it will be necessary to carry the road on a rocky ledge, but the grades will be comparatively easy. The ascent by the terrace line will require an approach commencing on the foot of the mountain north of the pass, and rising gradually to the top of the cañon walls; and above this will encounter broad ravines for 12 miles. From this point to Black Butte creek, 31 miles, the construction of the road will be easy. From Black Butte creek, there is still a heavy rise for 12 miles to the west side of Black Butte. For the first eight miles the line follows the valley of the creek, and the foot of the mountain enclosing it to the west, (for the course is southward.) It then passes to the south around a large field of lava rocks, and, on a return curve to the north, passes to the west of Black Butte, and is continued thence to the west side of Hat creek without a material change of level, and is continued thence on the side of the mountain spur, extending into Canoe creek valley, and separating Hat from Wolf creek, and crosses the latter nearly on a level with the former, and is continued, two miles, to the western summit of the range on the side of the range itself. The length of this section from Black Butte creek is 35 miles, and the highest point upon the pass is found on it a short distance west of the Black Butte, and is 6,275 feet above the sea. The descent from the western summit is by a broad, heavily timbered ridge, lying between Bear Creek valley on the north and deep rocky chasms on the south. Its length is forty miles, with a variable width of from one and a quarter to six miles. Its altitude at the summit is 6,074 feet above the sea, and more than 5,000 feet above the foot of the ridge. Its character and the difficulties of its descent will be best understood by a reference to the preceding journal for the 12th of July, and the table accompanying it. By the residents in the lumber district of the descent, we were informed that in the vicinity of their mills they had never seen the snow more than four or six inches deep at any time during the winter, and that it never remained upon the ground for more than a week at a time in sufficient quantities to enable them to use sleds in their vocation. About the 10th of last January, Dr. Wozencraft, of California, with

a small party, ascended this pass to its summit on a tour of exploration. They found the snow on the entire route, as they certify in a note placed in my hands by Dr. Wozencraft, "to average six inches in depth, and nowhere reaching eight or ten inches in its average fall. But," they say, "we encountered one drift of snow on the eastern slope of the Sierra Nevada, in a ravine extending a mile, averaging two feet or two feet and a half in depth." The entire length of the pass from Roop's farm, at the head of Honey Lake valley on the east, to the foot-hills of the Sierra Nevada on the west, is 110 miles, and its termination is at the head of steamboat navigation, in a fertile and cultivated portion of the Sacramento valley, which extends unobstructed to the tide-waters of the Pacific.

Further surveys upon this route would doubtless develop important improvements at various points; and at two, at least—one from the shore of the lake near Stansbury's island, by Pilot Peak, to the pass in the Humboldt mountains; and the other in crossing from Humboldt river to Mud lake—would probably diminish the length of the line by 106 miles. The grades, also, are doubtless susceptible of material improvement by minute surveys with the spirit-level, by which the irregular atmospheric variations, which more or less affect barometric observations, will be entirely avoided. This method of determining levels with limited means, on so extensive a line, infested throughout by hostile savages, in the brief time allowed for these explorations, was not practicable, nor was it necessary; for the accuracy of the method employed is quite sufficient for the determination of the general profile of the route.

There is an abundance of good stone for bridges and building purposes at short intervals upon all parts of this line. Water is also found in abundance for railroad purposes throughout those portions of the Sierra Nevada, Wahsatch and Rocky mountains explored, and also at a few miles intervals in the Basin, where it usually occurs in springs at the bases of the mountains, and in small streams descending from the higher peaks and ridges to the adjacent plains. And a simple reference to the map of the route will exhibit an important feature in the fact, that in its remarkably direct course, for its great length, from the Missouri west to the Pacific, it follows the ascending and descending valleys of permanent rivers and their tributaries for more than two-thirds of its entire length, and that water is abundant on all the intermediate spaces—affording the means of irrigation to a large extent wherever the lands are suitable for it; and that they will doubtless be found so wherever the sage plains are luxuriant; may be inferred from the rich aromatic odor and resinous properties of that plant, and from the exceedingly nutritious character of the grass scattered through it. And it is a well known fact, that the Mormons produce some of their finest crops from reclaimed sage plains.

By reference to the map and accompanying table of latitudes, it will be seen that the route explored conforms throughout to a remarkably straight line, deviating, west from Fort Bridger, only at the Timpanogos cañon, if that line be preferred to the Weber, and on the northern portion of the Sacramento river, and then only by 3 minutes and 4 minutes, respectively, from the line of the 41st parallel of north

latitude. The length of this route from the Missouri to the Black Hills may be safely estimated not to exceed 725.25 miles, the distance given by Captain Stansbury from Fort Leavenworth to Fort Laramie, and his distance from the Black Hills to Fort Bridger, 347 miles, is given from actual measurement. From Fort Bridger to Fort Reading, by the line of the accompanying profile, the distance is 1,011.71 miles, (which may hereafter be diminished by at least 106 miles, as before pointed out,) giving a total length for this line of 2,083.96 miles.

With much respect, I am, sir, your very obedient servant,

E. G. BECKWITH,

First Lieutenant 3d Artillery.

CHAPTER VIII.

I.—*Table of distances and of approximate average grades per mile upon the line explored for a railroad from Smith's Fork, near Fort Bridger, in the valley of Green river, Utah Territory, to Fort Reading, in the valley of the Sacramento river, California, 1854.*

Station.	Inter- mediate distance.	Total distance.	Average grade per mile.		Altitudes above the sea.	Remarks and dates.
			<i>Feet.</i>	<i>Feet.</i>		
Smith's Fork.....					7254.4	April 11 and 12.
Black's Fork.....		9.00	69.50		7880.3	April 10.
Divide between Black and Muddy creeks.	2.25	21.25	40.30		8373.7	Do.
Divide of Muddy and Bear rivers..	6.10	27.35	39.40		8133.3	Do.
Divide of Bear river and White Clay creek.	12.90	40.25	49.80		7490.8	April 9.
White Clay creek.....	11.50	51.75	41.90		7009.0	April 17.
White Clay creek, camp 13.....	8.75	60.50	54.20		6534.4	Do.
White Clay creek, camp 4.....	10.00	70.50	84.20		5692.1	April 7 and 8.
White Clay creek, camp 4.....					5692.1	} April 6.
Dry creek, camp 3.....		16.50	16.50		5419.1	
Sheep Rock, Weber river.....	8.50	25.00	27.00		5189.5	Do.
Ben Simon's creek, camp 2.....	12.20	37.20	28.50		4842.1	April 5.
Weber river, below the moun- tains.	7.80	45.00	53.60		4424.1	Do.
Weber river, camp 15.....	5.25	75.75	3.80		5671.9	April 19.
Weber river, Kamas prairie.....	12.00	87.75	54.00		6319.4	April 20.
Timpanogos river, Kamas prairie.	8.70	96.45	8.80		6242.6	Do.
Timpanogos river.....	5.70	102.15	32.80		6055.5	April 21.
Timpanogos river, head of Round prairie.	5.20	107.35	60.90		5738.8	Do.
Timpanogos river.....	5.00	112.35	44.40		5516.7	Do.
Timpanogos river, foot of Round prairie.	0.70	113.05	32.70		5493.8	Do.
Timpanogos river, head of cañon .	4.70	117.75	2.00		5434.3	Do.
Timpanogos river, in cañon	3.00	120.75	30.10		5394.1	Do.
Camp	8.00	128.75	39.70		5076.7	Do.
American Fork.....	14.20	142.95	19.80		5796.0	November 6, 1853.
Camp 2.....	39.60	182.55	3.50		4657.0	May 6, 1854.
Camp 3, west of Tuilla valley	20.59	203.14	8.10		4487.5	May 7 and 8.
Camp 4, opposite Stansbury's is- land.	13.70	216.84	18.20		4238.0	May 8 and 9.

I—Continued.

Station.	Inter- mediate distance.	Total distance.	Average grade per mile.	Altitudes above the sea.	Remarks and dates.
			<i>Feet.</i>	<i>Feet.</i>	
Camp 5, west side of Mt. Creek, Spring, or Lone Rock valley.	21.45	238.29	9.60	4444.3	May 9 and 10.
Dry creek	10.26	248.55	99.90	5469.5	May 10.
Entrance into Cedar Mt. Pass....	1.54	250.09	38.20	5528.4	Do.
Camp 6, in pass	3.24	253.33	16.10	5580.5	May 10 and 11.
Summit of Cedar Mt. Pass.....	2.15	255.48	364.40	6364.0	May 11.
First descent of Cedar Mt. Pass..	0.23	255.71	773.90	6186.0	Do.
Camp 7, west of Cedar Mt. Pass..	1.30	257.01	470.00	5575.0	Do.
Foot of mountain.....	2.43	259.44	329.00	4775.5	May 12.
Camp 8, Granite mountain.....	17.33	276.77	0.50	4666.4	Do.
Fish creek.....	39.80	316.57	10.20	5073.2	May 15.
Camp 10, Fish creek.....	16.50	333.07	0.20	5076.5	Do.
Summit of mountain spur.....	14.13	347.20	76.30	6154.1	May 16.
Camp 11, in mountain pass.....	7.47	354.67	10.90	6073.1	Do.
Ascent to divide of 1st and 2d creek of the pass.	1.82	356.49	226.50	6485.4	May 17.
Ascent to divide between 1st and 2d creek of the pass.	1.12	357.61	177.50	6684.2	May 17.
Ascending 2d creek.....	1.25	358.86	26.20	6717.0	Do.
Summit of pass.....	1.93	360.79	142.60	6992.2	Do.
Camp 12, descending pass.....	1.42	362.21	311.20	6550.3	May 17 and 18.
Foot of mountain.....	8.38	370.59	61.60	6034.4	May 18.
Open valley, lake to the left.....	6.86	377.45	12.00	5952.4	Do.
Camp 13, Willow spring.....	3.22	380.67	28.90	5859.3	May 18 and 19.
Base of hill.....	3.30	383.97	79.40	6121.4	May 19.
Top of deep ravine.....	5.07	389.04	101.30	6635.2	Do.
Passing over a mountain spur.....	1.65	390.69	18.10	6665.1	Do.
On a spur of mountain.....	2.57	393.26	17.50	6710.1	Do.
On a spur of mountain.....	0.54	393.80	29.60	6726.1	Do.
Camp 14.....	2.92	396.72	192.10	6165.1	May 19 and 20.
Camp 15, Franklin river, on plain east of the Humboldt mountains.	21.52	418.24	7.50	6004.2	May 20 and 21.
Camp 16, Franklin river, exten- sive grass-fields.	14.84	433.08	3.90	6061.4	May 21 and 22.
Crossing a mountain stream.....	7.65	440.73	58.20	6506.3	May 22.
Summit of pass in Humboldt Mt..	2.89	443.62	25.20	6579.1	Do.
On stream, western slope of pass.	0.80	444.42	78.40	6516.4	Do.
Creek, valley of Humboldt river..	8.36	452.78	89.20	5770.4	May 23.
Junction of main forks.....	35.00	487.78	30.60	4700.0	
Camp 33, east bank of Humboldt Mt.	135.00	622.78	4.10	4140.9	June 8 and 9.
Crossing of Humboldt river, camp 34.	6.80	629.58	0.90	4147.0	June 9 and 10.
Lawson's Meadows, California road, camp 35.	3.51	633.09	1.50	4152.2	June 10 and 11.
Foot-hills above Humboldt river..	9.64	642.73	16.30	4309.0	June 11.
In bed of Dry creek	7.86	650.59	23.30	4492.0	Do.
In bed of Dry creek	6.93	657.52	64.50	4938.7	Do.
Summit of pass.....	5.50	663.02	97.20	5473.2	June 12.
Descending from pass.....	10.55	673.57	87.20	4553.1	Do.
Junction of Dry creeks.....	4.68	678.25	30.50	4410.5	Do.
Bed of Dry creek.....	1.85	680.10	73.20	4275.0	Do.
In valley.....	2.55	682.65	1.30	4278.2	Do.
Dry creek	8.17	690.82	21.20	4451.5	June 13.
On stream, in cañon.....	1.95	692.77	67.60	4583.3	Do.
On summit.....	1.37	694.14	206.50	4866.2	Do.
Descending into valley.....	2.55	696.69	40.30	4763.4	Do.

I—Continued.

Station.	Inter- mediate distance.	Total distance	Average grade per mile.	Altitudes above the sea.	Remarks and dates.
			<i>Feet.</i>	<i>Feet.</i>	
Passing small hill in valley.....	7.04	703.73	44.40	5076.2	Do.
Passing small hill in valley.....	2.54	706.27	17.00	5033.0	Do.
Valley of Mud lake.....	11.75	718.02	76.50	4134.0	} Do.
Point of Mountain, lake valley....	15.39	733.41	00.00	4134.0	} June 14.
East base of Sierra Nevada.....	9.88	743.29	1.60	4118.1	June 15 and 16, Camp 39.
Point of mount, shore of Mud lake.	3.00	746.29	13.00	4079.0	June 16.
Foot of Madelin Pass, Smoky creek	16.00	762.29	18.20	4370.0	June 21.
Smoky creek, head of small cañon.	3.00	765.29	41.70	4495.2	Do.
Smoky creek, ascending pass.....	3.00	768.29	61.40	4679.5	Do.
Smoky creek, ascending pass.....	2.50	770.79	59.10	4827.3	Do.
Smoky creek, ascending pass.....	2.50	773.29	74.90	5014.6	Do.
Ascent of the Sierra Nevada.....	3.56	776.85	8.60	5045.3	June 22.
In a broad valley, ascending pass.	1.55	778.40	76.30	5163.5	Do.
In a broad valley do.....	1.56	779.96	78.30	5285.6	Do.
In a broad valley do.....	1.55	771.51	94.50	5432.1	Do.
In a broad valley do.....	1.56	783.07	50.90	5511.5	June 22.
Ascent	1.32	784.39	100.00	5643.5	Do.
Summit of Madelin Pass.....	0.79	785.18	30.40	5667.5	Do.
On broad summit of Sierra Nevada.	2.00	787.18	24.70	5620.0	Do.
On broad summit of Sierra Nevada.	1.93	789.16	31.80	5557.0	Do.
On broad summit of Sierra Nevada.	1.94	791.10	66.80	5427.5	Do.
Camp 45, broad plain, Sierra Ne- vada.	3.85	794.95	46.00	5250.5	June 22 and 23.
Camp 47, broad plain, Sierra Ne- vada.	21.90	816.85	0.50	5239.1	June 24 and 25.
Water-course.....	10.57	827.42	32.80	5585.5	June 25.
On divide in pass.....	1.63	829.05	92.30	5736.0	Do.
	1.63	829.05	18.70	5616.0	
	2.42	831.47	124.10	5315.6	} Deep Cut.
Stream west of summit of the Si- erra Nevada.	2.42	831.47	173.70	5315.6	June 25.
Stream west of summit of the Si- erra Nevada.	1.73	833.20	62.50	5207.5	Do.
Base of hill, in valley	3.20	836.40	86.00	4932.2	Do.
Waters of the Sacramento river..	3.67	840.07	125.40	4472.0	June 26.
East of stream, in Round valley ..	2.25	842.32	25.00	4415.7	Do.
Base of hill, in Round valley.....	2.08	844.40	10.00	4395.0	Do.
Leaving creek.....	1.25	845.65	76.60	4299.2	Do.
Camp 49, west side of stream	8.81	854.46	19.50	4127.4	Do.
Foot of Round valley, head of first cañon of Sacramento river.	4.76	859.22	5.60	4153.9	June 27.
Foot of first cañon of Sacramento.	13.74	872.96	38.70	3622.4	June 29.
Mouth of Fall river, and head of second cañon.	13.50	886.46	27.60	3249.9	Do.
Sacramento river, mouth of second cañon.	8.95	895.41	35.00	2937.0	July 21.
Mouth of Canoe creek	4.70	900.11	14.90	2867.2	Do.
Sacramento river.....	22.50	922.61	30.70	2177.2	July 20.
Sacramento river, Camp 5.....	7.50	930.11	59.60	1730.3	Do.
Sacramento river.....	26.50	956.61	21.70	1156.0	July 18.
Sacramento river, Camp 3.....	4.70	961.31	16.60	1078.1	July 17.
Sacramento river, Camp 2.....	10.50	971.81	11.80	954.2	Do.
Mouth of McCloud's river.....	5.25	977.06	6.10	922.0	July 16.
Sacramento river.....	11.75	988.81	7.20	837.5	Do.
Fort Reading	22.90	1011.71	7.10	674.7	July 12 to 15.

I—Continued.

Table of distances and of approximate average grades per mile upon the line explored for a railroad, from Mud lake, eastern base of the Sierra Nevada, to Fort Reading, California, 1854.—Noble's Pass.

Station.	Inter- mediate distance.	Total distance.	Average grade per mile.	Altitudes above the sea.	Remarks and dates.
			Feet.	Feet.	
Camp 39, east base of the Sierra Nevada.....				4118.1	June 15 and 16.
Shore of Mud lake.....	3.00	3.00	13.00	4079.0	June 16.
Warm Springs.....	42.00	45.00	3.60	4231.6	July 5.
Old shore-line.....	7.50	52.50	7.10	4285.2	Do.
Camp 55, shore of Honey lake....	8.50	61.00	22.40	4094.6	July 4, 5, and 6.
Willow creek.....	11.36	72.36	1.30	4080.0	July 4.
Camp 54, Roop's rancho.....	8.64	81.00	11.70	4181.0	July 3.
Susan river.....	4.00	85.00	10.10	4221.4	July 8.
Susan river.....	4.00	89.00	105.50	4643.6	Do.
Susan river.....	4.50	93.50	59.10	4909.7	Do.
Divide of Susan and Summit creeks.	7.25	100.75	75.10	5454.1	July 9.
Lake or pond.....	7.25	108.00	31.10	5679.4	Do.
Divide of Summit and Pine creeks.	2.25	110.25	54.30	5801.6	Do.
Pine creek, prairie.....	5.00	115.25	27.70	5663.3	Do.
Plains of the Sierra Nevada.....	2.89	118.14	63.30	5480.5	Do.
Plains of the Sierra Nevada.....	1.84	119.98	19.50	5516.3	Do.
Thick pine woods.....	1.70	121.68	71.90	5394.1	Do.
Thick pine woods.....	2.05	123.73	64.90	5261.1	Do.
Camp 59, Black Butte creek.....	1.55	125.28	113.70	5084.8	July 9, 10, 23, 24.
Bed of Dry creek.....	11.69	136.97	101.80	6275.4	July 10.
Near a pond.....	1.87	138.84	25.10	6233.4	Do.
Small creek and springs.....	1.53	140.37	19.00	6194.3	Do.
Canoe creek.....	3.75	144.12	5.80	6216.2	July 24.
West of Canoe creek, side of mountain.....	2.75	146.87	45.10	6092.3	Do.
Spur dividing the valley of Wolf creek.....	0.50	147.37	154.40	6015.1	Do.
Wolf creek.....	1.50	148.87	21.30	5983.1	Do.
Western summit of Sierra Nevada.	2.00	150.87	45.50	6074.1	July 25.
Battle creek.....	5.00	155.87	49.80	5825.1	Do.
Battle creek.....	2.50	158.37	212.60	5293.6	July 11.
Western descent of Sierra Nevada.	2.12	160.49	284.00	4691.5	Do.
Deer Flat, rancho.....	2.14	162.63	174.50	4318.1	Do.
Western slope of Sierra Nevada..	1.69	164.32	101.70	4146.3	Do.
Hill's rancho, on Battle creek....	2.00	166.32	7.30	4131.6	July 25.
Descending Sierra Nevada.....	4.14	170.46	47.60	3934.7	July 11.
Descending Sierra Nevada.....	3.58	174.04	136.60	3445.7	Do.
Camp 61, McCumber's mill.....	1.00	175.04	54.60	3491.1	July 12.
On stream.....	2.38	177.42	2.80	3497.8	Do.
Descent.....	3.05	180.47	230.10	2796.0	Do.
On stream.....	2.19	182.66	235.50	2280.2	Do.
Descent in valley.....	3.78	186.44	186.20	1576.4	Do.
Descent in valley.....	2.93	189.37	166.90	1087.4	Do.
On Dry creek.....	2.54	191.91	78.80	887.3	Do.
On Dry creek.....	4.37	196.28	41.40	706.5	Do.
Camp 62, Fort Reading.....	2.25	198.53	14.10	674.7	June 12, 13, 14, 15.

II.—Table of latitudes on the line of the forty-first parallel, explored for the Pacific railway, 1854.

SIR: In the following table of geographical positions, the latitudes are all deduced from meridional observations, and, when practicable, both north and south culminating stars were observed, for the purpose of eliminating instrumental and other errors.

The astronomical instruments were the same as those used last year with Captain Gunnison, and pronounced by him entirely inadequate for the determination of longitude. They were, besides, very much out of repair and adjustment when we started from Westport—defects which could not be remedied in Salt Lake City.

SHEPPARD HOMANS,
In charge of Astronomical Department.

First Lieut. E. G. BECKWITH,
U. S. A., commanding Expedition.

Geographical positions from Green river, Utah Territory, to Fort Reading, California, via Salt Lake City.

Date.	Locality.	Star.	Double mer. alt.	Index error.	Corrected altitude.	Deducted latitude.	Latitude of camp.
1854.							
April 15	Muddy creek	Alpha Hydra.	81 12 30	15 12.5	40 42 29		41 15 43
16	Bear river.....	do.	81 28 45	15 47	40 50 54		41 07 18
17	White Clay creek.....	do.	81 47 30	16 22.5	41 00 34		40 57 38
19	Weber river.....	do.	81 57 30		41 05 34		40 52 38
1853.							
Dec. 6	Salt Lake City.....	Sun	52 49 00	1 37	26 39 51		40 45 37
1854.							
May 9	Lone Rock valley.....	Spica.....	78 12 40	10	39 05 13		40 30 46
12	Camp 8, Granite mountain	do.	78 48 45	15	39 23 22		40 12 37
16	Camp 11.....	do.	79 03 05	15	39 30 24	40 05 35	
16	do.....	Polaris	77 18 00		38 37 55	40 06 14	40 05 56
17	Camp 12.....	do.	77 14 20	5	38 36 10	40 04 29	
17	do.....	Spica.....	79 04 40		39 31 22	40 04 37	40 04 33
18	Willow spring.....	Polaris	77 34 00		38 45 59	40 14 18	
18	do.....	Spica.....	78 45 35		39 21 50	40 14 09	40 14 14
19	Camp 14.....	Polaris	77 50 45	12.5	38 54 18	40 22 37	
19	do.....	Spica.....	78 27 40		39 12 45	40 23 14	40 22 56
20	Franklin river	Polaris	78 15 10	15	39 06 23	40 34 43	
20	do.....	Spica.....	78 04 10		39 00 58	40 35 01	40 34 52
21	do.....	Polaris	78 29 40	5	39 13 52	40 42 12	
21	do.....	Spica.....	77 50 40		38 54 20	40 41 39	40 41 50
26	Camp 20.....	Polaris	78 05 10	2.5	39 01 37	40 29 58	
26	do.....	Spica.....	78 14 35		39 06 20	40 29 39	40 29 49
27	Camp 21.....	Polaris	77 44 30		38 51 15	40 19 36	
27	do.....	Spica.....	78 35 15		39 16 39	40 19 20	40 19 28
30	Camp 24.....	Polaris	77 34 45		38 46 23	40 14 44	
30	do.....	Spica.....	78 44 30		39 21 14	40 14 44	40 14 44
31	Camp 25.....	Polaris	77 27 30	10	38 49 43		40 11 04
June 3	Camp 28.....	do.....	77 32 10		38 45 01		40 13 23
4	Camp 29.....	Spica.....	78 38 30	12.5	39 18 14		40 17 45
7	Camp 32.....	Polaris	78 10 35		39 04 19	40 32 34	
7	do.....	Spica.....	78 11 35		39 04 52	40 31 07	40 31 51
10	Lassen's meadows.....	Beta Libra.....	80 58 35		40 28 21		40 42 03
16	Mud lake	do.	80 57 05		40 27 37		40 41 48
19	Madelin Pass.....	do.	80 52 10		40 25 13		40 44 12
20	do.....	do.	81 03 30		40 30 51		40 38 35
22	Camp 45.....	do.	80 43 10		40 20 39		40 48 46
23	Camp 46.....	do.	80 50 10		40 24 10		40 45 15
24	Camp 47.....	do.	80 40 20		40 19 12		40 50 14
25	Camp 48.....	do.	80 13 20		40 05 42		41 03 43
26	Camp 49.....	do.	80 11 10		40 04 36		41 04 49
27	Camp 50.....	do.	80 23 10		40 10 38		40 58 47
30	Camp 51.....	do.	80 37 10		40 17 39		40 51 46
July 1	Camp 52.....	do.	80 54 40		40 26 25		40 43 00
2	Summit creek.....	Antares	46 48 50		23 22 36		40 31 02
3	Roop's rancho.....	do.	47 01 50		23 28 52		40 24 46
4	Shore of Honey lake.....	do.	47 09 00		23 32 42		40 20 56
9	Black Butte creek	do.	46 33 40		23 15 00		40 38 39
10	Wolf creek.....	do.	46 40 50		23 18 35		40 35 03
15	Camp.....	do.	46 28 30		23 11 55		40 41 43
17	Sacramento river	do.	46 20 40		23 08 04		40 45 34
18	do.....	do.	46 17 00		23 06 22		40 47 16
19	do.....	do.	45 47 00		22 51 17		41 02 21
20	do.....	do.	45 45 40		22 50 38		41 03 09
21	Camp near mouth of Canoe creek.....	do.	45 58 30		22 57 03		40 56 35
26	Near Fort Reading.....	do.	46 51 40		23 23 36		40 30 02

CHAPTER IX.

- I.—Introduction to meteorological table and table of altitudes and distances on the line of the forty-first parallel of north latitude, explored for the Pacific railway.
 II.—Meteorological table at Great Salt Lake City during the winter of 1853-'54.
 III.—Meteorological table and table of altitudes and distances of the line explored, 1854.

I.—Determination of altitudes and discussion of barometric observations.

The Bunten barometers Nos. 496 and 551 are exclusively relied upon for the determination of altitudes of the entire line. The readings of the Aneroid barometers exhibit variable errors; and as the mercurial barometers retain their reliable and uniform character throughout, no necessity exists for the use of the Aneroids. The zero errors found by Dr. Engelmann in his comparison at St. Louis, to apply to the Bunten barometers before the commencement of the work, did not remain as between the two instruments, even at the first considerable camps of the survey; they were therefore rejected in all the computations, and no zero error was at any time applied. For mean readings the two barometers usually agreed very nearly, the difference between them being, that No. 496 was too slow in its movement when considerable changes of altitude occurred, and required a correction or substitution of the other in such cases. For mean readings at stations where several observations were taken, the results of both are believed to be a very near approximation to standard accuracy, and the instruments appear to have been but slightly, if at all deranged at the termination of the survey. The zero errors found in them by Dr. Engelmann, on their return, were obviously introduced after the close of the work, and are therefore not applied to it.

In the discussion of the observations, the readings were first corrected for temperature to the height of the mercurial column, at 32° Fahrenheit. A minor error of non-adaptation of the common formula to the temperature expansion determined by Shumacher for barometers of this construction is thus avoided, and the greater advantage gained of combining all the observations at a station in a correct mean reading, to be used in a single computation of the altitudes. The mean of the observed air temperature is used in these cases also, as avoiding to some extent a source of error in extremes of surface temperature, for which, in single observations, a table of corrections is appended. All the observations were also corrected for *horary variations* of atmospheric pressure through the day, thus bringing each to the true mean position for the day. The accompanying scale of horary corrections gives the value employed for each hour; they are derived primarily from well-determined *curves* of daily variations of pressure for the eastern United States, but with material and important modifications and additions established by the observations of other surveys in the interior of the continent, principally by that of Lieut. Whipple. By the observations through the winter months at Great Salt Lake City, the measures of this horary scale are shown to be less for that season, and to conform these more nearly than

in summer to those observed in the eastern United States and in Europe. For the months occupied in the field-work of this survey, however, and for the districts traversed, the measure of the correction here employed is fully confirmed. At the sea-level, or so near it as both extremities of the line are, the measures of horary variation again fall off to those belonging to well known districts; yet as no determinations of importance occur at these extremities, it is not necessary to give the scale belonging to them. A correction previously found to be required for extremes of air temperature has been so well determined by the comparison of survey by levels and with the barometer, at the passes of the Sierra Nevada, surveyed by Lieut. Williamson, that a scale of corrections sufficiently precise for practical use has been constructed. When the error from this cause could not be eliminated by the use of mean temperatures, this scale has been employed in the determinations here made. The measures given for this correction belong to extremely arid climates, and to elevated districts, requiring modification in the position of the point where no correction is required; also, in different seasons. As it affects great elevations in these arid districts by an extreme amount, of at least 150 feet, it is too important to be neglected, notwithstanding a discretionary use of the value is usually necessary.

The reduced observations at stations on the plains, from Pawnee fork to camp 33, the first after crossing the Arkansas river, were referred to the mean barometric readings noted by Dr. Engelmann at St. Louis, for July, 1853, the month in which they were made.

The altitude of this station above the Gulf of Mexico, as determined by him from a long series of observations, was added to make up the entire altitude. For these stations and dates, the results thus obtained are very nearly identical with those computed by direct reference to the barometric mean at the level of the sea for the latitude.

For altitudes beyond this point, direct comparison of each camp is made to an assumed mean barometric reading at the level of the sea, in this latitude, of 30.000 inches, the barometer corrected to 32° , and a mean air temperature taken of 57° . The constant belonging to the latitude and climate of the Gulf is 30.050 inches of the barometer, and 64° of air temperature, which would add unduly to the altitudes.

The principle is assumed that the constants of pressure and temperature employed belong to the latitude, and that the resulting determinations of elevations belong, correctly and alike, to both the Gulf, the Atlantic and Pacific. There are no well-determined mean readings of the barometer on the Pacific coast, yet the most of those recently made in California give the impression that a slightly greater mean atmospheric pressure exists there, than in the same latitude of the Atlantic. The constant has not, however, been altered for any portion of this line.

The discussion of observations at the principal passes has been, in part, upon simultaneous observations at an hour's interval in time and distance. The slower movement of one barometer, however, rendered it necessary in many cases to take successive readings of the best one, corrected for horary variation, for determinations of successive differences. The termini of these lines of ascent and descent were also

checked by comparison of preferred results, as of the mean of several at the summit or elsewhere, with the nearer camps. The coincidence of results by single and successive steps has been so satisfactory as to warrant the conclusion that the grades and altitudes of these passes are quite accurately determined. The correct use of such data in the joining of intermediate with main lines, and in the correspondence of single observations with the mean of observations, is the surest test of barometric survey, and discrepancies cannot be wholly removed. The principal cause of these discrepancies is in the non-periodic variation of atmospheric pressure, for which no constant or correction can be given, except by reference to continued readings for a month or more at some station near. Mean results best eliminate this error, and they are therefore preferred in the order of their number, or of the number of days they cover. In the ascent of the Arkansas, the uniform grade of the stream permits the use of four or five successive camps as a near result, and two or three non-periodic variations are thus eliminated. Subsequently, to Great Salt lake, a less error from this cause is likely to occur, as this variation is least in August and September.

For the survey eastward from Great Salt lake to the valley of Green river, the field readings are compared with those of the same date by the other barometer at Great Salt Lake City: these may be regarded as nearly simultaneous, though the hours were not always the same, from the fact that the same days, and portions of the day, were compared. For the remainder of the line to California, no mode of correction of this error existed, except in the preference of the means embracing the greatest number of observations; yet the errors have probably no practical importance.

The observations generally sustain the checking and criticism which rank the results as a determinate survey, with a near approximation to absolute accuracy, and, as among themselves, sufficiently conclusive of grades and points of comparison.

Horary corrections of the barometer.

Hour.	Inches.	Hour.	Inches.
6 a. m.	+ .007	3 p. m.	— .030
7 a. m.	+ .020	4 p. m.	— .045
8 a. m.	+ .030	5 p. m.	— .050
9 a. m.	+ .040	6 p. m.	— .030
10 a. m.	+ .050	7 p. m.	— .020
11 a. m.	+ .055	8 p. m.	— .005
12 m.	+ .025	9 p. m.	— .000
1 p. m.	+ .005	10 p. m.	+ .010
2 p. m.	— .015	11 p. m.	+ .020

Scale of corrections for extreme air temperatures.

Low temperatures.	High temperatures.
At 35° add 25°	At 95° subtract 15°
At 40 add 23	At 93 subtract 13
At 45 add 21	At 90 subtract 11
At 47 add 20	At 88 subtract 10
At 50 add 19	At 85 subtract 8
At 53 add 15	At 83 subtract 7
At 55 add 13	At 80 subtract 5
At 57 add 10	At 78 subtract 3
At 60 add 5	At 75 subtract 2

NOTE.—The measures of this correction are variable to some extent with the season, and apply nearly to departures from the mean of the month in which observations are made. It is here given as required for summer months, in which most of the observations in field survey have been taken.

Captain Gunnison's barometers compared with the standard barometers of Dr. Engelmann.

ST. LOUIS, June 4 to 9, 1853.

Ten observations were made.

Range of standard barometer in that period from 29".505 to 29".748.
Range 0".240.

Variation.

Bunten, No. 551 = E + 0".006; var. from -0".021 to +0".027 = 0".048

Do. No. 496 = E + 0".080; var. from +0".046 to +0".109 = 0".063

Aneroid, No. 9,889 = E - 0".015; var. from -0".055 to +0".035 = 0".090

Do. No. 9,293 = E - 0".025; var. from -0".005 to -0".045 = 0".040

E represents Engelmann's standard barometer.

Both Bunten barometers are very slow in their movements. B. No. 551 gives a very dull sound when the tube is reversed, indicating air in the tube. No. 496 gives a clear sound, and is probably free of air.

The station of Dr. Engelmann's barometer is above low-water mark of the Mississippi 106.5, and above the Gulf of Mexico 482.0.

Bar. Engelmann was in June, 1853, equal to—

Bunten, No. 551 - 0".006

Do. No. 496 - 0".080

The Aneroids were both set to correspond exactly with bar. E.

After the voyage to California and back, bar. Engelmann was found in September, 1854, equal to—

Bunten, No. 551 - 0".072

Do. No. 496 + 0".116

Aneroid, No. 7,889 - 0".448

Do. No. 9,293 + 0".263

Therefore, as bar. E. has remained unaltered,

Bar. Bunten, No. 551	is now higher by 0".066	than 14 months ago.
Do. No. 496	is now lower by 0".196	“ “
Bar. Aneroid, No. 7,889	is now higher by 0".448	“ “
Do. No. 9,293	is now lower by 0".263	“ “

Bunten No. 551 is by far the best instrument of the whole set; but both barometers have the sides of the tubes at the lower as well as the upper levels so much soiled and darkened by oxydized mercury, that at a certain elevation of the barometer, at least, the reading becomes very difficult, if not impossible.

The Aneroids are certainly very unreliable; but within the limited range of my observations, (between 29 and 30 inches,) they performed well and corresponded pretty accurately with the changes of my own barometer.

In calculating elevations from barometrical data, it seems best not to compare isolated observations made on the same day or at the same hour, but to refer the observations made in the field (or the mean of several if they can be had) to the monthly means of the stationary barometer. I add, therefore, my monthly means for the last fourteen months. But the observations made west of the Rocky mountains cannot be referred to my barometer at all. It is hardly necessary to add—what everybody who is in the habit of observing the barometer, knows—that observations made in the forenoon, principally from 8 to 10 o'clock a. m., are generally higher, and those made in the afternoon, principally between 2 and 4 o'clock, are mostly lower than the average of the day. The noon observations come nearest the mean of the day. The barometer, at least in the Mississippi valley, is usually highest with westerly and northwesterly winds, and lowest with southerly and southeasterly winds. It is mostly higher, but much more irregular, in winter, and lower, but more regular, in summer.

Mean barometric elevation of St. Louis, 482' above the Gulf. Table of means corrected for temperature:

June,	1853.....	29.466
July,	1853.....	29.483
August	1853.....	29.431
September,	1853.....	29.474
October,	1853.....	29.538
November,	1853.....	29.601
December,	1853.....	29.508
January,	1854.....	29.575
February,	1854.....	29.514
March,	1854.....	29.465
April,	1854.....	29.445
May,	1854.....	29.338
June,	1854.....	29.432
July,	1854.....	29.498

G. ENGELMANN.

St. Louis, *September*, 1854.

The discrepancy found to exist by Dr. Engelmann in the Bunten barometers after our return from California, did not exist as between

themselves up to the termination of the exploration in July, and must therefore have arisen from some cause on our homeward journey, and is disregarded, therefore, in the discussion.

Horary variations of the barometer in California.

1. In the elevated portions of the interior.

Hour.	Inch.	Hour.	Inch.
4 a. m.....	— .007	2 p. m.....	— .025
5 a. m.....	— .005	3 p. m.....	— .030
6 a. m.....	+ .012	4 p. m.....	— .035
7 a. m.....	+ .025	5 p. m.....	— .033
8 a. m.....	+ .030	6 p. m.....	— .025
9 a. m.....	+ .035	7 p. m.....	— .015
10 a. m.....	+ .040	8 p. m.....	— .005
11 a. m.....	+ .045	9 p. m.....	+ .008
12 m.....	+ .015	10 p. m.....	+ .015
1 p. m.....	— .005	11 p. m.....	+ .013

2. At the sea-level, or near the coast.

Hour.	Inch.	Hour.	Inch.
4 a. m.....	— .007	2 p. m.....	— .025
5 a. m.....	— .005	3 p. m.....	— .030
6 a. m.....	+ .012	4 p. m.....	— .035
7 a. m.....	+ .025	5 p. m.....	— .033
8 a. m.....	+ .032	6 p. m.....	— .025
9 a. m.....	+ .041	7 p. m.....	— .015
10 a. m.....	+ .045	8 p. m.....	— .005
11 a. m.....	+ .035	9 p. m.....	+ .008
12 m.....	+ .015	10 p. m.....	+ .015
1 p. m.....	— .005	11 p. m.....	+ .013

METEOROLOGICAL OBSERVATIONS

AT

GREAT SALT LAKE CITY,

1853-'54.

II.—*Meteorological observations at Great Salt Lake City, 1853-'54.*

Locality.	Date.	Hour.	Barometer, No. 486.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (U.)	Corrected barometer, No. 486.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
Great Salt Lake City, at the house of Mr. Benson, opposite the Council-house and Tithing-office.	1853.									
	Nov. 29	10 a. m.	657	10.5	655.5	11	<i>Inches.</i> 25.773	<i>Inches.</i> 25.710	49	Rain in valley; snow in mountains; cool and unpleasant.
	29	12 m.	655.4	10	654.3	10	25.735	25.692	50	Rain ceased to fall, but it still continues cloudy.
	30	9.30 a. m.	657.6	9.5	657.6	10	25.802	25.802	47	A few light clouds.
	30	12 m.	657.9	12	658.5	12	25.822	25.849	51	Clear and pleasant.
	30	3 p. m.	657.9	13	658.5	12	25.873	25.897	53	Clear and pleasant, with a slight breeze from the southeast
	Dec. 1	9 a. m.	658	10	658.3	10.5	25.823	25.834	46	Clear and pleasant.
	1	12 m.	658	13.5	658.3	14	25.826	25.834	53	A few light clouds in the northwest.
	1	3 p. m.	658	15.5	658.3	16	25.873	25.881	57	Clear.
	2	9 a. m.	658.8	10.5	656.3	10.5	25.772	25.756	45	Clear; thermometer at sunrise 34°.
	2	12 m.	657.7	13.5	656.5	14	25.810	25.763	52	Light clouds.
	2	3 p. m.	656.5	14	655.1	14.5	25.818	25.763	55	Do.
	3	9 a. m.	656.5	11.5	655.1	12	25.756	25.701	48	Thermometer at sunrise 33°.
	3	12 m.	656.5	13	655.2	13	25.767	25.716	53	Clear.
	3	3 p. m.	656.5	13	655.2	13	25.822	25.771	54	Do.
	4	9 a. m.	655.8	10	653.9	10	25.736	25.661	44	Thermometer at sunrise 31°.
	5	9 a. m.	655	9	654.9	9.5	25.712	25.701	43	Do do. 30°.5
	5	12 m.	655.7	12	655.6	12.5	25.739	25.731	50	Morning clear and cool.
	5	3 p. m.	655.7	13.5	655.6	13.5	25.786	25.786	53	Clear and pleasant.
	6	9 a. m.	659.4	9.5	658.9	9.5	25.878	25.858	43	Thermometer at sunrise 30°.
	6	12 m.	659.6	12	659.2	11.5	25.893	25.881	51	Clear and pleasant.
	6	3 p. m.	659.6	14	659.2	14.5	25.936	25.920	54	Clear.
	7	9 a. m.	659.8	9	659.6	9	25.897	25.890	41	Thermometer at sunrise 28°.
	7	12 m.	659.8	12	659.6	12	25.897	25.893	51	Clear.
	7	3 p. m.	659.8	13	659.8	13.5	25.948	25.948	52	Clear and pleasant.
	8	9 a. m.	659	8	657.7	8	25.874	25.819	40	Thermometer at sunrise 28°.
	8	12 m.	657.8	11.5	655.6	11.5	25.822	25.735	47	Morning clear and cool, with heavy frost.
	8	3 p. m.	656.3	13.5	655	14	25.810	25.759	54	Clear.
	9	9 a. m.	650.7	5	651.1	5	25.555	25.574	34	Thermometer at sunrise 26°.
	9	12 m.	650.7	7	651.1	7	25.562	25.582	35	Heavy mist, with a cold northwest wind.
9	3 p. m.	648.6	8	650	8.5	25.538	25.589	37	Cloudy.	
10	9 a. m.	647	6	648.5	6	25.409	25.464	38	Thermometer at sunrise 28°; cloudy.	
10	12 m.	647	6	648.5	6	25.424	25.479	45	Cloudy; strong wind from northwest in the evening; rain.	

11	9 a. m.....	647.5	8.5	649.7	8	25.417	25.504	41
11	11 a. m.....	648.6	9	650.2	9.5	25.441	25.504	45
12	9 a. m.....	652.6	8	652.2	8	25.618	25.602	37
12	12 m.....	652.3	8	652	8	25.621	25.713	39
12	3 p. m.....	652	7.5	650.7	7.5	25.768	25.613	39
13	9 a. m.....	647.1	7	648.4	7	25.409	25.456	39
13	12 m.....	646	8	647.3	8	25.377	25.424	46
13	3 p. m.....	645.2	8	647.3	8.5	25.401	25.479	48
14	9 a. m.....	644.7	7	647	7	25.315	25.405	42
14	12 m.....	645	7	647.7	7	25.342	25.444	38
14	3 p. m.....	645	7	647.7	7	25.397	25.499	41
15	9 a. m.....	646.3	6.5	648.9	6.5	25.378	25.476	37
16	9 a. m.....	652.3	5	651.9	5	25.618	25.602	30
16	12 m.....	653.1	6	653	6	25.664	25.660	37
16	3 p. m.....	653.1	6	653	6	25.719	25.715	37
17	9 a. m.....	653.7	5	653.9	5	25.673	25.681	34
18	9 a. m.....	654.2	6.5	654.1	6.5	25.689	25.685	36
19	9 a. m.....	652.2	5	651.2	5	25.614	25.578	31
19	3 p. m.....	654.3	7.5	655.3	7.5	25.759	25.806	39
20	9 a. m.....	648.1	6	648.7	6	25.452	25.472	39
20	12 m.....	648.7	6	648.7	6	25.487	25.487	43
20	3 p. m.....	648.3	7	648.7	7.5	25.522	25.534	42
21	9 a. m.....	648.7	7.5	648.5	7.5	25.468	25.460	37
21	12 m.....	648.7	7.5	648.5	7.5	25.483	25.475	42
21	3 p. m.....	648	6.5	648	6.5	25.515	25.515	37
22	9 a. m.....	651.3	6.5	651.8	6.5	25.574	25.590	25
22	12 m.....	651.6	8.5	652.8	8.5	25.593	25.637	31
23	9 a. m.....	652.3	5	653.6	5	25.618	25.669	22
23	3 p. m.....	652.2	10	651.2	10	25.664	25.625	32
24	9 45 a. m.....	651.6	4	650.3	4	25.587	25.540	30
24	12 m.....	650.6	6	649.6	6	25.562	25.519	36
26	9 a. m.....	652.7	5	652.3	5	25.634	25.618	27
26	12 m.....	652.6	6	652.3	6	25.641	25.629	37
27	9 30 a. m.....	653.5	6	653.1	6	25.656	25.644	38
27	12 m.....	653.5	8.5	653.1	8.5	25.664	25.653	44
27	3 p. m.....	653.7	9	653.3	9	25.727	25.712	43
28	12 m.....	653	11	650	11	25.637	25.523	46
28	3 p. m.....	650.6	10	648.7	10	25.601	25.526	49
29	9 a. m.....	650.2	7.5	650	7.5	25.527	25.519	35
29	12 m.....	650.2	8	650	8	25.538	25.534	35
29	3 p. m.....	650.2	5.5	650	5.5	25.605	25.597	34
30	9 30 a. m.....	656.3	4.5	656.2	4.5	25.774	25.770	24
31	9 a. m.....	659.8	5.5	659.8	5.5	25.909	25.909	25
31	12 m.....	659.8	8	659.8	8	25.916	25.916	33
1854.								
Jan. 2	9 30 a. m.....	659	5.5	657.3	5.5	25.877	25.810	28
2	12 m.....	659.3	9	657.7	9	25.893	25.830	34
3	9 30 a. m.....	653.2	9	651.1	9	25.633	25.550	42
3	3 30 p. m.....	651.3	12	648.7	12	25.628	25.526	47
4	9 30 a. m.....	647.1	9	646.3	9	25.396	25.365	35
4	12 m.....	647.1	9	646.1	9	25.416	25.377	37

Cloudy.
Do.
Hazy and cloudy.
Hazy.
Cloudy.
Thermometer at sunrise 36°; cloudy.
Cloudy and disagreeable.
Cloudy, with indications of rain.
Thermometer at sunrise 40°; slight fall of snow.
Cloudy and damp.
Damp; snow in mountains.
Thermometer at sunrise 33°.
Thermometer at sunrise 26°; clear.
Cloudy.
Do.
Thermometer at sunrise 33°; cloudy.
Do. do. 30°; do.
Do. do. 26°; clear.
Cloudy.
Thermometer at sunrise 35°; cloudy.
Cloudy.
Cloudy; snow fell during the night to the depth of four inches.
Thermometer at sunrise 34°; snow falling very fast.
Snow.
Do.
Thermometer at sunrise 24°; clear.
Clear.
Thermometer at sunrise 16°; clear.
Clear.
Clear and cool.
Thermometer at sunrise 20°; cloudy.
A few light clouds.
Thermometer at sunrise 23°; cloudy.
Cloudy.
Thermometer at sunrise 35°; cloudy.
Cloudy.
Do.
Clear and pleasant.
Cloudy; snow fell during the night to the depth of three inches.
Cloudy; strong wind from northwest.
Cloudy; northwest wind.
Cloudy; slight fall of snow.
Clear; thermometer at sunrise 18°.
Clear.
Clear; thermometer at sunrise 22°.
Clear.
Cloudy.
Do.
Thermometer at sunrise 32°; light clouds.
Cloudy.

Meteorological observations at Great Salt Lake City—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.	
Great Salt Lake City.....	1854.						<i>Inches.</i>	<i>Inches.</i>			
	Jan.	4	3.30 p. m. . .	647.1	8.5	646.2	8.5	25.478	25.443	37	Cloudy.
		5	10 a. m.	654.2	4.5	650.7	4.5	25.687	25.549	17	Thermometer at sunrise 14°; light clouds.
		5	12 m.	650.2	4.5	650.6	4.5	25.554	25.570	21	Cloudy.
		5	3.30 p. m. . . .	650.9	5.5	651.5	5.5	25.636	25.663	22	Light clouds; storm of northwest wind.
		6	9.30 a. m. . . .	656.8	2	656.4	2	25.802	25.790	14	Thermometer at sunrise 8°; clear.
		6	12 m.	656.8	2	656.4	2	25.822	25.810	18	Clear; strong wind from northwest.
		6	3 p. m.	658.3	4.5	658.9	4.5	25.928	25.948	19	Clear.
		7	9.30 a. m. . . .	658.8	1	661.4	1	25.885	25.987	18	Thermometer at sunrise 12°; clear.
		7	12 m.	658.8	4	661.4	4	25.893	25.995	27	Clear.
		7	3.30 p. m. . . .	659.6	4	660.4	4	25.986	26.018	28	Do.
		9	9 a. m.	655.6	4.5	654.3	4.5	25.752	25.701	28	Thermometer at sunrise 25°; snow fell during night, depth three inches.
		10	10 a. m.	655.3	7	655.1	7	25.718	25.714	30	Cloudy, with signs of snow.
		10	12 m.	655.6	8	655.2	8	25.751	25.735	35	Clear.
		10	3.30 p. m. . . .	656.1	12	657.1	12	25.817	25.856	34	Light clouds.
		11	9.30 a. m. . . .	652.8	4.5	652	4.5	25.633	25.605	33	Thermometer at sunrise 25°; cloudy, with signs of snow.
		11	1.15 p. m. . . .	651.7	6.5	649.8	6.5	25.626	25.552	34	Light fall of snow.
		12	9.15 a. m. . . .	643.8	5	642.2	5	25.285	25.222	37	Thermometer at sunrise 36°; snow falling very fast.
		12	12 m.	643.9	5	642.4	5	25.306	25.247	36	Strong wind from northwest.
		12	3 p. m.	643.9	5	642.4	5	25.361	25.302	35	Snow still continues to fall.
		13	9.30 a. m. . . .	643.1	8.5	641.5	8.5	25.243	25.176	44	Cloudy; thermometer at sunrise 34°.
		13	3 p. m.	639.9	10	638.2	10	25.184	25.117	48	Cloudy; strong wind from northwest.
		14	9 a. m.	637.2	9	637	9	25.012	25.004	45	Thermometer at sunrise 45°; lowering clouds; strong wind from southwest.
		14	12.45 p. m. . .	624	11	635.7	11	24.922	24.965	40	Hail storm; wind from northwest.
		14	3.30 p. m. . . .	635.6	10	636.4	10	25.022	25.053	31	Snow falling very fast.
		15	9 a. m.	639.5	6	639.4	4	25.114	25.118	28	Thermometer at sunrise 22°; cloudy; snow eight to ten inches deep.
		15	12 m.	640.3	8	641	8	25.152	25.180	31	Cloudy.
		16	9 a. m.	643.2	3	643.2	3	25.271	25.271	20	Thermometer at sunrise 19°; light clouds.
		16	12.20 p. m. . .	643.3	5	643.8	5	25.288	25.307	26	Light clouds.
		16	3 p. m.	642.9	5	643.2	5	25.322	25.334	26	Cloudy; slight fall of snow during the night.
		17	9.15 a. m. . . .	643.4	1	643.8	1	25.285	25.301	26	Thermometer at sunrise 24°; cloudy.
		17	12 m.	643.2	4	642.4	4	25.283	25.251	34	Cloudy; slight fall of snow during the night.

18	9.15 a. m....	647.2	1	647.7	1	25.435	25.450	16
18	12.30 p. m....	645.8	1.5	645	1.5	25.403	25.371	29
18	3 p. m.	644.7	5	643.2	5	25.393	25.334	24
19	9.15 a. m....	636.7	-1	637.4	-1	25.029	25.057	19
19	12.25 p. m....	636.8	0	637.4	0	25.056	25.080	15
19	3.30 p. m....	639.1	1	639.4	1	25.195	25.207	13
20	9 a. m.	653.3	-6	654.6	-6	25.708	25.760	0
20	12.25 p. m....	654.9	-1	656.7	-1	25.777	25.848	0
20	3 p. m.	655.6	0	656.8	0	25.842	25.849	0
21	9.30 a. m....	654.9	-7	654.9	-7	25.770	25.770	-4
21	12 m.	654.9	-3	653.6	-3	25.775	25.723	5
21	3 p. m.	653.6	-3	652.2	-3	25.778	25.719	8
22	9.45 a. m....	658.6	-2	658.5	-2	25.881	25.890	8
22	3 p. m.	659.2	.....	660.1	.....	25.983	26.019	12
23	9.15 a. m....	658.1	-3	657.8	-3	25.880	25.872	16
23	12 m.	658.4	3	657.3	3	25.881	25.842	27
23	3.30 p. m....	657.9	3	656.2	-3	25.923	25.884	21
24	9 a. m.	651.7	-1	651.5	-1	25.665	25.736	26
24	12.20 p. m....	649.9	-0.5	648.7	-0.5	25.591	25.543	27
25	9.30 a. m....	646.2	3.5	648	3.5	25.381	25.451	39
25	12 m.	646.2	3.5	645	3.5	25.401	25.353	38
25	3.30 p. m....	647.1	3.5	648.3	3.5	25.498	25.545	33
26	9.30 a. m....	655.9	3	656.4	3	25.763	25.782	14
26	12.15 p. m....	657.2	5.5	657.3	5.5	25.831	25.835	28
27	10 a. m.	660.7	3	660.5	3	25.947	25.939	22
27	12 m.	660.7	5	660.5	5	25.964	25.956	30
28	9.15 a. m....	660.6	3	659.7	3	25.951	25.915	36
28	12 m.	660.7	7	659.8	7	25.956	25.920	37
29	9 a. m.	660.7	5.5	659.4	5.5	25.945	25.897	37
31	9 a. m.	659.6	3	658.4	3	25.913	25.866	24
Feb. 1	9 a. m.	644.9	3	647.7	3	25.338	25.445	24
1	12 m.	646.9	2	647.7	2	25.357	25.464	31
2	9 a. m.	655.3	2.5	654.9	2.5	25.738	25.728	18
2	12 m.	655.8	5	655.8	5	25.771	25.771	28
2	4 p. m.	655.6	6	655.6	6	25.829	25.829	26
3	9 a. m.	654.3	2.5	653.2	2.5	25.708	25.665	27
3	12.25 p. m....	654.7	6.5	653.8	6.5	25.730	25.694	34
4	9 a. m.	653.8	5	652.8	5	25.677	25.638	38
5	10 a. m....	653.9	6.5	653.5	6.5	25.663	25.651	44
5	3 p. m.	653.2	7.5	650.7	7.5	25.715	25.673	38
6	9 a. m.	652.7	8.5	651.8	8.5	25.692	25.582	40
6	11 a. m....	653.1	8	652.5	8	25.693	25.599	50
6	3 p. m.	653.1	8	652.5	8	25.708	25.684	44
7	9 a. m.	653.2	7	652.3	7	25.645	25.610	40
7	1 p. m.	653.3	7.5	652.6	7.5	25.684	25.653	45
8	9 a. m.	654.6	6	655	6	25.705	25.724	34
8	12 m.	654.6	10.5	655	10.5	25.700	25.720	47
9	9 a. m.	652.6	7	651.9	7	25.622	25.584	35
9	12.30 p. m....	652.8	10	651.8	10	25.643	25.603	48

Thermometer at sunrise 12°.
 Cloudy.
 Do.
 Thermometer at sunrise 19°; snow falling very fast; wind northwest.
 Snow ceased to fall; strong wind from northwest.
 Cloudy, with signs of snow.
 Thermometer at sunrise 2°; cloudy.
 Light clouds in northwest.
 Clear.
 Thermometer at sunrise 14°; light clouds in northwest.
 Clear; wind from northwest.
 Light clouds.
 Thermometer at sunrise 11°; clear.
 Clear.
 Thermometer at sunrise 8°; light clouds in northeast.
 Light clouds.
 Cloudy.
 Thermometer at sunrise 18°; cloudy.
 Cloudy, with signs of snow.
 Thermometer at sunrise 37°; snow fell during the night.
 Snow falling.
 Cloudy.
 Thermometer at sunrise 11°; clear.
 Clear.
 Thermometer at sunrise 6°; clear.
 Clear.
 Cloudy, with signs of snow.
 Heavy fog; thermometer at sunrise 15°.
 Frost; thermometer at sunrise 18°; cloudy.
 Cloudy.
 Clear; thermometer at sunrise 14°.
 Clear.
 Do.
 Cloudy; thermometer at sunrise 18°.
 Clear.
 Cloudy; thermometer at sunrise 28°.
 Cloudy.
 Cloudy; at 12 m. slight fall of rain.
 Clear in northwest; sky partially overcast.
 Cloudy.
 Do.
 Foggy.
 Cloudy, with signs of rain.
 Clear.
 Do.
 Do.
 Do.

Meteorological observations at Great Salt Lake City—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.	
Great Salt Lake City.....	1854.						<i>Inches.</i>	<i>Inches.</i>			
	Feb.	10	9 a. m.....	647.9	8	647.1	8	25.433	25.405	46	Cloudy; light breeze from southeast.
		10	12.15 p. m...	646.8	8.5	645.9	8.5	25.410	25.374	50	Do. do.
		10	3 p. m.....	646.5	8.5	645.7	8.5	25.448	25.416	46	Slight fall of rain.
		11	9 a. m.....	643	8	641.9	8	25.244	25.201	44	Stormy.
		11	12.30 p. m...	642.1	9	640.4	9	25.230	25.162	49	2.15 p. m. hail, with strong wind from southwest, 3 p. m. snow.
		11	3 p. m.....	642	9	640.3	9	25.271	25.204	37	Snow.
		12	9 a. m.....	643	5.5	644.2	5.5	25.275	25.299	34	Cloudy; light breeze from northwest.
		12	12 m.....	643.4	5.5	643.3	5.5	25.282	25.279	35	Snow, falling very fast.
		12	3 p. m.....	643.4	5.5	643.3	5.5	25.338	25.334	32	Cloudy.
		13	9 a. m.....	643.1	2	643.3	2	25.271	25.279	28	Snowing very fast; strong wind from northwest.
		13	12 m.....	645	4	645.2	4	25.353	25.361	32	Cloudy; snow ceased.
		13	3 p. m.....	646.5	7	647	7	25.456	25.475	35	Broken clouds; strong wind from northwest.
		14	9 a. m.....	652.2	2	652.3	2	25.630	25.630	25	Cloudy, with signs of snow; thermometer at sunrise 16°.
		14	12 m.....	652.3	4.5	652.4	5	25.637	25.637	40	Slight fall of snow.
		15	9 a. m.....	653.2	4	652.1	4	25.661	25.618	29	Cloudy; thermometer at sunrise 20°.
		15	12 m.....	653.2	3	652.1	3	25.680	25.637	44	Cloudy.
		15	3 p. m.....	653	3	652.1	3	25.727	25.692	38	Slight fall of snow.
		16	9 a. m.....	650.1	2.5	649.6	2.5	25.543	25.523	38	Thermometer at sunrise 32°; cloudy.
		16	12 m.....	650.1	5	649.6	5	25.550	25.527	44	Few light clouds visible.
		16	3 p. m.....	650.2	5	649.8	5	25.609	25.599	40	Cloudy in the north and west.
		17	9 a. m.....	649.9	4	650	4	25.527	25.535	33	Clear; thermometer at sunrise 28°.
		17	12 m.....	650.4	8	650.2	8	25.546	25.538	40	Clear; snow melting rapidly.
		17	3 p. m.....	650.4	10	650.2	10	25.593	25.586	40	Clear.
		18	Sunrise.....	649.8	3	650.1	3	25.547	25.563	24	Clear and calm.
		18	10 a. m.....	650.1	7.5	650.5	7.5	25.513	25.529	38	Clear and pleasant.
		18	12 m.....	650.1	7.5	650.5	7.5	25.538	25.554	36	Clear, with light breezes from the north.
		18	3 p. m.....	650.5	10	650.6	10	25.597	25.601	35	Clear.
		19	9 a. m.....	650.8	5.5	651.4	5.5	25.555	25.622	34	Clear and pleasant.
		19	12 m.....	650.8	9	651.4	9	25.558	25.582	40	Clear.
		19	3 p. m.....	650.8	11	650.9	11	25.605	25.609	42	Do.
		20	Sunrise.....	650.3	4.5	651	4.5	25.563	25.591	25	A few light clouds in northwest.
		20	9 a. m.....	650.3	6	651	6	25.535	25.567	38	Light clouds.
		20	12 m.....	650.3	7	651	7	25.546	25.578	38	Cloudy; at 2 p. m. slight fall of snow.

20	3 p. m.	650	7.5	649.8	7.5	25.589	25.578	40	Broken clouds, with signs of snow.
21	9 a. m.	651.1	5	651.8	5	25.574	25.698	38	Broken clouds; snow fell during the night; depth one inch.
21	12 m.	652.7	9	652.7	9	25.633	25.633	41	Light clouds.
21	3.30 p. m.	652.9	9	652.8	9	25.703	25.699	41	Clear; light breeze from northwest.
22	9 a. m.	656.1	6	653.4	6	25.768	25.736	34	Clear; light breeze from south.
22	12 m.	656.3	9	656.3	9	25.775	25.775	40	Clear.
22	3 p. m.	656.3	10	656.3	10	25.826	25.826	46	Light clouds.
23	9 a. m.	653	6.5	651.7	6.5	25.642	25.630	45	Cloudy.
23	12 m.	652.4	6.5	651.2	6.5	25.633	25.586	46	Cloudy, with signs of rain.
23	3 p. m.	651.8	6	651	6	25.664	25.637	39	Rain; 4.30 p. m. snow commenced to fall.
24	9 a. m.	653	5	652.5	5	25.649	25.626	37	Thermometer at sunrise 37°.
24	12 m.	653.1	6.5	653.8	6.5	25.660	25.684	44	Slight fall of snow.
24	3 p. m.	653.1	7	653.8	7	25.715	25.739	40	Light clouds.
25	9 a. m.	653.2	5	653.7	5	25.657	25.673	34	Clear.
25	12 m.	653.3	8	653.8	8	25.660	25.660	40	Clear and pleasant.
25	3 p. m.	652.7	10	651.2	10	25.684	25.625	40	Cloudy, with signs of snow.
26	9 a. m.	648.9	5	648.1	5	25.484	25.456	34	Snow falling very fast; strong wind from northwest.
26	12.30 p. m.	649.3	5	648.6	5	25.525	25.497	35	Do. do. do.
26	3 p. m.	649.9	8	649.7	8	25.582	25.574	40	Cloudy.
27	9 a. m.	649.9	3	649.7	3	25.531	25.523	37	Do.
27	12 m.	650.4	8	651.4*	8	25.546	25.586	46	Light clouds.
27	3 p. m.	650.4	8.5	651.2	8.5	25.601	25.633	47	Cloudy in the northwest.
28	9 a. m.	643.9	6	643.1	6	25.287	25.256	47	Light fall of snow.
28	12 m.	644.2	8	643.6	8	25.306	25.286	46	Cloudy in northwest; strong wind from southeast.
28	3 p. m.	644.2	10	643.6	10	25.353	25.326	46	Slight fall of snow.
March 1	9 a. m.	646.2	4	647.8	4	25.386	25.445	37	Cloudy, with signs of snow.
1	12 m.	646.8	5	648.9	5	25.420	25.499	42	Snow falling fast; strong wind from northwest.
2	9 a. m.	651.2	4	651.4	4	25.582	25.586	33	Light clouds.
2	12 m.	651.6	7	651.4	7	25.601	25.589	43	Do.
2	3 p. m.	651.6	7	651.4	7	25.656	25.644	44	Cloudy.
3	9 a. m.	651.2	4.5	651.8	4.5	25.578	25.698	32	Clear; snow fell during the night to the depth of an inch.
3	12 m.	651.6	8	652.3	8	25.593	25.621	39	Clear.
4	9 a. m.	648.7	5	647.7	5	25.476	25.437	46	Cloudy; light wind from south.
4	12 m.	648.1	7	647.2	7	25.464	25.428	48	Cloudy, with strong wind from south.
4	3 p. m.	646.8	6	646.5	6	25.471	25.460	47	Cloudy, with signs of snow; 4.30 p. m. snowing heavily.
5	9 a. m.	647.7	6	648.3	6	25.433	25.456	41	Slight fall of snow; strong wind from northwest.
5	12 m.	647.7	7	648.3	7	25.444	25.467	49	Snow falling fast.
5	3 p. m.	647.9	8	648.3	8	25.503	25.519	42	Cloudy.
6	9 a. m.	647.6	5.5	648.1	5.5	25.433	25.452	42	Snow.
6	12.20 p. m.	647.6	8	648.1	8	25.441	25.465	56	Cloudy.
6	3 p. m.	647.5	8	648	8	25.487	25.511	54	Fine snow.
7	9 a. m.	648	5.5	650.4	5.5	25.449	25.473	48	Cloudy.
7	12 m.	649.2	8.5	650.4	8.5	25.499	25.546	42	Clear.
7	3 p. m.	649.7	11	647.7	11	25.562	25.569	40	Do.
8	9 a. m.	648.2	6	647.7	6	25.456	25.433	43	Cloudy.
8	12 m.	648.1	8	651.1	8	25.460	25.440	46	Do.
9	9 a. m.	650.6	5	643.8	5	25.551	25.574	38	Clear and pleasant.
12	9 a. m.	644.1	7	646.6	7	25.391	25.379	45	Do.
13	9 a. m.	645	5.5	646.9	5.5	25.331	25.393	34	Snow.
13	12 m.	645.3	9	649.7	9	25.346	25.406	49	Cloudy; three inches of snow on the ground.

Meteorological observations at Great Salt Lake City—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer No. 551.	Air temperature, (F.)	Remarks.	
Great Salt Lake City.....	1854.						<i>Inches.</i>	<i>Inches.</i>			
	March 15	12 m	648.3	12.5	650.4	12.5	25.448	25.499	54	Clear.	
	16	9 a. m.	649.3	10.5	651.1	10.5	25.476	25.523	50	Do.	
	16	12 m	649.6	13.5	649.9	13.5	25.491	25.554	64	Light clouds.	
	17	9 a. m.	651.5	11.5	648.6	12	25.559	25.496	49	Do.	
	20	9 a. m.	648.1	11	648.8	11	25.429	25.456	50	Rain, accompanied by thunder and lightning.	
	20	12 m	648.6	12	648.3	12	25.460	25.448	44	Stormy.	
	21	9 a. m.	652.4	11	652.2	11	25.598	25.590	49	Cloudy.	
	21	12 m	654.7	13.8	653.5	14	25.692	25.645	57	Rain.	
	21	3 p. m.	652.3	16.5	653.6	17	25.641	25.688	54	Clear.	
	22	9 a. m.	655.2	8	653.8	8	25.681	25.622	47	Do.	
	22	12 m	655.2	13	653.8	13	25.716	25.857	53	Do.	
	22	3 p. m.	655.2	16	653.8	16	25.759	25.700	57	Do.	
	23	9 a. m.	655.3	12	653.6	12	25.708	25.643	52	Do.	
	23	12 m	655.2	13.5	653.9	14	25.716	25.657	54	Do.	
	24	9 a. m.	649.8	17	648.6	17	25.538	25.495	59	Light clouds.	
	24	12 m	652.6	12	651.4	12	25.602	25.555	49	Light clouds; strong breeze from northwest.	
	24	3 p. m.	651	14	649.7	14	25.546	25.495	58	Light clouds.	
	25	9 a. m.	649.8	11.5	649.3	11.5	25.492	25.472	49	Do.	
	25	12 m	650.2	15	649.6	15	25.511	25.487	57	Do.	
	26	9 a. m.	650.3	11.3	649.5	11.3	25.516	25.484	54	Do.	
	26	12 m	650.6	15.5	650	15.5	25.523	25.503	59	Clear.	
	27	9 a. m.	650.4	13	650	12	25.512	25.496	58	Light clouds.	
	27	12 m	650.7	16.5	650	16.5	25.523	25.511	68	Do.	
	28	12 m	650.6	15.5	650	15.5	25.523	25.503	59	Slight fall of rain.	
	28	3 p. m.	651.3	16.6	651	16.7	25.601	25.593	63	Cloudy.	
	29	9 a. m.	653.4	14.8	652.6	15	25.622	25.590	58	Light clouds.	
	29	12 m	649.3	16.9	648	17	25.467	25.416	61	Clear.	
	29	3 p. m.	647	19	648.2	19.5	25.424	25.471	62	Do.	
	30	9 a. m.	649.7	11.5	648.8	11.5	25.488	25.452	39	Snow and rain, with strong wind from northwest.	
	30	12 m	649.9	12.5	649.2	12.5	25.507	25.483	35	Do. do. do.	
	30	3 p. m.	649.9	10	649.2	10	25.574	25.546	36	Cloudy.	
	April	1	9 a. m.	659	10.5	656.6	10.5	25.862	25.760	51	Do.
		1	12 m	659.6	12.5	655.9	12.5	25.889	25.743	55	Do.
		2	9 a. m.	656.3	11	655.4	11	25.752	25.716	52	Slight fall of rain.
2		12 m	656.1	15	654.5	15.5	25.743	25.676	68	Cloudy.	

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2	3 p. m.	654.9	15	653.4	15	25.747	25.692	69
4	9 a. m.			654.3	10		25.677	54
4	12 m.			659.1	16.6		25.853	60
4	3 p. m.			658.5	19.8		25.869	64
5	9 a. m.			657	16		25.760	62
5	12 m.			655	18.5		25.684	68
5	3 p. m.			654.4	21		25.704	71
6	6 a. m.			648.4	15		25.458	47
6	9 a. m.			654.4	21		25.634	57
6	12 m.			653.9	16.1		25.649	59
6	3 p. m.			649				42
7	Sunrise			648.1	11		25.456	42
7	12 m.			649.2	11.5		25.472	47
7	3 p. m.			646	12		25.361	51
7	Sundown			654	13.7		25.723	44
8	Sunrise			648.5	11.6		25.511	35
8	9 a. m.			651.2	9.5		25.586	41
8	Noon			648.7	10		25.456	48
8	3 p. m.			648.8	12.7		25.464	49
8	Sundown			653.4	16		25.688	48
9	Sunrise			658.8	15.5		25.901	34
9	9 a. m.			651.3	9.4		25.590	46
9	Noon			651.5	10		25.567	56
9	3 p. m.			647.1	11.8		25.460	52
9	Sundown			647	12.7		25.452	51
10	Sunrise			647.4	9		25.440	39
10	9 a. m.			647.5	9.5		25.413	37
10	Noon			649	11		25.483	44
10	3 p. m.			649.1	15		25.522	52
10	Sundown			649.6	14.7		25.542	49
11	Sunrise			649.8	9.5		25.523	41
11	9 a. m.			649.6	10		25.492	54
11	Noon			649.9	12.5		25.507	56
11	3 p. m.			647.8	14		25.475	57
12	9 a. m.			648.2	9		25.445	57
12	Noon			650.8	10		25.554	49
12	3 p. m.			651.8	10.5		25.644	45
12	Sundown			646.8	10.6		25.452	47
13	9 a. m.			655.1	9		25.712	42
13	Noon			643	8.5		25.255	51
13	3 p. m.			654.5	14.7		25.771	52
13	Sundown			656.4	13		25.743	49
14	9 a. m.			656.4	11		25.756	49
14	Noon			655.6	13		25.731	56
14	3 p. m.			656.4	16		25.806	59
14	Sundown			654.8	16		25.739	57
15	9 a. m.			655.7	12		25.724	54
15	Noon			652.8	15.5		25.609	64
15	3 p. m.			653.5	18		25.680	66
15	Sundown			659.1	17.7		25.904	63
16	9 a. m.			652.8	14		25.598	54
16	Noon			651.9	17.7		25.562	69
16	3 p. m.			650.7	20		25.562	71

Light clouds.
 Do.
 Wind from southwest; clear.
 Do. do.
 Light clouds.
 Light northwest wind.
 Thermometer at sunrise 21°.
 Thermometer at sunrise 42°.
 Wind north.
 Clear; thermometer at sunrise 35°.
 Wind northwest.
 Light clouds.
 Thermometer at sunrise 40°.
 Clear; wind south.
 Rained until 11 a. m.
 Wind northwest; clear.
 Clear; wind southeast.
 Wind northwest.
 Cloudy.
 Thermometer at sunrise 40°.
 Hail and rain; wind north.
 Do. do.
 Rain; wind north.
 Thermometer at sunrise 38°.
 Clear; wind northwest.
 Thermometer at sunrise 24°.
 Clear; wind northwest.
 Thermometer at sunrise 50°; clear; wind northwest.
 Therm. at sunrise 49°; wind west; unsteady all day.
 Light clouds.

Meteorological observations at Great Salt Lake City—Continued.

Locality.	Date.	Hour.	Barometer, No. 496.	Attached thermometer, (C.)	Barometer, No. 551.	Attached thermometer, (C.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Air temperature, (F.)	Remarks.
Great Salt Lake City.....	1854.						<i>Inches.</i>	<i>Inches.</i>		
	April 16	Sundown.....			650.2	20.4		25.542	69	
	17	9 a. m.....			650.1	15		25.492	60	Thermometer at sunrise 50°; wind south; clear.
	17	Noon.....			650.6	20		25.503	72	
	17	3 p. m.....			650.4	22.5		25.542	74	
	17	Sundown.....			649.4	20.8		25.511	69	Wind northeast.
	18	9 a. m.....			649	17		25.441	67	Therm. at sunrise 54°; light clouds, wind southeast.
	18	Noon.....			648.7	23		25.420	75	Southerly wind.
	18	3 p. m.....			646.8	25.5		25.393	79	Light clouds.
	18	6 p. m.....			646.2	20.7		25.385	69	Cloudy.
	19	9 a. m.....			647.7	15		25.397	48	Rain during the night; thermometer at sunrise 51°.
	19	Noon.....			648	15		25.424	52	At 7 a. m. rain, wind west; at 9 a. m., south wind; noon clear.
	19	3 p. m.....			647.1	19.8		25.428	57	Wind southeast.
	19	Sundown.....			647.5	17		25.452	54	Light clouds.
	20	Sunrise.....			646.7	13.7		25.399	47	Thermometer at sunrise 47°; rain until 7 a. m.
	20	9 a. m.....			646.9	14		25.374	50	Rain from 10 to 12.
	20	Noon.....			647.1	14.8		25.393	46	Clear.
	20	3 p. m.....			647.6	18.5		25.448	59	Thunder; cloudy in the southwest.
	20	6.15 p. m.....			646.1	16		25.404	55	
	22	Sunrise.....			644	10		25.306	42	Northwest wind; heavy clouds in the east.
	22	9 a. m.....			643.9	11.5		25.296	47	Cloudy.
	22	Noon.....			643.9	12.7		25.292	49	Commenced to rain at 10 a. m.
	22	3 p. m.....			643.6	11		25.286	43	Rain.
	22	6.30 p. m.....			644.2	11		25.310	44	Rain ceased at 4½ p. m.; wind northeast.
	23	Sunrise.....			642.8	9		25.263	41	Cloudy in the east; heavy rain during the night.
	23	9 a. m.....			642.5	10.5		25.246	50	Northwest wind and flying clouds.
	23	Noon.....			642	11.5		25.222	57	Do. do.
	23	3 p. m.....			640.4	14.5		25.147	56	High wind.
	23	Sundown.....	642	13	640.9	13	25.216	25.173	64	Rain.
	24	Sunrise.....	643.1	11	642.7	10.5	25.266	25.254	44	Heavy rain during the night.
	24	9 a. m.....	647.7	11	645.9	11.5	25.447	25.375	46	Rain; wind northwest.
	24	Noon.....	645.2	12	646.1	12	25.345	25.380	49	Heavy clouds.
24	3 p. m.....	645.3	14	647.8	13.5	25.341	25.441	54	Northeast wind; clearing up.	
24	Sundown.....	645.4	15.4	646.7	15	25.339	25.391	53	Northeast wind; clear.	
25	Sunrise.....	644.8	10	644.6	10.5	25.387	25.326	41	Wind south.	
25	9 a. m.....	643.5	18	644.1	12.8	25.275	25.300	57	High wind from the south, with heavy clouds.	

	25	Noon.....	644.8	13.4	645.5	13	25.323	25.354	56	Do.	do.	do.
	25	3 p. m.....	643.6	16	644.3	15.6	25.266	25.295	59	Southerly wind; light clouds.		
	25	4.30 p. m....	644.1	14.7	644.8	14.0	25.291	25.322	53	Heavy squall of wind from southwest, with rain.		
	25	6.20 p. m....	644.6	10.5	645.1	10	25.307	25.249	43	Wind changed to northwest; cold rain.		
	26	Sunrise.....	648.8	9.5	649.2	10	25.507	25.510	37	Rain all night; snow in the eastern mountains.		
	26	9 a. m.....	649.9	10	650.7	10.5	25.538	25.567	51	Wind south, with heavy clouds.		
	26	Noon.....	650.9	12.6	651.4	12.8	25.567	25.586	51	Wind northwest; heavy squall of rain; duration 20 minutes.		
	26	3 p. m.....	651.6	14.9	651.7	14.9	25.585	25.589	52	Wind northwest; heavy clouds.		
	26	Sundown....	652.7	14.5	651.7	14.6	25.630	25.591	49	Do. light clouds.		
	27	Sunrise.....	652.9	9	651.5	9.5	25.659	25.603	36	Wind northeast; light clouds; frost during the night.		
	27	9 a. m.....	653.2	12	653.7	12	25.660	25.680	50	Wind southwest; clear.		
	27	Noon.....	652.4	14.9	653.5	14	25.615	25.672	55	Wind northwest; clear.		
	27	3 p. m.....	652.4	16	653.4	15.8	25.612	25.652	60	Wind northwest; cloudy.		
	27	6.30 p. m....	653	14	652.5	14.4	25.644	25.622	54	Wind west; cloudy.		
	28	Sunrise.....	650.9	10.5	652.5	11	25.575	26.636	43	Wind northeast; light clouds.		
	28	9 a. m.....	652.2	14.9	651.9	14	25.609	25.601	61	Wind northwest; cloudy.		
	28	Noon.....	651.7	17	651.4	16.4	25.581	25.571	68	Do do.		
	28	3 p. m.....	650.7	19.2	650.6	18.8	25.531	25.530	68	Wind northwest; hazy.		
	28	Sundown....	650.6	17	649.3	17	25.537	25.486	61	Wind west; hazy.		
	29	Sunrise.....	648.8	14.1	648	15	25.479	25.442	55	Wind northeast; cloudy in the west.		
	29	9 a. m.....	648.4	17.5	648.6	17	25.448	25.458	69	Wind northeast; hazy.		
	29	Noon.....	647.9	20	646.7	19.5	25.418	25.373	78	Wind southeast; light clouds.		
	29	3 p. m.....	645.6	20.3	646.7	19.8	25.327	25.254	73	Wind southeast; cloudy.		
	29	Sundown....	644.5	17	642.8	17.8	25.297	25.227	65	Wind northeast; heavy clouds.		
	30	Sunrise.....	642.4	16	640.5	16	25.219	25.145	59	Do do.		
	30	9 a. m.....	643.3	17.2	642.9	17	25.249	25.235	62.5	Wind southeast; heavy clouds.		
	30	Noon.....	643.2	18.9	644.1	18.5	25.200	25.276	67	Wind south; heavy clouds in the west.		
	30	3 p. m.....	642.5	19.5	645.4	19	25.206	25.325	65	Wind southwest; heavy clouds.		
	30	Sundown....	643.9	17	644.8	17	25.273	25.309	59	Wind northwest; heavy clouds.		
May	1	Sunrise.....	644.7	15.4	646.6	15	25.311	25.387	47	Wind southeast; heavy clouds.		
	1	9.30 a. m....	645.5	16	647	16	25.341	25.400	59	Wind northwest; heavy clouds.		
	1	Noon.....	646.1	19	648.6	18.5	25.352	25.453	66	Wind southeast; heavy clouds.		
	1	3 p. m.....	645.5	18	648.3	18	25.332	25.442	62.5	Wind northwest; heavy clouds.		
	1	6.30 p. m....	646.5	16.8	647.9	17	25.377	25.431	53	Wind northeast; cloudy.		
	2	Sunrise.....	647.3	15	647.9	14.6	25.415	25.441	47	Cloudy; westerly wind.		
	2	9 a. m.....	647.3	17	649.6	16.1	25.408	25.501	62	Cloudy; wind northwest.		
	2	Noon.....	647.2	19	650.6	18.9	25.396	25.490	68	Do do.		
	2	3 p. m.....	647.2	21	649.7	20.9	25.388	25.520	68.5	Light clouds in northwest.		
	2	Sundown....	648	19.3	649.1	19	25.426	25.471	61.5	Clear; wind northwest.		
	3	Sunrise.....	648	15.9	649.3	15.9	25.439	25.490	52	Clear; easterly wind.		
	3	9 a. m.....	648.1	17	649.8	16.1	25.455	25.510	62	Clear; westerly wind.		
	3	Noon.....	647.3	19	650	18.9	25.400	25.506	67	Clear; northwest wind.		
	3	3 p. m.....	647.5	23.2	649.4	22.5	25.390	25.467	71	Do do.		
	3	6.30 p. m....	648.1	21	649.1	21	25.422	25.462	65.5	Do do.		
	4	Sunrise.....	648.7	16.5	649.9	16.8	25.465	25.510	50	Clear; easterly wind.		
	4	9 a. m.....	648.5	18.9	650	18.5	25.447	25.508	65	Clear; westerly wind.		
	4	Noon.....	648.6	21	649.6	20.3	25.442	25.484	71	Do.		
	4	3 p. m.....	648.2	23.5	648.6	23	25.416	25.446	74	Do.		
	4	Sundown....	648.5	22.3	647.6	22	25.433	25.398	68.5	Clear; north wind.		

The altitude of the place of observation in Great Salt Lake City, as deduced from the mean of all the foregoing observations, is 4,351 feet above the sea.

Summary of meteorological observations at Great Salt City in 1853 and 1854, in mean results at each observed hour for the several months; barometric readings corrected for temperature.

	Barometer No. 496.				Barometer No. 551.				Mean of both barometers.	Air temperature.				Remarks.
	9 a. m.	12 m.	3 p. m.	Month.	9 a. m.	12 m.	3 p. m.	Month.		9 a. m.	12 m.	3 p. m.	Month.	
December, 1853.	25.673	25.664	25.665	25.667	25.672	25.678	25.656	25.669	25,668	36.57	42.90	45.10	41.52	30 observations at 9 a. m.; 22 at 12 m.; 19 at 3 p. m.
January, 1854 ..	25.624	25.592	25.558	25.591	25.613	25.584	25.547	25.581	25,586	24.20	28.35	24.43	25.66	26 observations at 9 a. m.; 21 at 12 m.; 17 at 3 p. m.
February, 1854..	25.593	25.585	25.570	25.583	25.592	25.581	25.558	25.577	25,580	35.46	41.12	39.60	38.73	28 observations at 9 a. m.; 26 at 12 m.; 21 at 3 p. m.
March, 1854.....	25.543	25.542	25.535	25.540	25.543	25.542	25.535	25.540	25,540	40.50	50.80	50.60	47.30	23 observations at 9 a. m.; 22 at 12 m.; 11 at 3 p. m.
April, 1854.....	25.501	25.460	25.379	25.447	25.574	25.545	25.531	25.550	25,550	52.40	58	59.80	56.73	Observations of barometer 551, and of temperature full for the month. Barometer 496 observed nine days only.
May, 1854.....	25.453	25.422	25.351	25.409	25.519	25.508	25.439	25.489	25,449	62	68	68.80	66.30	Observations for the first four days only.

Barometric means for the months from all the observations, including those at irregular hours, and corrected in detail for horary variation of pressure.

	Barometer No. 496.	Barometer No. 551.	Mean of both barometers.	Remarks.
December, 1853.....	25.651	25.651	25.651	The mean of the last column is used for determination of the altitude of Salt Lake City, 25.573, with a mean air temperature, for this period of five months, of 45° F.
January, 1854.....	25.581	25.577	25.579	
February, 1854.....	25.569	25.565	25.567	
March, 1854.....	25.513	25.520	25.517	
April, 1854.....		25.552	25.552	

Meteorological observations and table of altitudes and distances from Great Salt Lake City to Green River—April, 1854.

Station.	Date.	Hour.	Distance from Great Salt Lake City.	Barometric reading. (Bar. No. 496.)	Attached thermometer, (C.)	Air thermometer.	Corrected barometer.	Barometric means.	Altitude above the sea.	
Session Settlement.....	1854. April 4	5 p. m.	10.50	661.4	18	65	26.011	2183.2	
		Sunset		661	13	56	25.991			
		Sunrise....		658.8	7	45	25.903			
		6 a. m.		658.4	8.5	49	25.879			
On hill, en route.....	5	7.15 a. m.		658.9	11	53	25.867	25.930		
		1 p. m.		645	26.5	76	25.283			
Weber river, north side....	5	1.45 p. m.	29	653.6	25	76	25.634	4430.1	
Camp 2, Weber river.....	5	6 p. m.	36.80	643.4	15	60	25.302	4842	
		6.30 p. m.		643.5	12	54	25.313			
On march, Sheep rock....	6	Sunrise....		638.2	0.2	35	25.115			
		6.30 a. m.		638	4.5	40	25.086			
		7.15 a. m.		638.1	7.5	45	25.069	25.177		
		6.30 a. m.		636.1	17.5	64	24.953		5189.5
		4.30 p. m.	57.50	625.3	8	48	24.634		5419.1
		6.10 a. m.		625	2.5	36	24.585			
Camp 3, Dog creek.....	7	7 a. m.		625	2.5	36	24.575		24.590	
		7.30 a. m.		624.9	2.5	36	24.566			
		9.30 a. m.		624.3	7	49	24.507			
		3.30 p. m.	64	616	6.5	47	24.262		5692.1
		4 p. m.		615.9	5	42	24.274			
		5 p. m.		615.9	3	39	24.287			
		6 p. m.		615.3	2	36	24.247			
		7 p. m.		615.3	1	33	24.241			
		5 a. m.		618.3	2.5	28	24.355			
		5.30 a. m.		618.3	2.5	27	24.332			
On hill, en route.....	8	6 a. m.		619.6	1	29	24.483		24.308	
		7 a. m.		619.8	3	32	24.370			
		12.30 a. m.	77.25	596.6	3	37	23.450		6562.1
		4.40 p. m.	87.40	585.7	0	32	23.119			
		5 p. m.		585.7	0	33	23.121			
		6 p. m.		585.5	4	33	23.101			
		6.30 p. m.		585.2	4.5	21	23.096			
		Sunrise....		583.2	9.5	10	22.991			
Camp 5, near divide of the waters of Bear and Weber river, side of mountain.	9	5.30 a. m.		582.8	9.5	11	22.988		23.052	
		6 a. m.		582.8	9.5	13	22.986			
		7 a. m.		584.3	4	20	23.012			
		9 a. m.		573.3	7	37	22.519		7749.7
		11 a. m.	90.00	577.5	4.5	40	22.662		7490.8
		1 p. m.	96.20	575	5	41	22.614		7551.7
		4 p. m.	104.40	576.1	5	40	22.723		7494.5
		5 p. m.		575.2	0	32	22.688			
		6.30 p. m.		574.8	2	28	22.663			
		5.30 a. m.		572.9	3	25	22.556			
Bear river valley.....	10	6 a. m.		573.3	1.5	29	22.572			
		6.30 a. m.		572.4	1.5	37	22.507			
		7 a. m.		572.1	3.5	42	22.500	22.601		

Meteorological observations, &c.—Continued.

Station.	Date.	Hour.	Distance from Great Salt Lake City.	Barometric reading. (Bar. No. 496.)	Attached thermometer, (C.)	Air thermometer.	Corrected barometer.	Barometric means.	Altitude above the sea.	
	1854.									
Divide of Bear and Muddy Camp 7, Muddy river.....	April 10	10.30 a. m.	109.60	561.2	3	37	22.034	.....	8133.3
	10	2.30 p. m.	115.60	570.7	4	36	22.476	.....	7779.1
	10	3.30 p. m.	.....	569.8	3	34	22.459	.....	.....
	10	4.30 p. m.	.....	569.3	1.5	33	22.457	.....	.....
	10	5 p. m.	.....	569.3	1.5	33	22.460	.....	.....
	10	6 p. m.	.....	568.3	0.5	32	22.445	.....	.....
	11	5 a. m.	.....	570.3	2.5	26	22.464	.....	.....
	11	5.30 a. m.	.....	570.3	2.5	27	22.461	.....	.....
	11	6 a. m.	570	1.5	29	22.435	22.445	6873.9
	11	8 a. m.	120.60	559.4	5.5	41	21.978	.....	.....
	Divide of Muddy and Black's forks.									
Black's fork.....	11	9.40 a. m.	124.60	570.9	8	46	22.406	.....	7880.5
Smith's fork, camp 8.....	11	3.30 p. m.	.....	580.9	7.5	49	22.877	.....	.....
	11	4 p. m.	.....	580.9	7	47	22.885	.....	.....
	11	4.30 p. m.	.....	580.9	7	47	22.887	.....	.....
	11	5 p. m.	.....	580.4	5.5	43	22.885	.....	.....
	12	5.45 a. m.	.....	580.5	0.5	32	22.850	.....	.....
	12	6.45 a. m.	.....	580.5	0	32	22.839	22.870	.....
Cottonwood.....	12	1 p. m.	.....	584.2	8	51	22.965	.....	7263.9
Camp 9, Henry's fork.....	12	7 p. m.	156.30	587.6	0.5	34	23.145	.....	7136.6
	13	5.30 a. m.	.....	585.8	0.4	24	23.065	.....	.....
	13	6 a. m.	.....	585.8	0.3	27	23.061	.....	.....
	13	6.30 p. m.	.....	587.3	2	34	23.136	.....	.....
	14	5.30 a. m.	.....	587.8	0.5	20	23.142	23.110	.....
Mountain peak, overlooking country; (end of eastern course.)	13	11 a. m.	169.50	571.9	7	34	23.435	.....	8067.8
Dry Timber creek; (return trip.)	13	1.30 p. m.	163.10	594.4	13	50	23.355	.....	7024.7
			Dist. Pm Green river.							
Top of pass, between Smith's & Henry's forks.	April 14	8 a. m.	31.50	582.9	6	40	22.890	.....	7529.6
Camp 10, Smith's fork.....	14	5.30 p. m.	54	594.4	13	50	23.395	.....	6970.8
	14	6.30 p. m.	.....	594.1	7.5	44	23.385	.....	.....
	14	6.46 p. m.	.....	593.9	5.5	41	23.392	.....	.....
	15	6.40 a. m.	.....	595.7	7.5	35	23.410	.....	.....
	15	7 a. m.	.....	595.9	14	39	23.390	23.392	.....
	15	11 a. m.	65	584.8	15	56	22.915	.....	7446.9
Divide of Muddy and Black's fork.										
Camp 11, Muddy creek.....	15	1.05 p. m.	69.75	596.8	22.5	76	23.415	.....	6964.2
	15	3 p. m.	.....	596.8	22	69	23.450	.....	.....
	15	5 p. m.	.....	595.4	21	61	23.417	.....	.....
	16	Sunrise.....	.....	592.6	5	22	23.328	.....	.....
	16	6.30 a. m.	.....	593.3	7	43	23.317	23.385	.....
Camp 12, Bear river.....	16	3 p. m.	94.25	586.5	17	66	23.062	23.444	7195.6	
	16	4.30 p. m.	.....	586.3	16.5	63	23.067	.....	.....
	16	5.30 p. m.	.....	585.7	14	58	23.050	.....	.....
	16	6.30 p. m.	.....	584.7	5.5	42	23.025	.....	.....
	17	5.30 a. m.	.....	585.1	0	31	23.030	.....	.....
	17	5.58 a. m.	.....	585.2	2.5	36	23.025	23.043	.....
Near upper camp, on White Clay creek.	17	10 a. m.	105.25	592.3	21	69	23.195	.....	7009.2
Camp 13, White Clay creek.	17	1.30 p. m.	114.45	601.2	22.5	75	23.588	.....	6534.6
	17	3.30 p. m.	.....	601.7	26	73	23.632	.....	.....
	17	5 p. m.	.....	601	22.5	69	23.630	.....	.....
	18	5.30 a. m.	.....	598.3	2.5	35	23.542	.....	.....
	18	6.25 a. m.	.....	598.2	2.5	36	23.531	.....	.....
	18	6.45 a. m.	.....	598.9	5	39	23.544	23.578	.....
First summit.....	18	9 a. m.	117.95	585.5	18.5	65	23.940	.....	7270
High summit.....	18	2 p. m.	126.70	556	17	60	21.846	.....	8618.9
Camp 14, side of mountain.	18	3 p. m.	.....	560.2	17	60	22.027	.....	8335.4
	18	3.30 p. m.	.....	560.1	16.5	59	22.027	.....	.....
	18	4 p. m.	.....	560	13.5	56	22.045	.....	.....
	18	6.30 p. m.	.....	559.4	9	47	22.015	.....	.....
	19	Sunrise.....	.....	556.9	2	36	21.915	.....	.....
	19	7 a. m.	.....	556.6	2	37	21.895	21.987	.....
Camp 15, Weber river.....	19	5 p. m.	145.95	616.1	13.5	59	24.259	.....	5672.1
	19	5.30 p. m.	.....	616.3	13.5	57	24.257	.....	.....
	19	6 p. m.	.....	616.3	13	54	24.286	24.267	.....

Meteorological observations, &c.—Continued.

Station.	Date.	Hour.	Distance from Green river.	Barometric readings. (Bar. No. 496.)	Attached thermometer, (C.)	Air thermometer.	Corrected barometer.	Barometric means.	Altitude above the sea.
1854.									
Camp 15, Weber river.....	April 20	Sunrise.....		614.8	5	42	24.183		
		6.30 a. m.....		614.9	7	43	24.168		
Weber river at Kamas prairie Divide on Kamas prairie....	20	7.17 a. m.....		614.3	6.5	43	24.139		
		11.30 a. m.....	157.95	602.1	9	57	23.620		6319.6
Bank of Timpanogos river..	20	2 p. m.....		598	8.5	46	23.525		6505
		3 p. m.....	166.65	603.9	12	52	23.759		6242.8
Camp 16, near river.....	20	3.10 p. m.....		603.8	11.5	51	23.761	23.760	
		5 p. m.....		591	7	45	23.290		6775.6
	20	6 p. m.....		591	5	42	23.279		
		6 a. m.....		589.9	6.5	42	23.193		
Timpanogos river.....	21	6.35 a. m.....		590.1	6.5	43	23.195		
		7.15 a. m.....		590.3	3.5	39	23.207	23.233	
Head of long plain.....	21	8 a. m.....	172.35	607.4	9	53	23.841		6055.7
Foot of hill before passing over a spur.....	21	11 a. m.....	177.75	615.4	11.5	52	24.130		5739
River bank.....	21	12 m.....	182.75	620.4	14.5	64	24.341		5516.9
Head of cañon.....	21	12.40 p. m.....	183.45	620.8	16.5	65	24.362		5494
Still in cañon.....	21	2 p. m.....	188.15	621.7	15	60	24.433		5484.5
Camp 17, Timpanogos river.	21	3 p. m.....	191.15	623.2	14	59	24.511		5390.3
		6.30 p. m.....	199.15	627.3	13	55	24.671		5056.9
	21	7 p. m.....		627	11	53	24.662		
		5.30 a. m.....		628	3	37	24.711		
Camp 107, American fork ..	Nov. 5	6 a. m.....		628	5	42	24.698		
		6.30 a. m.....		628	7	46	24.683	24.685	
	5	3 p. m.....	213.35	647.5	19	68	25.448		4596.2
		6 p. m.....		646	12	52	25.416		
Great Salt Lake City.....	April 22	9 p. m.....		646	9	48	25.398		
		6 a. m.....		645.7	6	42	25.391	25.411	

Data for profile from Smith's Fork, Green River valley, to that of Great Salt Lake, via the Timpanogos river.

Station.	Date.	Hour.	Intermediate distances	Distance from Smith's Fork.	Altitudes above the sea.
1854.					
Smith's Fork, near Fort Bridger.....	April. 11, 19	Camp.....			7254.4
Black's Fork.....	April. 11	9 40 a. m.....		9	7880.3
Divide of Black and Muddy.....	April. 11	8 a. m.....	12.25	21.25	8373.7
Divide of Bear and Muddy.....	April. 10	10.30 a. m.....	6.10	27.35	8133.3
Divide of Bear and White Clay creek.....	April. 9	11 a. m.....	12.90	40.25	7490.8
White Clay creek.....	April. 17	10 a. m.....	11.50	51.75	7009
White Clay creek, Camp 13.....	April. 17, 18	Camp.....	8.75	60.50	6534.4
White Clay creek, Camp 4.....	April. 7, 8	Camp.....	10.00	70.50	5692.1
Weber river, Camp 15.....	April. 19, 20	Camp.....	5.25	75.75	5671.9
Kamas Prairie.....	April. 20	11.30 a. m.....	12	87.75	6319.4
Timpanogos river.....	April. 20	3 p. m.....	8.70	96.45	6242.6
	April. 21	8 a. m.....	5.70	102.15	6055.5
Timpanogos river, head of Round Prairie.....	April. 21	11 a. m.....	5.20	107.35	5738.8
Timpanogos river.....	April. 21	12 m.....	5	112.35	5516.7
Timpanogos river, foot of Round Prairie.....	April. 21	12.40 p. m.....	0.70	113.05	5493.8
Timpanogos river, head of Cañon.....	April. 21	2 p. m.....	4.70	117.75	5484.3
	April. 21	3 p. m.....	3	120.75	5394.1
Camp near foot of Cañon.....	April. 21	Camp.....	8	128.75	5076.7
American Fork.....	Nov. 6, 1853		14.20	142.95	4796
1854.					
Camp west side of the valley of the Jordan, on the base of the mountain.	May.....	6		39.60	182.55
					4657

Data for profile via Weber river, branching from White Clay creek, Camp 4, the section east of that point being in common.

Station.	Date.	Hour.	Inter- mediate distances.	Distance from Smith's Fork.	Altitudes above the sea.
	1854.				
White Clay creek, Camp 4.....	April.....7	Camp.....	.....	70.50	5692.1
Dry creek, Camp 3.....	April.....8	Camp.....	16.50	87.00	5419.1
Sheep rock, Weber river.....	April.....6	12.15 p. m.	8.50	95.50	5189.5
Ben Simons' creek, Camp 2.....	April.....5	Camp.....	12.20	107.70	4842
Weber river, below the mountain.....	April.....5	1.45 p. m..	7.80	115.50	4424.1

Meteorological observations and tables of altitudes and distances from Great Salt Lake, Utah Territory, to the valley of the Sacramento river, California—1854.

NOTE.—It is to be noted that in the entries in the column headed "barometric means" the upper entry is for barometer No. 496; the lower for barometer No. 551. The altitudes are entered opposite the head of the means from which they are deduced.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
			<i>Miles.</i>	<i>Miles.</i>	<i>Mm.</i>		<i>Mm.</i>			<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>	
Left Council House, Great Salt Lake City, at 5 p. m. Jourdan ferry, Camp No. 1. Camp 2, good grass, brackish water.	May 5	3 p. m.	.....	.....	642.3	16.2	644	16.1	65	25.255	25.322	.....	4351	Slight fall of rain; wind southwest.
	5	.....	9.45	2.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	6	6 p. m.	12.98	15.43	643.2	14.9	643.2	14.7	59	25.294	25.294	.....	4657	Dark cl'ds; wind southwest.
Left camp 2 at 6.50 a. m. Camp 3, west side of Tuilla valley.	7	Sunrise	.....	.....	645.2	3.9	643.2	3.9	39	25.383	25.305	25.338 25.299	.....	Cloudy; wind southwest; snow for two hours.
	7	Sundown	20.59	36.02	645	5	645	5.5	41	25.396	25.393	25.419	4487.5	Squally; wind southwest.
Camp 4, opposite Stansbury's island, Great Salt Lake.	8	Sunrise	.....	.....	646.6	3	647.1	3	34	25.443	25.463	25.428	.....	Heavy cl'ds; wind southwest.
	8	3 p. m.	13.70	49.72	654.5	15.5	653	15.5	62	25.731	25.676	.....	4238	Light clouds; wind northwest.
Camp 5, west side of Mountain creek, in Lone Rock valley.	8	Sundown	.....	.....	654.8	10	652.3	9.7	48	25.757	25.758	25.730	.....	Heavy clouds in the east.
	9	Sunrise	.....	.....	653.6	6	651.8	6	38	25.703	25.632	25.688	.....	Heavy clouds in south; wind southeast.
Dry creek, coming from the west.	9	4 p. m.	21.45	71.17	648.4	17.9	647.6	17.9	68	25.498	25.467	.....	4444.3	Light clouds; wind northwest.
	9	Sundown	.....	.....	648.4	10.9	649.5	10.5	49	25.501	25.544	25.501	.....	Light clouds in the east; wind south.
Entrance into Cedar Mountain Pass.	10	Sunrise	.....	.....	648.1	1.9	648.6	2	33	25.506	25.522	25.511	.....	Heavy clouds; wind east.
	10	3 p. m.	10.26	81.43	627.9	17	625.3	17.9	59	24.684	24.578	.....	5469.5	Heavy cl'ds; wind southwest.
Camp 6, in pass	10	4 p. m.	1.54	82.97	626.8	19	624.7	19.5	64	24.648	24.561	.....	5528.4	Light clouds; wind east.
	10	5 p. m.	.....	.....	626	16	624.1	19	61	24.633	24.543	.....	5576.5	Heavy cl'ds; wind southwest.
	10	6 p. m.	3.24	86.21	626.1	16	623.4	16	57	24.617	24.511	24.530	5580.5	Light clouds; wind north.

Meteorological observations and tables of altitudes and distances—Continued.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		Miles.	Miles.	Mm.		Mm.			Inches.	Inches.	Inches.	Feet.	
Camp 6, in pass.....	May 11	Sunrise...	.....	.....	621.3	4	621.5	4	36	24.443	24.451	24.481	.....	Heavy cl'ds; wind south-west.
Summit of Cedar Mountain Pass.	11	9.30 a. m.	2.15	88.36	607.3	11	610.2	10.5	60	23.822	23.936	23.794	6364	Heavy cl'ds; wind north-east.
First descent of Mountain Pass.	11	10.30 a. m. . . . .	.....	.....	606.5	16	609.3	15	59	23.766	23.887	23.911	.....	Light clouds.
	11	11.30 a. m. . . . .	.23	88.59	613.3	18.9	614.1	17.3	69	24.031	24.071	24.032	6188	
	11	12.30 p. m. . . . .	.....	.....	612.4	16.5	611.6	16.3	60	24.033	24.001	24.036	.....
Camp 7, west side of Cedar Mountain Pass.	11	6.20 p. m.	1.30	89.89	624.5	12	621.7	11.9	52	24.567	24.457	.....	5575	Wind northeast; signs of rain.
	11	7.10 p. m. . . . .	.....	.....	623.9	8.5	621	8.5	44	24.546	24.436	24.547	.....	Rain; wind southeast.
	12	Sunrise.....	.....	.....	623.7	5.6	622.8	5.3	39	24.530	24.498	24.463	.....	Heavy clouds in east; wind north.
Foot of mountain.....	12	8 a. m.	2.43	92.32	639.5	9.5	639.9	9	30	25.108	25.128	.....	4775.5	Heavy clouds in south; calm.
Camp 8, at Granite mountain*.	12	6.40 p. m.	17.33	109.65	645.4	15.5	644.6	15	59	25.370	25.338	.....	4666.4	Clear; strong southwest wind.
Camp 9, eastern base of Goshoot mountain, at fine spring; grass, but no wood. (Not in line of profile).....	13	7.20 p. m.	25.32	134.97	646.5	10.5	642.8	10	52	25.425	25.283	.....	4659.5	Cloudy; wind northeast.
	14	6 a. m. ....	.....	.....	646	6.5	645.1	6	41	25.399	25.367	.....	.....	Do do.
	14	12 p. m. ....	.....	.....	645.2	16.9	643.7	17	69	25.310	25.247	.....	.....	Clear; wind southwest.
	14	3 p. m. ....	.....	.....	646.1	18	643.6	18.5	69.5	25.393	25.294	25.390	.....	Squally; wind southwest.
	14	6.50 p. m. . . . .	.....	.....	646.5	12.5	645.4	12	54	25.424	25.381	25.314	.....	Equally; wind northeast.
	15	Sunrise.....	.....	.....	647.9	7.5	648.1	7	41	25.476	25.488	.....	.....	Cl'dy; snow in the night.
Summit of mountain in pass, (not in profile.)	15	2.30 p. m.	13.10	148.07	.....	.....	609.5	14	59	.....	23.961	.....	6233.2	Cloudy; in the northwest squally.
Camp 10, Pangwich or Fish creek.	15	Sundown..	5.53	153.60	634.3	14.2	632.1	14.5	56	24.930	24.843	.....	5076.5	Clear; wind northwest.
Exploring the Goshoot mountain for a pass. (Not in profile line.)	15	9.45 a. m. . . . .	.....	.....	614.2	9.3	.....	.....	49	24.193	.....	.....	5903.5	
		11.20 a. m. . . . .	.....	.....	605.3	10.9	.....	.....	57	23.743	.....	.....	6473.1	
		1 p. m. ....	.....	.....	618.4	13.6	.....	.....	58	24.287	.....	.....	5852.3	
Fish creek, near Desert.....	15	3.15 p. m. . . . .	.....	.....	635.8	16.6	.....	.....	62	24.999	.....	.....	5073.2	From camp at Granite Mt., 39.8 miles across the Desert, and 16.5 miles to camp on Fish creek.

	16	Sunrise			635	3	633.9	3	39	24.988	24.944			Clear; wind east.
Summit of mountain spur....	16	5 p. m.	14.13	167.73	611.5	13.5	609.3	13.7	59	24.074	23.987			Cloudy; wind northeast.
Camp 11, in mountain pass....	16	10 p. m.	7.47		611.1	12	610.5	11.9	39	23.962	23.939		6154.1	Rain.
Camp 11, in mountain pass....	16	10 p. m.	7.47	175.19	611.1	12	610.5	11.9	39	23.962	23.939		23.996	6073.1
	17	Sunrise			610.9	5	609.7	5.7	36	24.031	23.980		23.959	Cloudy; wind northwest.
On ascent to divide between	17	8.5 a. m.	1.82	177.01	605	13	605.3	13.5	59	23.738	23.750			Clear; wind northwest.
1st and 2d creeks of the pass.	17	9.5 a. m.	1.12	178.13	602.8	16.3	602.4	16.9	67	23.630	23.614			Do do.
Ascending 2d creek.....	17	10.5 a. m.	1.25	179.38	602.6	16.9	602.7	17	70	23.612	23.619			Do do.
Summit of pass.....	17	11.5 a. m.	1.93	181.31	695.7	16.9	596.2	17	64	23.335	23.355			6992.2
														Cloudy in the south;
Camp 12, good grass, wood, and	17	12.20 p. m.	1.42	182.73	600.4	13.6	601.4	13.6	57	23.586	23.606			wind northeast.
water.													6550.3	Thunder; wind south-
	17	Sundown			600.6	11.9	599.8	12.3	54	23.619	23.575		23.628	east.
	18	Sunrise			602.4	4	601.4	4	32	23.700	23.661		23.614	Do do.
Foot of mountain.....	18	9 a. m.	8.38	191.11	614.6	14.9	616.6	15	60	24.102	24.177			Clear; wind southeast.
In open valley, lake to the left.	18	12 m.	6.86	197.97	618.1	21.6	619.5	21.6	68	24.227	24.282			Clear and calm.
Camp 13, (spring) grass and	18	3 p. m.	3.22	201.19	617.7	22	618.2	22	69	24.263	24.282			Clear; wind northeast.
willows.	18	Sundown			617.8	20	616.9	22.6	60	24.260	24.217		24.267	Clear; wind northwest.
	19	Sunrise			617	2.9	616.2	3	32	24.279	24.247		24.248	Do do.
Base of hill.....	19	8 a. m.	3.30	204.49	616	21.5	615.2	21.9	71	24.140	24.108			Do do.
Top of deep ravine.....	19	10.30 a. m.	5.07	205.56	605.2	20.6	604.5	20.8	70	23.695	23.668			Clear; wind northeast.
Passing over a mountain spur,	19	12	1.65	211.21	604.8	25	603.6	24.8	73	23.692	23.645			Do do.
extending into valley.														Do do.
On a spur of mountain.....	19	1.15 p. m.	2.57	213.78	602.8	26.3	603.1	26.6	73	23.630	23.642			6710.1
	19	1.45 p. m.	.54	214.32	601.9	25.3	602.5	25.9	73	23.612	23.632			Do do.
Camp 14, good water and grass	19	3.10 p. m.	2.92	217.24	612.6	29.4	611.2	29	72	24.036	23.985			Do do.
	19	Sundown			611.8	24.9	610.3	22.9	66	23.976	23.925			6165.1
	20	Sunrise			613.4	7	612.7	7	39	24.121	24.094			Do do.
Camp 15, Franklin river, in	20	Sundown	21.52	238.76	614.5	21.5	613.3	21.7	71	24.136	24.075			Clear; wind southeast.
large meadows of grass,	21	Sunrise			615	5	613.6	5	37	24.192	24.137			Clear; wind west.
on plain east of Humboldt														Clear; wind east.
mountains.														
Camp 16, Franklin river, ex-	21	3.30 p. m.	14.84	253.60	614.5	24	612.9	24.5	75	24.136	24.073			6061.4
tensive grass fields.	21	7 p. m.			615.5	24.5	613.8	24.4	69	24.158	24.091		24.142	Clear; wind southwest.
	22	Sunrise			613.6	5.9	613.8	6	39	24.133	24.141		24.101	Do do.
Crossing a mountain stream...	22	10.30 a. m.	7.65	261.25	608.8	26.3	609.1	26.6	76	23.814	23.835			Clear; wind northeast.
Foot of pass, in Humboldt	22	1.30 p. m.		263.30	607.9	21.9	608.7	22	73	23.856	23.883			6506.3
mountains.														Clear; wind northwest.
Summit of pass.....	22	2 p. m.	2.89	264.14	604.5	21.9	605.3	22	73	23.732	23.760			6433.1
On stream, western slope of pass	22	3 p. m.	.80	264.94	606.3	24.9	607.5	25	78	23.806	23.849			Not in line of profile.
Camp 17, good grass and water.	22	7.30 p. m.		265.56	607.6	16	608.4	16.8	59	23.874	23.905			6579.1
Not in line of profile.	23	Sunrise			606.8	8.9	607.5	9	42	23.854	23.881			5516.4
Camp 18. Not in line of profile.	23	3.30 p. m.		264.85	604.4	14.5	605.8	14.9	63	23.761	23.800			6274.2
	23	7 p. m.			606.4	14.5	605.5	14.9	67	23.761	23.800			23.862
On creek, valley of Humboldt	23	12 m.			626.4	25.7			82	24.534				23.893
river†	23	1 p. m.	8.36	273.21	625.3	26.4			86	24.511				6520.2
	23	1.30 p. m.			623.4	23.2			75	24.458				Mean of last 3 observ's.
	23	2 p. m.			623	24			78	24.449			24.472	Do do.

* From this point the profile passes the Goshoot mountains by crossing the Desert to Fish creek, and thence ascending this stream to our camp of the 15th instant—the distances being 39.8 miles to the creek station, and 16.5 miles thence to camp.

† From this point (in the open valley of Humboldt river) the proposed line for a railroad descends Humboldt river to the vicinity of our camp of June 8. The line explored to the south of this is given in profile by itself, from data in this table from May 24 to June 8.

Meteorological observations and table of altitudes and distances—Continued.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		Miles.	Miles.	Mm.		Mm.			Inches.	Inches.	Inches.	Feet.	
Camp 18, east of Camp 17.....	May 24	Sunrise .....	.....	.....	602.6	9	604.3	9.3	44	23.688	23.755	.....	.....	Cl'dy; wind northwest.
On mountain spur, eastern base of Humboldt mountain.	24	10.20 a. m.	6.25	271	597.1	19	598.2	19.5	67	23.383	23.492	.....	6946.1	Clear and calm.
Crossing mountain stream.....	24	1 p. m.	4.50	275.50	605.9	22.9	606.2	23	73	23.763	23.854	.....	6505.1	Cl'dy; wind northwest.
Camp 19, near forty hot springs	24	Sundown..	8.45	284.06	606	11.5	606.9	11.9	52	23.830	23.826	23.848	6288.2	Heavy rain from 4 to 7 p. m.
	25	Sunrise .....	.....	.....	607.5	13	608.6	13.5	56.3	23.866	23.909	23.885	.....	Cloudy; heavy rain all day.
Camp 20.....	26	.....	7.97	292.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Camp 21, wood, water, and grass	27	7.10 p. m.	13.91	305.94	608.3	16.3	607.7	16	60	23.904	23.881	23.910	6245.2	Cl'dy; wind southwest.
	28	Sunrise.....	.....	.....	608.1	6.3	607.9	6	41	23.917	23.909	23.895	.....	Cl'dy; wind northwest.
At base of pass of Humboldt mountains.	28	2 p. m.	22.07	328.01	604.9	11.5	603.4	11.5	52	23.785	23.726	.....	6425.2	Strong wind from northwest.
On summit of pass in Humboldt mountains.	28	4 p. m.	3.11	331.12	592.3	9	594.6	9	49	23.329	23.419	.....	6848.4	Strong wind from northwest.
Camp 22, creek.....	29	Sunrise.....	9.93	341.05	616.1	0	615.4	0	26	24.255	24.228	.....	5706.4	Clear; snow in mountains.
Base of hill.....	29	10.20 a. m.	1.55	342.60	617.6	6.2	615.8	6.4	39	24.240	24.169	.....	5828.5	Clear; wind northwest.
Foot of cañon.....	29	12 m.	3.83	346.43	616.6	7	618.6	6.9	47	24.223	24.302	.....	5813.1	Do do.
Summit of cañon.....	29	1 p. m.	1.45	347.88	614.1	11	614.8	10.9	49	24.129	24.157	.....	5960.4	Do do.
Camp 23, creek.....	29	Sundown..	9.19	357.07	609.3	4.5	611.1	4.9	39	23.986	24.053	23.935	6066.2	Do do.
	30	Sunrise.....	.....	.....	607	2.9	608.9	3	31	23.885	23.960	24.006	.....	Do do.
On summit of spur.....	30	9 a. m.	1.95	359.02	599.8	11	602.1	10.9	51	23.531	23.622	.....	6627	Do do.
Descent from ditto.....	30	10 a. m.	2.40	361.42	606.3	9	607	9.5	52	23.785	23.813	.....	6374.3	Do do.
Descent base of hill on left....	30	11 a. m.	2.37	363.79	608.2	10	610	10.5	54	23.851	23.922	.....	6288	Cloudy; hail; wind northwest.
Top of mountain.....	30	1 p. m.	1.45	365.24	604	13	606.9	14	54	23.724	23.834	.....	6411	Cl'dy; wind northwest.
At stream at base of mountain.	30	3 p. m.	1.26	366.50	620.9	14	622.4	14.4	60	24.420	24.479	.....	5681	Do do.
Camp 24, on bank of stream...	30	Sundown..	1.11	367.61	625	17.5	626.8	16.9	49	24.553	24.624	24.567	5388.1	Clear; wind northwest.
	31	Sunrise.....	.....	.....	624.4	0	626.2	-0.5	23	24.582	24.653	24.638	.....	Do do.
West side of stream.....	31	9 a. m.	5.79	.....	625.5	16.3	624.7	16.5	74	24.523	24.492	.....	5693.3	Do do.
Ascending.....	31	11 a. m.	5	373.40	615.5	20	616.3	20	72	24.099	24.130	.....	6139.4	Cl'dy; wind southeast.
On a summit.....	31	2.45 p. m.	4.67	383.07	612.2	18.9	611.1	18.6	66	24.054	24.011	.....	6197	Cl'dy; wind southwest.
On stream.....	31	.....	4.23	387.35	611.6	16	610.8	16.6	60	24.064	24.033	.....	6149.2	Do do.
Camp 25, creek, sage and grass	31	Sundown..	2.20	389.55	609.5	13.9	610.3	14	59	23.964	24.028	23.945	.....	Cl'dy; wind northwest.

	June 1	Sunrise.....			608.8	7.9	609.9	8	45	23.936	23.980	24.002	.....	Clear; wind northwest.
Confluence of streams, base of pass.	1	8 a. m.	2.15	391.70	603.6	13.5	605	13.5	59	23.683	23.738	.....	6526.1	Do do.
Ascent of mountain.....	1	10.30 a. m.	2.50	394.20	583.9	12.5	586.2	12.9	51	22.888	22.979	.....	7387.3	Do do.
Summit of Quartz mountain.....	1	11.30 a. m.	.64	394.84	580.1	14.9	581.9	15.6	56	22.744	22.810	.....	7615.1	Cl'dy; wind northwest.
First descent on stream.....	1	12 m. ....	.82	395.66	597.8	13.7	599.3	14	56	23.460	23.515	.....	6766.3	Do do.
Camp 26, in Agate Pass.....	1	7 p. m. ....	.72	396.38	606.2	9	608	9.4	46	23.851	23.922	.....	6627	Do do.
	2	Sunrise.....			606.8	5	608.6	5.5	37	23.870	23.940	23.851	.....	Hail and snow.
	2	12.30 p. m.			606.7	10.4	606.7	11	45	23.832	23.828	23.896	.....	Clear.
Camp 27, foot of Agate Pass...	2	Sundown..	2.65	399.03	635.1	9	635.9	9	48	24.982	25.013	24.977	.....	Rain; wind southwest.
	3	Sunrise.....			635.2	8.5	635.4	8	46	24.972	24.984	24.998	.....	Cloudy; wind south.
	3	8.10 a. m.	2.56	401.59	642.5	17	642.6	17	59	25.193	25.197	.....	4840.5	Clear; wind southeast.
Base of hill.....	3	11.30 a. m.	7.34	408.93	640.9	18	640.7	18.5	57	25.118	25.110	.....	4919.5	Rain; wind northwest.
Divide of streams.....	3	2 p. m.	3.30	412.23	631.8	18.6	631.3	18.9	68	24.815	24.795	.....	5323.3	Clear; wind southwest.
Base of hill, in valley.....	3	2.30 p. m.	58	412.81	632.3	19	634.2	19.5	68	24.842	24.913	.....	5241.5	Do do.
Pass between buttes.....	3	3.40 p. m.	3.52	416.33	626.3	15.8	627.5	15	60	24.635	24.686	.....	5442.2	Cl'dy; wind southwest.
On summit.....	3	4.20 p. m.	.73	417.06	625.7	12.9	627.3	13	54	24.630	24.693	.....	5441.4	Rain; wind northwest.
Camp 28, west side of creek....	3	Sundown..	.56	417.62	627.7	13.2	628.6	13.9	51	24.675	24.706	24.670	5296.3	Clear; wind northeast.
	4	Sunrise.....			627.1	5.6	626.9	5	32	24.665	24.739	24.722	.....	Clear; wind northwest.
	4	10 a. m.	3.08	420.70	621.7	18.9	622.4	19	69	24.352	24.380	.....	5829.1	Clear; wind northeast.
In ravine, on stream, base of hill	4	11.20 a. m.	2.39	423.09	609.4	21.9	608.2	22	78	23.865	23.814	.....	6502.2	Clear; wind northwest.
On ascent of mountain.....	4	12 m. ....	.77	423.86	600.9	21.9	602.9	22.3	70	23.550	23.625	.....	6747.2	Do do.
Top of pass.....	4	2 p. m.	2.19	426.05	587.3	18.9	589.4	19	69	23.067	23.150	.....	7315.2	Do do.
On stream, running from pass..	4	2.40 p. m.	.50	426.55	603.7	22	605	22.5	72	23.710	23.758	.....	6470	Do do.
Camp 29, end of stream.....	4	Sundown..	2.44	428.99	622.3	18	622	18.3	55	24.453	24.431	24.433	5648.5	Do do.
	5	Sunrise.....			621.2	11.5	621.7	11	48	24.413	24.433	.....	.....	Clear; wind northeast.
Base of small hill.....	5	8.50 a. m.	2.60	431.59	632.9	19.2	633.5	19.5	67	24.805	24.825	.....	5306.3	Clear and calm.
In valley.....	5	10 a. m.	1.84	433.43	639.4	21.8	641.3	22	69	25.037	25.108	.....	5029.4	Clear; wind west.
In valley, base of hill on the left.	5	12 m.	8.27	441.70	642.8	28.5	644.4	29	82	25.168	25.227	.....	4955.6	Clear; wind southwest.
On rise in valley.....	5	1 p. m.	3.90	445.60	642.4	28.8	645.8	29	86	25.172	25.224	.....	4974.5	Do do.
Camp 30, fine mountain stream, good grass.....	5	10 p. m.	13.49	459.09	633.9	20.3	634.9	20.9	62	24.485	24.520	24.498	5601.1	Do do.
Base of hill.....	6	5.30 a. m.			624.1	13.8	624.9	14	56	24.511	24.543	.....	.....	Do do.
Top of hill.....	6	8 a. m. ....	.72	459.81	629.6	18.9	628.9	18	66	24.683	24.659	.....	5463.4	Clear; wind northeast.
In pass.....	6	9 a. m.	2	461.81	628	20.7	621.9	20.4	70	24.366	24.366	.....	5835.1	Do do.
On ascent.....	6	11 a. m.	3.54	465.35	622.7	24.6	621.2	24.4	71	24.363	24.308	.....	5877.2	Do do.
Camp 31, on west side of stream.	6	1.30 p. m.	4.43	469.78	631.5	26	630.1	26	75	24.765	24.710	.....	5438.3	Do do.
	6	Sundown..	3.43	473.21	631.2	12.2	630.3	12	54	24.817	24.781	24.806	5249	Rain and thunder; wind northeast.
	7	Sunrise.....			630.6	7.7	629.1	7.7	46	24.795	24.735	24.758	Cloudy; wind west.
In pass, at base of hill.....	7	8 a. m.	1.25	474.46	628.3	9.9	628	10.4	50	24.727	24.715	.....	5316.6	Do do.
Descending in pass.....	7	9.15 a. m.	2.76	477.22	629	13.9	630	14	58	24.667	24.706	.....	5400.6	Do do.
Mouth of ravine, in valley....	7	10.30 a. m.	3.74	480.96	642.9	17	643.1	17.4	62	25.188	25.196	.....	4859.6	Cloudy; wind northwest.
Entering pass.....	7	1.30 p. m.	7.19	488.15	641.8	18.9	640.8	19	66	25.198	25.155	.....	4898.1	Do do.
In ravine or pass.....	7	3.50 p. m.	4.64	492.79	632.1	19.3	631	19	67	24.853	24.810	.....	5288.3	Clear; wind northwest.
Camp 32, water and grass.....	7	Sundown..	.99	493.78	628	10.5	629	10	50	24.698	24.738	24.734	5259.1	Do do.
	8	Sunrise.....			629.7	5	629.6	5	38	24.771	24.767	24.752	Clear; wind southwest.
Summit of pass.....	8	7.30 a. m.	2.25	496.03	614.2	17.3	612.8	17	61	24.090	24.035	.....	6129.2	Clear; wind northwest.
Crossing stream.....	8	9.30 a. m.	3.73	499.76	651.5	19.5	650.3	19.8	70	25.522	25.475	.....	4561.3	Do do.
In valley.....	8	3.30 p. m.	16.15	515.91	651.4	21.8	650.2	22	72	25.593	25.545	.....	4493	Do do.
On a small spur of mountain...	8	4.30 p. m.	2.73	578.64	646.8	20.5	646.4	20.9	75	25.430	25.411	.....	4686.3	Clear; wind west.
Base of mountain.....	8	5.30 p. m.	2	520.64	652.2	21.3	.....	.....	71	25.627	.....	.....	4424.3	Do do.

Meteorological observations and table of altitudes and distances—Continued.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
Camp 33, east bank of Humboldt river.*	1854, June 8	Sundown.	3.40	594.04	656.7	90.3	656.3	90.3	69	95.781	95.765	95.831	4140.9	Cloudy; wind west.
Camp 34, Humboldt river crossing	9	Sunrise	6.50	590.84	658.9	11	659.4	11	47	95.981	95.913	95.830	4147	Cloudy; wind east.
Camp 35, on California road, at Lassen's meadows.	10	Sundown.	3.51	584.35	658.8	14.6	657.9	14.6	64	95.860	95.836	95.898	4152.2	Clear and calm.
In bed of Dry creek.	11	Sunrise.	9.64	543.92	658.5	21.5	657.7	21.5	70	95.866	95.813	95.859	4152.2	Do.
Foot-hills, above H. river.	11	10 a. m.	7.96	543.92	658.4	13.5	657.7	13.5	53	95.862	95.826	95.819	4309	Cloudy; wind northeast.
	11	2.30 p. m.	6.93	551.82	653.3	34	657.7	34	75	95.765	95.734	95.859	4492	Cloudy; wind northwest.
	11	3.30 p. m.	5.13	563.78	641.2	22.8	640.4	22.8	84	95.614	95.636	95.859	4492	Cloudy; wind northwest.
Camp 36, not on line of profile.	12	Sunrise.	5.13	563.91	615.4	13.6	616.2	13.6	35	95.194	95.158	95.859	4938.7	Do do.
Summit of pass, profile distance 5.50 miles.	12	9 a. m.	1.95	565.86	629.4	18.9	629.3	18.9	66	94.177	94.208	95.859	5173.2	Do do.
Descending from pass, not on line of profile.	12	1.20 p. m.	10.55	576.41	649	19	649.7	19	65	95.473	95.496	95.859	4553.1	Do do.
Junction of D y creeks, on descent.	12	2 p. m.	4.08	581.09	648.4	18.9	648	18.9	64	95.464	95.479	95.859	4579.2	Do do.
Bed of Dry creek.	12	3.30 p. m.	1.85	582.94	652.4	19.3	651.6	19.3	65	95.641	95.613	95.859	4410.5	Strong northwest wind.
In valley.	12	4.15 p. m.	2.55	585.49	654.7	18.7	654.5	18.7	64	95.739	95.731	95.859	4275	Do do.
Camp 37. This height not used in profile.	12	5.13 p. m.	7.17	582.66	647.2	17	653.9	17	60	95.711	95.711	95.859	4278.2	Cloudy; wind northwest.
Dry creek, in valley. Distance from second preceding station, line of profile, 8.17 miles.	13	5.30 a. m.	3.17	595.83	650.8	12	646.7	10.6	49	95.436	95.413	95.859	4544	Rain; wind northwest.
On stream, in cañon.	13	9 a. m.	1.95	597.78	648.5	16	650.5	12.2	53	95.531	95.519	95.859	4451.5	Do do.
Summit.	13	10 a. m.	1.37	599.15	642.3	16	649.3	16	59	95.415	95.446	95.859	4583.3	Do do.
Descending into valley.	13	12.30 p. m.	2.55	601.70	644.6	16	642.3	16	57	95.171	95.167	95.859	4886.2	Cloudy; wind northwest.
Passing small hills in valley.	13	4 p. m.	7.04	608.74	635.5	17	644.2	16	64	95.286	95.281	95.859	4763.4	Do do.
Passing small hills, on direct line to Mud lake, by an open passage north.	13	5 p. m.	2.54	611.28	635.7	14.5	635.8	14.5	62	94.998	94.994	95.859	5076.2	Do do.
Camp 38, grass, but no water.	13	5 p. m.	11.75	616.78	632.6	11.6	635.5	11.6	59	95.019	95.023	95.859	5033	Rain; wind northwest.
Summit.	14	Sunrise.	5.50	616.78	632.6	11.6	632.9	11.8	50	94.468	94.869	95.859	5376.2	Do do.
In pass.	14	8.40 a. m.	1.65	618.96	627.9	17.9	627.5	19	60	94.617	94.597	95.859	5501.1	Clear; wind northwest.
	14	9.30 a. m.	1.65	620.63	627.6	21	636.4	21	63	94.976	94.984	95.859	5385	Do.

Valley of Mud lake, point of mountain. Distance, by line of profile, 15.39 miles.	14	5 p. m.	11.54	632.17	659	21	658.8	21	69	25.872	25.860	.....	4134	Do	do.
Camp 39, east base of Sierra Nevada.	15	Sunrise....	9.88	642.05	659.2	15.3	658.9	15	54	25.886	25.873	25.874	4118.1	Clear; wind west.	
	15	Sundown....	.....	.....	658.9	21.7	659.3	21.9	71	25.860	25.876	25.874	.....	Do	do.
	16	Sunrise....	.....	.....	660.2	15	660.3	15	58	25.929	25.933	.....	.....	Cloudy; wind west.	
At point of mountain	16	8 a. m.	3	645.05	661.4	20	661.4	21	65	25.923	25.919	.....	4079	Clear and calm.	
Foot of Madelin Pass, Smoky creek.	21	1 p. m.	16	661.05	657	29.5	.....	.....	86	25.740	.....	.....	4370	Light clouds; high wind.	
	21	12 ni .....	.....	.....	656.9	27.5	.....	.....	82	25.720	.....	.....	.....	Do	do.
Smoky creek, head of small cañon.	21	11 a. m.	3	664.05	654.3	31	.....	.....	74	25.575	.....	.....	4495.2	Do	do.
Smoky creek, ascending pass..	21	10 a. m.	3	667.05	649	27	.....	.....	70	25.391	.....	.....	4679.5	Do	do.
	21	9 a. m.	2.50	669.55	646	28.6	.....	.....	74	25.275	.....	.....	4827.3	Do	do.
	21	8 a. m.	2.50	672.05	640.6	24.4	.....	70.5	.....	25.092	.....	.....	5014.6	Do	do.
Madelin Pass, camp 44; wood, water, and grass. This altitude not in line of profile.	22	Sunrise....	2	674.05	639.4	2.9	639.7	3	32	25.161	25.173	.....	4914.5	Clear; wind northwest.	
	21	Sundown....	.....	.....	639	16	638.2	16.9	56.5	25.108	25.072	.....	.....	Wind all day.	
	21	Sunrise....	.....	.....	637.9	9	637.9	9	41	25.078	25.078	.....	.....	Cloudy in southwest.	
	20	Sundown....	.....	.....	640	29.5	640.4	22.5	72	25.190	25.135	.....	.....	Clear; wind southwest.	
	20	3 p. m. ....	.....	.....	641	28	641.4	28	78	25.152	25.168	25.125	.....	Strong south wind.	
	20	12 m .....	.....	.....	642	26	641.5	26	72	25.145	25.125	25.227	.....	Strong northwest wind.	

Meteorological observations and determinations for altitudes from Mud lake, via Mud creek, to the summit of the Sierra Nevada and Madelin Pass. †

Mouth of ravine.....	June 16	12 m	8.85	653.90	652.8	25	652.2	25	73	25.570	25.550	.....	4507.4	Clear; wind west.	
Summit of hill.....	16	1 p. m.	1.47	655.37	643.7	23.3	643.4	23.3	72	25.244	25.232	.....	4858.6	Clear; wind northwest.	
Camp 40, on Mud creek.....	16	Sundown....	1.88	657.25	654.9	20.8	655	21	89	25.706	25.714	25.711	4275.4	Do.	do.
	17	Sunrise....	.....	.....	654.2	9	653.5	9	45	25.716	25.688	25.701	.....	Cloudy; wind northwest.	
In cañon.....	17	8.20 a. m. ....	.49	657.74	655.4	18.8	653.1	18.6	67	25.692	25.691	.....	4385.5	Cloudy; calm.	
	17	9.50 a. m. ....	.46	658.20	653.4	21.8	651.4	22	73	25.582	25.508	.....	4533.5	Cloudy; wind south.	
In cañon. (Branches at this point.)	17	10.30 a. m.	1.30	659.50	652.2	21.5	650.7	21.9	72	25.534	25.471	.....	4566.7	Cloudy; wind southwest.	
In cañon.....	17	11.25 a. m.	1.53	661.03	651.7	18.9	650.1	19.4	63	25.535	25.476	.....	.....	Do.	do.
Camp 41, Mud creek, water, grass, and wood.	17	Sundown .	.....	.....	649.3	11.8	649.8	12	51	25.525	25.545	25.558	4406.5	Rain all night; wind south.	
Top of 1st terrace.....	18	Sunrise....	.....	.....	651	11.5	650.3	11.5	49	25.582	25.555	25.550	.....	Cloudy; wind south.	
Junction of streams in cañon..	18	10 a. m.	2.05	663.08	638.7	13	639.5	13.3	55	25.045	25.076	.....	4969.1	Cloudy; wind northeast.	
In cañon.....	18	12.30 p. m.	1.96	665.04	633.8	19	633.6	19.5	65	24.863	24.855	.....	5245.6	Do.	do.
End of cañon.....	18	1.40 p. m.	2.17	667.21	627.7	20	627.3	20.7	64	24.643	24.624	.....	5495.6	Do.	do.
	18	2.50 p. m.	1.82	669.03	619.6	20.9	618.9	19.5	64	24.338	24.319	.....	5843.2	Clear; wind southwest.	
	18	3.8 p. m. ....	.35	669.26	620.5	17.3	619	17.6	62	24.393	24.350	.....	5792	Do.	do.
Descent.....	18	4.8 p. m.	1.60	670.86	621.4	18.2	621.9	18.5	67	24.439	24.459	.....	5722.2	Do.	do.
Camp 42, wood, water, and grass.	18	Sundown....	.35	671.21	619.1	13	619.6	13	53	24.336	24.356	24.372	5668.3	Clear; wind west.	
	19	Sunrise....	.....	.....	620.3	5	620.4	5	34	24.401	24.405	24.367	.....	Clear; wind southwest.	

* At this point we return to the proposed line for a railroad, descending the valley of Humboldt river.

† Not used in profile.

‡ This sheet of the table not used in profile.

Meteorological observations and determinations for altitudes—Continued.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.	
	1854.		<i>Miles.</i>	<i>Miles.</i>	<i>Mm.</i>		<i>Mm.</i>			<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Feet.</i>		
Descent.....	June 19	6 a. m. ....	.....	.....	620.4	10	619.4	9.8	42	24.379	24.340	.....	.....	Clear; wind southwest.
	19	10 a. m.	4.30	675.51	.....	.....	622	16.5	56.5	.....	24.376	.....	5742	Do. do.
Descending into Madelin Pass. Madelin Pass, camp 43, wood, water, and grass.	19	19 m.	2.53	678.04	.....	.....	614.9	16	59	.....	24.121	.....	6049	Do. do.
	19	1 p. m. ....	.64	678.68	.....	.....	617.7	19.7	67	.....	24.239	.....	5963.6	Do. do.
	19	4.30 p. m.	1.83	680.51	.....	.....	631.9	24	73.6	.....	24.832	.....	5337	Do. do.
	19	Sundown..	630.2	21.2	629.3	22.4	69	24.742	24.702	24.760	Do. do.
	20	Sunrise....	630.3	9	629.4	8.8	41	24.779	24.743	24.759	Cloudy; wind east.

Meteorological observations and table of altitudes and distances from Great Salt lake, Utah Territory, to the valley of the Sacramento river, California—1854.

Ascent of Sierra Nevada..... In broad valley.....	June 22	8 a. m.	1.56	675.61	637.5	16	637	16.5	55	25.006	24.986	5045.3	Light clouds; high wind. Do. do. Do. do. Do. do. Do. do. Do. do. Do. do.
		9 a. m.	1.55	677.16	636.2	19.3	636.3	19.8	65	24.933	24.833	.....	5163.5
Ascent..... Summit of Madelin Pass..... On broad summit of Sierra Nevada. On broad summit; not used in profile. Camp 45, water, wood, and grass.* (Distance from preceding profile station, 3.85 miles.) Broad plain of the Sierra Nevada.	22	10 a. m.	1.56	678.72	634.2	20	633.4	20	65	24.840	24.809	5285.6	Clear; wind northwest. Do. do. Do. do. Do. do. Do. do. Do. do. Do. do. Do. do. Do. do.
		11 a. m.	1.55	680.27	631	20.2	630.6	20.5	66	24.709	24.669	.....	5432.1
		12 m.	1.56	681.83	628.8	21.5	628.3	21.3	68	24.649	24.629	.....	5511.5
		12.50 p. m.	1.32	683.15	626.1	22	625	22	70	24.555	24.512	.....	5643.5
		1.30 p. m. ....	.79	683.94	626.7	22	622.9	22	70	24.587	24.437	.....	5667.5
		2.20 p. m.	2	685.94	625.5	22.6	625.3	22.4	70	24.556	21.552	.....	5620
		3.20 p. m.	1.98	687.92	627	23.8	626	24	69.5	24.626	24.587	.....	5557
		4 p. m.	1.94	689.86	629.1	21.9	628.7	22	69	24.726	24.711	.....	5427.5
		5.20 p. m.	2.14	692	627.3	21.3	626.5	21	68	24.658	24.626	.....	5507.5
		Sundown..	1.71	693.71	629.2	13.9	628	14	54	24.730	24.683	24.736	.....		5250.5
Sunrise....	.....	.....	628.2	-3	628.6	-3	25	24.743	24.759	24.721	.....	5490.2	
10 a. m.	6.03	699.74	.....	.....	630.6	21.4	64.5	.....	24.694	.....	.....	5430	Clear; wind southwest. Do. do. Do. do.
11.40 a. m.	3.48	703.22	.....	.....	631.3	21.5	71.5	.....	24.737	.....	.....	5480.2	

East from camp of June 23 and 24.	23	10.30 a. m.	2.25	628.3	30.6	64	24.562	5576.2						
	23	12 m.....	2.25	631.6	23.8	72	24.747	5411.3						
	23	1 p. m.....	1	634.4	23.2	73	24.881	5265.4		Not used in any section.				
	23	2 p. m.....	1	640.4	26.5	77	25.122	5015.3						
Camp 46, summit of Sierra Nevada.	23	Sundown..	.86	630.4	22	62	24.746	5326.3						
	24	Sunrise....		627.2	6.2	32	24.669			Clear; wind southwest. Cloudy in southeast; wind southwest.				
Crossing summit of Sierra Nevada.	24	12 m.....	13.26	628.1	23.5	627.8	23.7	72	24.593	24.577	5596.4	Light clouds in southwest.		
∞ Camp 47, grass, water, and wood.†	24	Sundown..	6.27	628.7	11	627.1	11	48	24.722	24.659	24.750	5239.1	Light clouds; wind southwest.	
Water-course.....	25	Sunrise.....		629.6	2.5	629.3	2.3	28	24.779	24.767	24.713	5585.5	Cloudy; wind southwest.	
On divide, in pass.....	25	12 m.....	10.57	624.8	15.4	624.9	15.6	57	24.515	24.515		5736	Clear; wind southwest.	
Stream west of summit of the Sierra Nevada.	25	1 p. m.....	1.63	625.81	621.1	14.7	620.9	14.9	57	24.389	24.381		5315.6	Clear; wind northwest.
On spur. Not in line of profile.	25	2.30 p. m..	2.42	630.9	17.9	630.8	17.6	63	24.790	24.786		5297.5	Do. do.	
Base of hill in valley.....	25	3.40 p. m..	1.73	632.9	16.9	632.3	17.3	62	24.891	24.867		4933.2	Do. do.	
Camp 48, fine grass. Not used in profile.	25	5 p. m.....		623.9	14.3	625	14.9	58	24.558	24.598		4468.4	Do. do.	
On the waters of the Sacramento river. Distance from preceding profile station 3.67 miles.	25	6.10 p. m..	3.20	639.1	15.9	639.1	16	62	25.127	25.137		4472	Clear; wind north	
East of stream in Round valley.	26	Sundown..	2.14	646.3	10.2	645.8	10.5	48	25.415	25.395	25.435		4472	Clear; wind northwest.
On stream at base of hill, Round valley.	26	Sunrise....		646.4	-2	645.7	-2	19	25.455	25.429	25.412			
Leaving creek.....	26	7.50 a. m..	1	648.7	7.9	647.7	7.9	42	25.476	25.441				
Round valley. Not used in profile.	26	9 a. m.....	2.25	651.2	9.8	650.9	10.7	50	25.555	25.539		4415.7	Do. do.	
Camp 49, west side of stream. Distance from last profile station, 8.8 miles.	26	10 a. m.....	2.08	652.8	11.4	651.7	11.7	53	25.600	25.557		4395	Do. do.	
Foot of Round valley, and head of first cañon of the Sacramento or Pitt river.	26	11.30 a. m.	1.25	654.2	13.4	654.6	13.6	53	25.661	25.673		4299.2	Do. do.	
	26	3 p. m.....	7.78	656.8	18	657.4	18	63	25.810	25.838		4174.8	Do. do.	
	26	Sundown..	1.03	657.9	16.2	656.7	16.3	69	25.844	25.797	25.843	4127.4	Do. do.	
	27	Sunrise....		656.9	4	656.8	4	38	25.842	25.838	25.817			Clear; wind northeast.
	27	9 a. m.....	4.76	658.9	16	657.9	16.2	55	25.831	25.791		4153.7	Do. do.	

* From this point to the camp of June 24, 25, the line of profile is direct and the grade uniform, the distance being 21.9 miles.

† From this point back to the camp of June 22, the line of profile is direct and the grade uniform.

Meteorological observations and determinations for altitudes in crossing from Madelin to Noble's Pass, on summit of the Sierra Nevada.*

Locality.	Date.	Hour.	Intermediate distance.	Distance from foot of Round vale.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.	
			Miles.	Miles.	Mm.		Mm.			Inches.	Inches.	Inches.	Feet.		
Camp 50, above valley on the Sacramento.	June 27	Sundown..	4.58	.....	652.2	19.4	651.7	19	62	25.612	25.588	.....	4467.4	Cloudy; wind west.
	28	Sunrise....	.....	.....	652.7	9	651.6	9	43	25.657	25.613	.....	.....	Cloudy; wind southeast.
	28	Sundown..	.....	.....	.....	.....	651.5	21	74.5	.....	25.572	.....	.....	Clear; wind northwest.
	29	Sunrise....	.....	.....	.....	.....	651	9	47	.....	25.594	.....	.....	Cloudy; wind southeast.
	29	12.20 p. m.	.....	.....	.....	.....	651.2	22.5	72.5	.....	25.526	.....	.....	Light clouds; wind southwest.
	29	4 p. m.	.....	.....	.....	.....	650.1	24.2	76.3	.....	25.541	25.561	.....	Do. do.
Summit, returning to eastern base of Sierra Nevada.	29	Sundown..	.....	.....	648.9	20.4	649	20.7	69	25.474	25.478	.....	.....	Cloudy in west; wind southeast.
	30	Sunrise....	.....	.....	647.7	9	647	9.3	47	25.460	25.432	.....	.....	Cloudy; wind southeast.
	30	8.15 a. m.	2.25	6.83	632.9	13.9	633.7	13.6	53	24.831	24.862	.....	5195.2	Light clouds; wind southwest.
	On terrace.....	30	2 p. m.	10.17	17	632.2	19.3	631.4	19.6	67	24.830	24.795	5310.2	Light clouds; wind northwest.
	Summit.....	30	3 p. m.	1.53	18.53	633	21.3	632.5	21.7	66	24.869	24.845	5253.6	Do. do.
	Camp 51, wood, water, and grass.....	30	Sundown..	1.59	20.12	641	16.4	639	16.6	62	25.123	25.104	4841.5	Do. do.
Ascent.....	July 1	Sunrise....	.....	.....	640.5	4	638.7	4.3	38	25.200	25.129	25.116	.....	Clear; wind southwest.
	1	9.40 a. m.	5.04	25.16	632.3	17.7	622.7	17.3	62	24.383	24.402	.....	5758	Do. do.
	1	12 m.	4.68	29.84	615.1	18.8	615.5	18.8	65	24.117	24.133	.....	6083.2	Clear; wind northwest.
	1	2.30 p. m.	5.68	35.52	610	24	608.7	24.3	68	23.942	23.891	.....	6346	Do. do.
	On divide.....	1	Sundown..	3.43	38.95	621.1	14.3	619	14.5	56	24.411	24.328	24.441	5492.4	Do. do.
	Camp 52.....	2	Sunrise....	621.6	0	620	-0.2	28	24.472	24.421	24.374	Clear; wind northeast.
On a terrace, plain of Sierra Nevada.	2	8.40 a. m.	4.25	43.20	621.1	17.5	621.1	15.6	57	24.349	24.357	.....	5771.1	Light clouds; wind southwest.
Pine creek.....	2	11 a. m.	6.25	49.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* This table not used in profile.

Meteorological observations and table of altitudes and distances from Great Salt Lake, Utah Territory, to the valley of the Sacramento river, California—1854.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
	1854.		Miles.	Miles.	Mm.		Mm.			Inches.	Inches.	Inches.	Feet.	
Foot of first cañon of Sacramento river.	June 29	11 a. m.	13.74	779.19	675.3	30	.....	.....	80	26.402	.....	.....	3622.4	Clear.
Mouth of Fall river, and head of second cañon.	29	6.30 a. m.	13.50	792.69	677.9	6	.....	.....	46	26.636	.....	26.661	329.9	Clear; wind northwest.
	29	Sunrise. . . . .	.....	.....	678	5.5	.....	.....	32	26.669	.....	.....	.....	Do do.
	28	Sundown. . . . .	.....	.....	679.3	18.2	.....	.....	59	26.679	.....	.....	.....	Do do.
Sacramento river, and mouth of second cañon.	July 21	2.30 p. m.	8.95	801.64	691	29	689.4	29	85	27.094	27.031	.....	2937	Do do.
Mouth of Canoe creek.	21	12.30 p. m.	4.70	806.34	693.4	28.5	691.8	28	82.3	27.151	27.089	.....	2867.2	Clear; wind northeast.
Camp 6, in mountain valley. Not in line of profile.	21	Sunrise. . . . .	.....	.....	680.6	5.6	681.9	5.6	39	26.756	26.807	26.772	3170.1	Do do.
	20	Sundown. . . . .	.....	.....	679.7	16.5	677.8	16.5	59	26.710	26.637	26.733	.....	Clear; wind southwest.
Sacramento river.	20	9 a. m.	22.50	828.84	709.9	23.8	708.4	24	72	27.794	27.734	.....	2177.2	Clear; wind southeast.
Camp 5, Sacramento river.	20	Sunrise.	7.50	836.34	717.5	7.5	717.3	7.5	47	28.198	28.190	28.186	1730.3	Do do.
	19	Sundown. . . . .	.....	.....	717.4	21	717.7	21	71	28.171	28.123	28.184	.....	Do do.
Camp 4, on mountain. Not in line of profile.	19	Sunrise. . . . .	.....	.....	708	10	708.3	10	50.5	27.213	27.825	27.819	.....	Clear; wind northwest.
	18	Sundown. . . . .	.....	.....	708.1	17	707.6	16.9	65	27.833	27.814	27.823	2086.7	Clear; wind west.
Sacramento river.	18	10.15 a. m.	26.50	862.84	737.3	25.5	734.1	25.5	76	28.859	28.733	.....	1156	Clear; wind northeast.
Camp 3, Sacramento river.	18	Sunrise. . . . .	.....	.....	739.5	12	736	12	54	29.052	28.910	.....	.....	Probable error in record of temperature. Not used in computation of altitude of camps.
	17	Sundown.	4.70	867.54	737.4	23	733.3	23	74.5	28.955	28.794	.....	1078.1	Clear; wind northeast.
Camp 2, Dribbley's ferry.	17	Sunrise.	10.50	878.04	738.5	13	737	13	51	29.127	28.950	.....	954.2	Clear; wind east.
Mouth of McCloud's river.	16	6.45 p. m.	5.25	883.29	742.4	23.5	738.2	24	72	29.094	28.925	.....	922	Clear; wind northeast.
Sacramento river.	16	11 a. m.	11.75	895.04	745.6	29	741	29	79	29.162	28.981	.....	837.5	Do do.
Camp 1, not in line of profile.	16	Sunrise. . . . .	.....	.....	743.6	21	738.9	21	70	29.170	28.985	28.978	.....	Do do.
	15	Sundown. . . . .	.....	.....	742.6	31	738.8	31	88	29.121	28.971	29.145	899.9	Clear; wind west.
Fort Reading.	12 to 15	Sundown.	22.90	917.94	.....	.....	.....	.....	.....	.....	.....	.....	674.7	Height from mean of four days' observations.

Meteorological observations and determinations for altitudes for profile from Mud Lake to Fort Reading, on the Sacramento river, California, via Noble's Pass.

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.
			Miles.	Miles.	Mm.		Mm.			Inches.	Inches.	Inches.	Feet.	
Camp 39, east base of Sierra Nevada.	June 15 and 16			642.05									4118.1	
Point of mountain, shore of Mud lake.	16	8 a. m.	3	645.05	661.4	20	661.4	21	65	25.923	25.919		4079	
Foot of Madelin Pass, Smoky creek.	21	12 m.	12	657.05	656.9	27.5			82	25.720			4370	Above the line of profile.
Warm springs.	21	1 p. m.		657.05	657	27.5			86	25.740				
Old shore-line.	July 5	8.15 p. m.	30	687.05	658.2				75	25.820			4231.6	Clear.
Camp 55, shore of Honey lake, near boiling springs.	5	9.45 a. m.	7.50	694.55	661	26.4			88	25.823			4285.2	Do.
	4	Sundown	8.50	703.05	660.4		659.3	25	76	25.908	25.865		4094.6	Clear; wind southwest.
	5	Sunrise			660.1	12	658.9	19	52	25.930	25.883			Clear; wind northeast.
	5	Sundown					658	24	76	25.936	25.936	25.919		Clear; wind southwest.
	6	Sunrise					659.6	14.4	36.5	25.903	25.903	25.896		Cloudy; wind northeast.
Willow creek.	4	12 m.	11.36	714.41	662.4	26.5	661.2	28.5	62	25.932	25.885		4080	Clear; wind northeast.
Camp 54, Roop's rancho.	3	4 p. m.	8.64	723.05	656.9	32	655.8	32	88	25.770	25.737		4181	Clear; wind west.
	3	Sundown			656.5	26.5	654.5	26.4	78	25.747	25.672			Clear; wind northeast.
	4	Sunrise			656.7	11	657.8	11.5	50	25.807	25.846			
	7	Sundown			659.7	19	657.9	19	73	25.924	25.853	25.845		Clear; wind southwest.
	8	Sunrise			660.6	3.5	658.8	3.8	32	25.966	25.915	25.802		
Susan river.	8	8 a. m.	4	727.05	658.5	21.8			96	25.805			4221.4	Do do.
Top of ravine, (same point as above.)	8	8.15 a. m.			647.5	21.3			64	25.372			4672.2	Not in profile.
Susan river.	8	10 a. m.	4	731.05	649	21.5			67	25.411			4643.6	Clear; wind southwest.
12 o'clock peak.	8	12 m.			623	24.5			71	24.401			5801.5	Not in profile.
Susan river.	8	2 p. m.	4.50	735.55	642.8	25			78	25.220			4909.7	Clear; wind southwest.
Divide between Susan river and Summit creek.	9	9.45 a. m.	7.25	742.80	632.1	25.5			76	24.730			5454.1	Do do.
On lake, up Susan river.	9	11.20 a. m.	7.25	750.05	627.2	26.2			77	24.538			5679.4	Do do.
Divide between Summit and Pine creeks.	9	12.45 p. m.	2.25	752.30	626.8	26.5			80	24.448			5801.6	Do do.
Pine creek, prairie.	9	12 m.	5	757.30			627.6	29	79		24.562		5663.3	Do do.
Plains of the Sierra Nevada.	9	1.50 p. m.	2.89	760.19			631	27.8	80		24.726		5480.5	Clear; wind west.
	9	2 p. m.	1.84	762.03			630	28	81		24.700		5516.3	Clear; wind southwest.
Thick pine woods.	9	2.40 p. m.	1.70	763.73			632.8	28.8	83		24.816		5394.1	Do do.

Camp 59, Black Butte creek...	9	3.45 p. m.	2.05	765.78	635.2	28.2	82	24.928	24.928	5261.1	Do	do.	
	9	Sundown..	1.55	767.33	634.7	19	60	24.935	24.939	5081.8	Do	do.	
	10	Sunrise ..			633.4	4.7	34	24.903	24.940		Do	do.	
	23	Sunrise ..			632.9	2	32	24.896	24.975		Clear; wind northwest.		
Bed of Dry creek, above Black Butte.	23	Sundown..			634.3	20	71	24.896	24.939	24.909	Clear; wind southwest.		
	24	Sunrise ..			633.3	6	45	24.915	24.895	24.937	Clear; wind southeast.		
	10	11.40 a. m.	11.69	779.02	614.8	27	80	24.069	24.017	6275.4	Clear; wind southwest.		
	10	12.30 p. m.	1.87	780.89	615.3	26.8	77	24.098	24.042	6223.4	Do	do.	
Near a pond.....	10	1.10 p. m.	1.53	782.42	616.1	27	81	24.144	24.089	6194.3	Do	do.	
	24	11.40 a. m.	3.75	786.17	616	30.5	80	24.093		6216.2	Do	do.	
Small creek and springs.....	24	1 p. m.....	2.75	788.92	618.1	30.5	81.5	24.206		6092.3	Do	do.	
Hat creek.....	24	2 p. m.....	.50	789.42	620.1	32.5	88.5	24.309		6015.1	Do	do.	
Side of mountain, west of Hat creek.		2.30 p. m.	1.50	790.92	621	32	89	24.339		5983.1	Do	do.	
Spur dividing valley of Wolf creek.	25	7 a. m....	2	792.92	616.8	18.5	69.5	24.185	24.130	6074.1	Cl'dy; wind southwest.		
Wolf creek.....	11	10 a. m.....			623.8	28.5	84	24.397	24.289	5948.2	Clear; wind southwest.		
Western summit of Sierra Nevada.	25	8 a. m.....	5	797.92	626.6	28	90	24.523	24.435	5825.1	Cl'dy; wind southwest.		
Battle creek.....	11	11 a. m.....	2.50	800.42	638.2	29.5	85	24.945	24.884	5293.6	Clear; wind southwest.		
	11	12 m.....	2.12	802.54	651.1	30	86	25.478	25.423	4691.5	Do	do.	
Western descent of Sierra Nevada.	11	1 p. m.....	2.14	804.68	659.2	31	87	25.811	25.768	4318.1	Do	do.	
Deer flat.....	11	2 p. m.....	1.69	806.37	662.8	31.6	88	25.971	25.928	4146.2	Do	do.	
Western slope of Sierra Nevada	25	3 p. m.....	2	808.37	662.4	29	80	25.980	25.880	25.967	4131.6	Cl'dy; wind southwest.	
Hill's rancho, on Battle creek..	25	Sundown..			661.1	23	73.5	25.954	25.861	25.870	Cl'dy; wind northwest.		
Descending Sierra Nevada.....	11	5 p. m.....	4.14	812.51	666.2	28	82	26.154	26.087	3934.7	Clear; wind southwest.		
	11	7.20 p. m.	3.58	816.09	674.9	26	80	26.567		3445.7	Do	do.	
Camp 61, McCumber's mill....	12	Sunrise ..	1	817.09	675.2	16	59	26.500	26.402	3491.1	Clear; wind northeast.		
On stream.....	12	8 a. m.....	2.38	819.47	678.3	26.3	78	26.555	26.468	3497.8	Clear; wind southwest.		
Descent.....	12	9.30 a. m.	3.05	822.52	696.3	30.3	86	27.227	27.172	2796	Clear and calm.		
On stream.....	12	10 a. m.....	2.19	824.71	709.6	32.5	91	27.741	27.671	2280.2	Calm.		
On descent in valley.....	12	11.30 a. m.	3.78	828.49	727.8	37.5	99	28.435	28.380	1576.4	Clear; wind northeast.		
On Dry creek.....	12	12.45 p. m.	2.93	831.42	740.5	40.7	106	28.951	28.848	1087.4	Do	do.	
	12	1.45 p. m.	2.54	833.96	745.8	42.7	109	29.167	29.037	887.3	Clear; wind northwest.		
	12	3.40 p. m.	4.37	838.33	749.5	41.6	108	29.351	29.213	706.5	Do	do.	
	12	Sundown..	2.25	840.58	750.3	36.2	100	29.396	29.190	674.7	Do	do.	
Fort Reading, camp 62... ..	13	Sunrise ..			750.2	20	67	29.434	29.288		Clear and calm.		
	13	Sundown..			748.5	35	95	29.333	29.184		Clear; wind southeast.		
On stream.....	14	Sunrise ..			749.4	25.5	72	29.375	29.198		Clear; wind northeast.		
	14	Sundown..			748.7	34.2	93	29.345	29.168	29.386	Do	do.	
	15	Sunrise ..			750.3	26.2	79	29.434	29.228	29.209	Do	do.	

Meteorological observations and determinations of altitudes on Noble's Pass.*

Locality.	Date.	Hour.	Intermediate distance.	Distance from Great Salt Lake City.	Bar. reading, No. 496.	Attached thermometer, (C.)	Bar. reading, No. 551.	Attached thermometer, (C.)	Air thermometer, (F.)	Corrected barometer, No. 496.	Corrected barometer, No. 551.	Barometric means.	Altitudes.	Meteorological remarks.	
	1854.		Miles.	Miles.	Mm.		Mm.			Inches.	Inches.	Inches.	Feet		
Ascent of Noble's Pass.....	July	8	7.30 a. m..	1.04	.....	.....	653	18	58.5	.....	25.609	.....	4385.1	Clear; wind northeast.	
		8	8.45 a. m..	2.72	.....	.....	.....	647.8	19.8	61.5	.....	25.389	.....	4611.3	Do do.
Ascent of Noble's Pass, (small stream.)	8	8	10 a. m..	2.51	.....	.....	641.1	21.5	65.5	.....	25.100	.....	4980	Do do.	
		8	11.15 a. m.	2.77	.....	.....	.....	633.4	21	67.5	.....	24.804	.....	5322.5	Do do.
Ascent of Noble's Pass, (spring)	8	8	12 m.....	1.43	.....	.....	632.6	22.7	70	.....	24.786	.....	5356.4	Do do.	
		8	1.30 p. m..	2.84	.....	.....	.....	620.3	23.2	69.5	.....	24.330	.....	5874.5	Do do.
Eagle Butte, overlooking lake..	3	8	2.20 p. m..	1.69	.....	.....	617.6	25.3	72	.....	24.235	.....	6000.1	Do do.	
		3	9.40 a. m..	.....	.....	609.4	19	609.1	19.6	66	24.871	24.859	.....	6392	Clear.
Camps 53 & 58, Summit creeks	2	8	3.40 p. m..	2.28	.....	.....	623.6	24.5	75.3	.....	24.489	.....	5726.1	Clear; wind southwest.	
		2	Sundown..	2.35	.....	.....	623.5	16	622.7	16	60	24.499	.....	5460	Clear; wind west.
In direct line for Pine creek ...	9	3	Sunrise....	.....	.....	622.5	1	623.7	.7	29	24.503	.....	.....	Clear and calm.	
		8	Sundown..	.....	.....	626.1	17	625.4	17	60	24.609	24.582	24.561	.....	Clear; wind southwest.
Open prairie, near Pine creek .	9	9	Sunrise....	.....	.....	626.1	0	627.1	0	29	24.635	24.674	24.568	.....	Clear; wind northeast.
		9	8.15 a. m..	3	.....	.....	.....	626.4	20	65	.....	24.544	.....	5603.2	Clear; wind southeast.
	9	9	9.10 a. m..	3	.....	.....	.....	628.8	22.9	73.5	.....	24.605	.....	5582	Do do.
		9	11 a. m....	1.65	.....	.....	.....	629	28	79	.....	24.589	.....	5632.5	Clear; wind west.

* This sheet of the table is not used in profile.

Meteorological observations and determinations for altitudes in crossing from the mouth of Canoe creek, (Poinsett river,) to Black Butte creek, and thence west to Hat and Wolf creeks.*

Camp 7, Canoe creek.....	July	21	Sundown..	.....	.....	687.7	19.5	686.4	19.5	68.5	27.012	27.022	2897.5	Clear; wind northwest.
		22	Sunrise....	.....	.....	687.5	4.3	687.7	4	41	27.033	27.003	.....	Clear; wind northeast.
In a ravine.....	22	12.30 p. m.	.....	.....	666.4	28.5	665	28.5	82	26.095	26.040	.....	3992.1	Do do.
West from camp on Black Butte creek, 4 miles.....	24	8.15 a. m..	.....	.....	634.1	27.5	.....	.....	78	24.815	.....	.....	5367.6	

West from last reading 2.50 miles, in valley of Canoe creek, (Poinsett river.)	24	12 m. ....	.....	657.3	33.5	.....	.....	91	25,706	.....	.....	4400.6	
Hat creek—distance given from spring.	10	3.30 p. m..	4.49	640.2	30.3	638.9	31	87	25,111	25,059	.....	5108.4	Clear; wind southwest.
Camp 60, Wolf creek.....	10	Sundown..	3	633.6	23.5	631.8	23 5	74.5	24,872	24,802	24,871	5245.3	Do do.
Camp on Wolf creek one mile below the preceding camp.	11	Sunrise...	.....	633.1	10.5	632.2	10.5	49	24,870	24,834	24,818	.....	Clear; wind east.
	24	Sundown..	1	634.5	23.5	635	23,8	76.5	24,909	24,920	24,899	51e5.5	Thunder; wind southwest.
	25	Sunrise....	.....	633.6	10	634	10	51	24,890	24,906	24,913	.....	Cloudy; wind southwest.

* This sheet of the table is not used in profile.

GEOLOGICAL REPORT.

Geological report of the country explored under the 38th and 41st parallels of north latitude, in 1853-'54.

SIR: In the report which I have the honor herewith to transmit to you, I have endeavored to give a description of the geology of the country through which we travelled after leaving Westport. It may, perhaps, more properly be termed a geology of the road over which we have travelled, since the geological exploration had to be confined to those parts of the country which lay in the immediate neighborhood of that road. I have not entered in this report into a too minute, and therefore tiresome description of details; nor have I attempted to found unwarrantable generalizations on restricted and, from their very nature, insufficient observations; but I have tried to represent, in as small a picture as possible, the chief geological features of the explored country. Many things that would have to be mentioned in an independent geological paper—as the shape and elevation of mountains and mountain chains, the configuration of the different parts of the explored country, &c.—have been omitted as a useless repetition of what has been given in your general report of explorations.

In describing the sedimentary rocks of the plains, it must, of course, be left undecided whether, in the succession of the strata as they have been enumerated, there are still some other strata lying between, for sometimes we travel a great distance, and the level changes many hundred feet before we meet again with an accidental outcropping of rock.

Between Westport and the Little Arkansas there is a series of limestone strata composed of rocks which differ in appearance and physical properties, fracture, color, hardness, &c., but which must, nevertheless, be considered as members of one and the same formation. Of the limestone around Westport, which extends into the Shawnee territory, (now Kansas,) there is a denudation on a creek near our first camp. It is in some places densely filled with petrifications, *Terebratula subtilita*, *Spirifer*, (*elviatus*?) *Productus splendens*, and two species of *Productus* not to be determined from my specimen, apparently a new species of *Phillipsia*, so as to appear almost as a conglomerate of these shells.

On Indian creek we find a limestone of a yellow red color, not very hard, and interspersed with white crystal leaves belonging to the organic remains of the rock, which have become obliterated by crystallization. It would be impossible to recognise to what kind of organism they belonged, but for the agency of the creek, which, in running over the rock, dissolves the softer part of it, leaving the crystallized parts behind, so that the whole surface of this limestone along the creek is thickly overspread with fossils. They are mostly parts of broken stems of a species of encrinites, fragments of some bryozoa, and of some other undistinguishable shells.

The next limestone, found near Willow creek, is gray, hard, of sub-crystalline fracture, and includes fossils, *Fenestella*, *Productus semireticulatus*, and *Productus æquicostatus*.

More westward, up to the Little Arkansas, we meet, from distance to distance, with outcroppings of limestone strata, but the rock becomes more compact, sometimes excessively hard, and petrifications are extremely rare, if they are not wanting entirely. I found in one case only a fragment of a small trilobite in a limestone west of Willow creek. The dip of all these strata, which must be considered as members of the coal formation, is a few degrees northeast.

A white, fine-grained, non-fossiliferous limestone on the Little Arkansas, and a red ferruginous sandstone, out of which Pawnee rock is formed, have a horizontal stratification. The latter is again found on Coon creek, and according to a specimen brought to me by Captain Gunnison, it extends up to the Republican Fork of the Kansas river. It supports a loose conglomerate of quartzose rocks, which is seen to extend some thirty miles along the Arkansas west of Fort Atkinson. It is very probable that these strata belong to the chalk formation, which, going westward, we find distinctly represented by several kinds of limestone strata; the first, about ninety miles from the fort, is a soft, argillaceous, yellowish limestone, with *inoceramus*. It seems to have a slight dip to the southwest. About thirty miles farther west, we meet with another limestone of the cretaceous period. It is a gray rock, a little harder than the preceding one, and is replete with *inoceramus mytiloides*. The row of low hills which, in these localities, stand at a short distance from, and extend along the road, consist of this limestone. These hills show lines which mark the banks of an ancient sea; they lie in one and the same horizontal plain, in whatever direction these hills may run.

At some distance east of Bent's Fort, a hard, compact, gray limestone has an outcropping on the road. It does not seem to include any organic remains; but a yellow red sandstone lying over it contains numerous impressions of shells. It is so soft that in transporting them the specimens of it were crushed to powder in the first hour, and I am left unable to determine to what species they belong. As much as I can recollect of them, they may belong to some species of *pecten*.

The chain of high and steep bluffs which begins some miles above Bent's Fort, is chiefly made up of two kinds of limestone; the upper one white, pure, hard, and fine-grained nearly to compactness, includes no organic remains, and would, if located in a less remote part of the country, offer a very valuable material to the practical arts, or for building purposes; the lower, a brownish rock, is interspersed with thin layers of crystals of carbonate of lime, and bears some indications of petrifications, but so undistinguishable that it is hardly possible to make out what they are. The stratification of both is horizontal. To judge partly from what I saw myself, partly from specimens brought to me, a blackish, hard limestone and a soft shale support them; the latter cropping out some twenty miles west of the fort in a kind of bottom land.

Having crossed the Arkansas near the mouth of the Apishpa, (presumed Huerfano,) our road leads over a gravelly and, in general, sterile soil—we are in the great American desert—and over sandstone, through which a number of creeks and rivers have cut their channels.

The underlayers of this sandstone are a yellowish, hard, fine-grained rock, the upper part soft, and eaten through by the atmospheric agents.

A few miles east of the cañon through which we entered the mountains proper, a hard, compact, dark-gray limestone, with some slight traces of petrifications and sulphuret of iron interspersed, and above it a limestone which is apparently identical with the lower brown limestone near Bent's Fort, crop out with a dip of 8° to 9° to the northeast. They rest on a hard silicious shale, through which igneous rocks have made their eruption near the mountains, forming buttes of sometimes remarkable shape. The most remarkable of them is the Huerfano butte, a little mountain of conical shape, consisting of black granite (quartz and black mica) and the just-mentioned hard silicious shale, the latter lying on the top of the butte.

In concluding the geology of the plains, I will here mention a kind of geological riddle which I have not been able to solve: About fifteen yards distant from the above-mentioned limestone hills of the cretaceous period, there is a little butte almost as high as the hill to which it stands nearest—about thirty-five feet—and of a shape which will be best seen from the accompanying drawing of it. It stands quite isolated, and consists not of limestone, but of a soft foliating shale. Even should that shale be found to support the limestone of these hills—which I could not decide, not having any instruments to dig into the ground—it would still appear strange that the shale of this butte could lie in the same horizontal plane with the limestone of the hills, and that it should have resisted devastation so long.

An analysis of atmospheric air, which I made in the neighborhood of Fort Atkinson, may also properly find a place here. The mean of three analyses executed with all care after the method of Prof. V. Liebig—absorption of the oxygen by a solution of pyrogallic acid in caustic potash—gave:

Nitrogen.....	79.09
Oxygen.....	20.91
	<hr/>
	100
	<hr/> <hr/>

This shows, as was to be expected, that the composition of the air on the high prairie does not differ from the well known invariable composition of atmospheric air elsewhere.

On entering the mountains we find a white, fine-grained, very hard sandstone, torn, fractured, and upheaved to nearly a vertical position by plutonic rock. The steep slopes of the mountains are covered with fragments of a white silicious rock, which in some places are of considerable size, forming blocks of twenty and more feet in diameter. The hills on the foot of the higher mountains are covered with drift rocks of all kind—quartz, porphyry, sandstone, &c.; even hypersthene rock is occasionally met with. About fifteen miles west of the cañon through which we entered the mountains, sandstone, and a red shale lying under it, are nearly vertically uplifted by a trachytic porphyry, which seems to have given to those mountains their peculiar

shape and elevation. This porphyry consists of a brownish gray, rough base, in which a great number of crystals of feldspar and crystals of black mica are imbedded, forming a rock of great beauty. The crystals of feldspar and mica are mostly perfect, and of the size of one to two tenths of an inch; the latter are hexaëdrix prisms, with basal cleavage. This rock, which forms the ridge from the trail in Sangre de Cristo to the route laid down by Captain Gunnison through that pass, seems to be of a very changeable character. East of the ridge the base of it is of a purer gray, the number of feldspathic crystals is less, and the numerous mica crystals are smaller, sometimes almost of microscopic size; but the basal cleavage is still easily detected. West of the ridge, the mica seems to have passed into tourmalin, the crystals of feldspar being scarce. The rock contains sometimes tolerably large crystallizations of a zeolitic substance, which for its physical properties and crystal form, as well as behavior before the blow-pipe, must be considered as stilbite. The predominating rock in the Sangre de Cristo valley is a feldspathic granite, passing gradually into gneiss on the right bank of the creek, the gneiss supporting a hard shale, sandstone, and a bluish brittle limestone. The latter belong perhaps to that class of non-fossiliferous transition rocks lying under the silurian system,* and the existence of which on this continent has been recognised by several distinguished geologists.

In the neighborhood of Fort Massachusetts, there are indications of iron ore, and even faint indications of cobalt ore, but I had neither the time nor the means to follow them up.

In the sandy, and for the most part sterile, San Luis valley, I looked in vain for some section or outcropping of the rock lying under the soil. During many days' travelling, this valley presents nothing but sand; and it was not even possible to ascertain the character of the under-soil. A striking and very curious illustration of the abundance of sand in this valley, is found in an isolated row of sand-hills opposite Roubideau's Pass. They are from 500 to 600 feet high, running for several miles in a direction from northwest to southeast. It is very probable that some solid rock is buried under this sand, having been the cause of its accumulation. Along the foot of the White mountains (Sierra Blanca) we found numerous boulders of igneous rocks which do not seem to correspond with the rocks of the neighboring mountains. The chief rock of the Sierra Blanca in and around Roubideau's Pass, is an altered, rough, bluish violet, mica slate, through which quartzose, granitic, and porphyritic rocks have erupted, including pieces of each other, so as to form quite a chaos of rocks.

The entrance to the beautiful Sawatch valley is marked by an isolated butte of hard, gray, granitic porphyry, with glassy feldspar and mica. The valley is formed by picturesque mountains, which are often vertical, or of a true trapp form, on the south

* The cambrian system, as distinguished from the silurian system by its age and organic remains, is not recognised any longer by geologists. Comp. Murchison, in *Quarterly Journal of Geology*, vol. VIII, 1852. Murchison's *Siluria*, 1854.

side, less steep and covered with timber on the north side, where the destruction of the mountains by the melting snows, rains, &c., is less rapid. The rock which constitutes these mountains is a red trapp-porphry,* with a red feldspathic base, with glassy feldspar and mica. Thin splinters of this base melt with difficulty on the edges before a well-directed jet of the blow-pipe.

More westward the mica in this rock becomes scarce, though it never disappears entirely from it. Near camp 53, where we left the Sahwatch creek in order to go over the pass, the mountains on the right bank of the little creek, coming down from the north, are composed of a kind of granitic rock, black mica imbedded in a crystalline mass of glassy feldspar. The only sedimentary rock found between Sangre de Cristo valley and Coochetopa creek was a hard, fine-grained sandstone near the divide of the Sierra St. Juan.

On the west side of the Coochetopa Pass, we meet again with two kinds of porphyry; the one resembling the gray porphyry of Sangre de Cristo, the other that of the Sahwatch butte, containing, however, more mica. In the lower regions of the mountains, forming the valley of the Coochetopa creek and the Grand River valley, feldspathic granite, gneiss, a rough silicious shale and a fine mica slate, the latter dissolving only under a powerful lens into a mixture of quartz and mica, and a white sandstone, are the predominating rocks; in the upper regions, sandstone and trapp-porphry, the latter resembling very much the trapp-porphry of Sahwatch valley. It consists of a compact, hard, brown-violet feldspathic base, interspersed with crystallized glassy feldspar, and a few mica crystals. Thin splinters of

*The term trapp is used so vaguely, and with so little distinction, that it is often impossible to know what kind of rock is meant by that name. With some authors it seems to designate any kind of igneous, not granitic, rock. That this looseness of language is a general one, will appear from quotations from three distinguished geologists:

"Connected with the aforementioned rocks—diabase rocks, (euphotides;) hypersthene rocks; pyroxene rocks, including basalt, dolerite or greenstone; amphibolic rocks, including diorite or greenstone; trachytic and porphyritic rocks—there is a whole series of rocks which agree with those in so far as all of them contain only simple silicates, whilst the granites and their neighbors, containing an excess of silica, are multi-silicates. But what distinguishes the trappean rocks from all the preceding ones, is the want of any perceptible structure; not even the microscope shows any structural elements in the trapp rocks. They are in some manner related to the basalts; they have the same volcanic origin, were in a state of fusion at the time of their formation, and separate like those in regular masses, or even in hexahedral prisms. All these rocks, which Hatty called 'aphanites' on account of their undeterminable structure, are rough to the touch. It is probable that chemical analysis will offer the means of classification for these rocks; at present this is impossible. In his examination of the trapps of the Ferroe islands, Durocher has pointed out the way chemical analysis has to follow in this respect; he has shown these trapps to consist of two varieties, of which one must be reckoned amongst the hyperites, the other amongst the euphotides; the latter being easily distinguished by its yielding water when heated."—*Elie de Beaumont, in his "Cours de Géologie à l'École des Mines," German version, by C. Vogt.*

"Trapp or greenstone is a dark and heavy blackish-green or brownish rock, consisting of hornblende and feldspar; it usually has a crystalline texture, but is sometimes compact: When albite replaces the feldspar, it is called diorite and diabase. Basalt is a similar rock, &c., &c."—*Dana's Mineralogy, (3d édition.)*

"Trapp and trappean rocks. Volcanic rocks, composed of feldspar, augite, and hornblende. The various proportions and state of aggregation of these simple minerals, and differences in external forms, give rise to varieties which have received distinct appellations, such as basalt, amygdaloid, dolerite, greenstone, and others. The term is derived from trappa, a Swedish word for stairs, &c., &c."—*Lyell: Principles of Geology.*

this base melt more easily on the edges before the blow-pipe than the Sahwatch porphyry. This rock lies mostly horizontal, about sixty to seventy feet thick, on the summit of the mountains, over a white sandstone, forming sometimes remarkable platforms. It seems to have an immense extension, for we found it for over a hundred miles along our road. As it must necessarily have been in a state of fusion at the time it spread over the sandstone, we may form an idea as to the scale on which eruptions of igneous rocks have taken place at a time when sedimentary strata of considerable thickness were already in existence.

By contact with granite, this rock has in some places (along Grand river) become blackish and very brittle. It seems to have been displaced when already in a solid state, for it has polished surfaces which could only be produced by its sliding over some other solid rock. I cannot positively assert that this rock is an altered trapp-porphry, for I could nowhere trace a direct connexion; but in their lithological character, they stand very near each other. The narrow cañon of Grand river, below camp 58, is formed of granite and this rock. Some miles above that cañon, a conglomerate of igneous rocks of all kinds, imbedded in a very hard cement, lies under the sandstone; and, when during and after the gradual upheaval of the mountains, the other rocks were completely washed and worn away, this conglomerate has partially resisted the action of time and the weather, so that parts of it are seen hanging over the steep sides of the mountains in the shape of towers, resembling very much those ruins of old castles which, though remnants of barbarous ages, give unequalled charms to so many landscapes in the eastern world. The great hardness of the cement of this conglomerate—I nearly broke my steel hammer in the attempt to break some pieces off—induced me to make some chemical experiments as to its composition. It consists, however, of nothing but impure carbonate of lime, being entirely soluble in diluted chlorhydric acid. The solution evaporated to dryness, and redissolved, does not leave a trace of silica behind.

The country between the St. Juan and Wahsatch mountains is a barren, dreary desert. The road leads mostly over sand or its generator, sandstone; which latter constitutes the several smaller mountain ranges between these two great chains. Sandstone, assuming all shades of color, sandy calcareous clay slate, argillaceous limestone of green and red colors, sandy shale, and uppermost a soft foliating shale from gray to black, including much fibrous and lamellar gypsum, seem to be the formations composing the "Elk mountains." All these different strata are concordant, and of a slight northeast dip. Some miles distant from where we crossed the Nah-un-kah-rea, blocks of a dark trachytic porphyry lie over the sandstone and shale, extending some miles along our road. Boulders of this trachytic rock are occasionally met with quite up to the Wahsatch mountains. In the valley of the Blue river, a coal measure, supported by sandstone, crops out at several places; but the coal does not seem to be of a good quality. Not far from where the latter river empties into Grand river, a hard conglomerate of pebbles baked together, a hard, bluish lime-

stone, and a dark, silicious shaly rock, with agate, are met with, but do not seem to have a great extension.

That the disintegrations of such rocks cannot yield a good soil is evident, and not much organic life can be expected in such a country. But there does not even seem to have been any organic life in the ancient seas, in which the sedimentary rocks of this country have been deposited. I could not detect any rock including organic remains of any kind whatever. It is true, in the neighborhood of Grand river, near camp 72, there are fragments of a dark gray limestone, with numerous casts of shells—mostly fragments of ammonites—strewn over the ground on the top of a sand-hill, together with quite a number of loose shells, "*Gryphæa pitcherii*," showing the rock to have originated in the cretaceous period; but within a circuit of several miles, it could not be found in situ. The want of petrifications in the rocks of these desolate regions, renders a determination of their relative ages somewhat hazardous.

It is a remarkable feature in the character of the country between the Rocky mountains and the Sierra Nevada, that whole formations disappear, as it were, before our eyes. The wearing and washing away of mountains takes place here on an immense scale, and is the more easily observed, as no vegetation of any account covers the country, hiding the destruction from the eye. Nature here seems only to demolish, without showing any compensating creative activity. Days before we found the above-mentioned towey conglomerate on Grand river, we saw mostly small pieces of rocks on the road which did not belong to the surrounding mountains, and which afterwards could be identified with the rocks contained in that conglomerate. As these rocks could not have been drifted there from a place about a thousand feet lower, we must conclude that large masses of this conglomerate have been carried away, leaving a number of these rocks behind. All along our road in the Grand and Green river country, on the slopes of high mountains, and in the level country, the soil is overstrewn with pieces of agate, cornelian, calcedony, and other quartzose minerals, which I could not refer to any rock. In the neighborhood of the Wahsatch mountains, these minerals again make their appearance; but here they are traceable to a rock which still constitutes a great part of the mountains of this range. The devastation may here be followed step by step. A similar process has been going on in the country of Blue and Green rivers with other strata. The black, soft shale, with gypsum and the strata below it, have disappeared from an immense tract of land. For days before we struck Green river, we travelled over a black, clayish, absolutely sterile soil, produced by the decaying mountains, and in different places, chiefly at a short distance from where we crossed Green river, we found remnants of those strata in buttes of sometimes considerable height, some of them assuming the shape of huge chimneys.

On the foot of the Wahsatch mountains, close to Akanaquint creek, and about a mile from camp 88, a coal measure of an excellent bituminous coal crops out. It rests on sandstone, a thin layer of a brown, soft clay intervening between them, and is about three feet thick on the outcropping.

As soon as we are over the first ridge of the Wahsatch mountains, porphyritic rocks again make their appearance, and their disintegration again gives rise to a better soil and more luxuriant vegetation. These porphyries, from red to dark gray, belong undoubtedly to different periods. One of them erupted, when an oolitic limestone covered the country.

At a short distance from our road, over the second high ridge, numerous pieces of this limestone may be seen. That the presence of the latter rock in these localities is not merely accidental, is proved by the fact that by contact with the porphyry, it has been altered, and has baked together with it. White sandstone, a white, very pure, compact limestone, a greenish and a red argillaceous limestone, and a sandstone containing mica, are the sedimentary rocks of the Wahsatch mountains in the regions of Swambah creek. None of them contain fossils.

A bed of pure crystallized gypsum in the valley of the Ungot-tah-bi-kin creek, deserves to be particularly mentioned. The crystals are imbedded in a red or green marl in such abundance as to form a whole mountain of this valuable mineral. The section of the bed, about a mile from our road, extends about forty feet above the level of the soil, and it has very likely a considerable depth.

In many parts of the Wahsatch and Tuilla mountains, a silicious rock, mostly calcedony and agate, breaks through a gray-white or gray limestone, infiltrating the latter, and forming veins of sometimes considerable thickness. The cañon leading to Swambah creek, and the ridge of the Tuilla mountains, east of Cedar creek, consists of this infiltrated limestone.

On Swambah creek, I found an extraordinarily large block of crystals, apparently calcareous spar. They were white, semi-transparent, of granular fracture, and consisted of—

Carbonate of lime.....	93.66
Carbonate of magnesia.....	4.12
Carbonate of protoxyd of iron.....	2.02
Water.....	0.20

100

To the simple minerals occasionally mentioned in the preceding, the following may be added :

Dolomite, found in the valley of Ungot-tah-bi-kin creek.

Hyalite, in the trapp-porphry of the valleys of Coochetopa creek and Grand river.

Sulphuret of molybdena, in the Wahsatch mountains.

Asphaltum, in different places in the Wahsatch and Tuilla mountains.

Had the Indian difficulties during last winter made geological excursion in Utah Territory admissible, the extraordinary deep snows of that winter would have made them quite useless, if not impossible. For the same reason, our winter excursion into the Wahsatch mountains and Green river country resulted quite unproductively in geological facts, and I am not able to add anything new to the geology

of that country, as it has been described in former reports, with the exception, however, of a phenomenon which the Great Salt lake offers, and which not only possesses a scientific interest, but may be made of great importance to the development of chemical arts in the valley of the Saints.

In summer the evaporation of the water of the lake is so great and the solution of salts, becomes so concentrated, that a part of them is deposited on the bottom of the lake. In some places, I have been told, this sediment has been found to be two feet thick. It consists of variable quantities of *sulphate of soda* and chloride of sodium, the sulphate exceeding by far the chloride, at least in the specimens which came under my examination. In the manufacturing of soda, an immense capital is annually wasted in producing this sulphate, which is finally converted into carbonate of soda. It can be had here for the mere trouble of taking it out of the lake.

Another interesting mineral production of the localities around that remarkable lake is found in great quantity at Alum Point, and in other places in Utah Territory. It is the manganesian or feather alum, a mineral of great use in the so-called tawing process, and an excellent material for preserving the skins of birds and other animals. It has rather been considered hitherto as a rare mineral.

The composition of this alum does not seem to be constant; at least not in relation to its proportions of water. I obtained from one specimen 37.25 per cent. sulphuric acid, and 39.45 per cent. of water; and from another 37.26 per cent. sulphuric acid, and only 32.85 per cent. of water. There was no time to complete the analysis.

In the regions between the Tuilla mountains and the Sierra Nevada, the desert character is not so constantly preserved as in the country east of the Wahsatch mountains, and the soil offers in many places, as far as its chemical composition is concerned, by far more resources. The slopes of the mountains west of the Humboldt mountains are often covered with an excellent soil, producing a good grass, and the want of a more luxuriant vegetation can only be explained by atmospheric and similar influences.

The mountains on the west side of the Great Salt lake have their chief geological features in common with those on the east side. A dark limestone belonging to the coal formation, and above it a conglomerate, resting on porphyritic and granitic rocks, in some places on a silicious shale, constitute the materials out of which they are formed. This limestone as well as the conglomerate, or rather remnants of them, are occasionally met with in many other places travelling westward. The former is one of the main rocks constituting the Humboldt mountains, where it overlies granitic masses. In the northern parts of this mountain range, the granite passes gradually into quartz, the latter assuming in some places a shaly structure. It is through this limestone that the waters of a subterranean creek in the Humboldt mountains have broken an outlet. Both limestone and conglomerate are often found on the summits of the highest peaks of those regions. A soft shaly rock has almost entirely disappeared from that country, and I found remnants of it only in one single place east of the Humboldt mountains; but the clayish soil, over which

we had to travel for days, and which contained a number of small pieces of the rock, led to the belief that it extended once far over the country.

The island mountains in the salt desert immediately west of Great Salt lake consist of granitic and porphyritic rocks; the latter is like most of the porphyries we met with, trachytic, its brownish base dissolving under a lens into small grains and broken crystals melted together. It includes numerous crystals of feldspar and grains of quartz, many half an inch thick, and is very hard.

About a mile and a half from the eastern foot of the Humboldt mountains, about camp 19, (1854,) an interesting phenomenon is presented to the view, by a number of warm springs—some forty—all of them lying in a circuit of about a hundred yards in diameter. They rise in tubular channels cut through the granite, most of them having a kind of funnel-shaped reservoir on the surface. The smell of the water and a deposit around the springs, show at once that they contain sulphuretted hydrogen, and, although quite tasteless when cooled, the water contains, besides the sulphuretted hydrogen, a slight proportion of chlorides and sulphates, as shown by chemical test. The temperature of the water on the surface is about 132° Fahrenheit. The spring we found afterwards in Honey Lake valley seems to have the same chemical composition, but its temperature is at the boiling-point.

The mountains lying between the Humboldt mountains and Humboldt river, by our path, are chiefly composed of quartz rocks, trachytic or dioritic porphyry, the above-mentioned dark limestone and conglomerate, and a soft, white, argillaceous or calcareous sandstone. The most remarkable rock in that country, and which deserves a particular mention, is found around the gorge we came through on the 2d of June, and for which I proposed the name of "Agate cañon." This rock is a compact mixture of minerals of the quartz family—agate, calcedony, and jasper, and is evidently of igneous origin. To the practical arts it would offer a material, which for beauty and hardness can hardly be surpassed.

West of Humboldt river we find quartzose rocks, syenites, and granites, and a soft clay-slate, as the predominating rocks; but the nearer we approach to the Sierra Nevada, the more the so-called volcanic rocks take their place, and at last become the only constituent material of the mountains. In Mud Creek cañon, at the foot of the Sierra, we find for the last time a rock which, by its lithological character, is related to the rock I designated as trapp-porphyry, only that it has become shaly or foliating, by the influence of the surrounding volcanic rocks. In the neighborhood of that cañon I found a rock which has all the appearance of standing between this rock and the trachytes of these regions, and which seems to have been formed by the action of these rocks upon each other.

Leaving the cañon where a conglomerate of igneous rocks crops out from under the above-described shaly trapp, we no longer meet with any older plutonics, or with any sedimentary rocks. Even sandstone, so abundant in the country we before traversed, has disappeared, and the more recent rocks, basalt, phonolithe, ringing beautifully to the hammer, and chiefly trachytes, with a number of intermediate rocks,

become masters of the ground. The trachytic rocks seem to be the predominating, if not the only rocks in those parts of the Sierra, which we had to traverse when travelling from the headwaters of the Sacramento river down to Honey Lake valley, and which are covered with the most magnificent pine forests.

The highly interesting scenery around the so-called "Black Butte" bears, of all the parts of the Sierra Nevada we passed over, most strikingly the character of a volcanic country. Surrounded by elevated peaks and high cliffs, and quite isolated, stands a mountain, from eight hundred to a thousand feet high, of conical shape, and formed of black lava, apparently a monument of the latest disturbing forces in these regions. The lava is in some degree decomposed at the surface, and the butte, as well as the soil around, are covered with volcanic sand and blocks or small pieces of that lava. In the cliffs on the west side of the butte, the lava passes gradually into trachyte. The summit of this mountain butte is rounded, and no opening in it is perceptible from below.

On the western slopes of the Sierra we find a granitic trachyte, which is distinguished from all other trachytic rocks of the Sierra we met with. It is a reddish gray rough rock, interspersed with crystals of mica, pyroxene—a crystallized mineral, splinters of which melt before the blow-pipe into a pearl, giving out an intense light—and another transparent substance, on which the blow-pipe has no effect, and which, on closer examination, will very likely prove to be a very brittle quartz. The time allowed to this report unfortunately does not admit of a thorough chemical examination, as well of this as some other interesting rocks described above. It would be of the highest scientific interest to know whether these rocks, and chiefly the trachytes of the Sierra Nevada, conform to the law which in the last few years has been established by K. Bunsen. The great importance of this law, which seems to explain complicated phenomena in a very simple way, and which is not so generally known as it deserves to be, induced me to give a short exposition of it in this report, and to verify it by such analyses as I have been able to make during the limited time allowed for the preparation of this report.

In the fact, established by him experimentally, that the point at which melted substances become solid, varies according to the pressure exercised on these substances, Bunsen expected to find an explanation for the great variety of eruptive rocks, and for the contradictions in the succession of the crystallization of the several mixing substances in relation to their fusibility. The analyses of rocks in the lump, without separating the different simple minerals of which they are composed, which hitherto have been so much neglected, again become important. The analysis of a great number of the characteristic rocks of Iceland, led to the opinion that all these rocks have originated from separate or combined eruptions out of only two independent hearths. One of these hearths furnished the trachytic, the other one the pyroxenic rocks. Their mixing up gave rise to a series of intermediate rocks, which Bunsen called "trachyto-pyroxenic." Great as may be the difference between their ages, mineralogical character, and arrangement, the trachytic and the pyroxenic rocks

show a constant average composition, which has only in a few cases been disturbed by local influences, which are easily traced.*

The first of the extreme members of these rocks, the normal trachytic, is a mixture of bisilicates of alumina and bisilicates of alkalis, the oxygen of the acid to that of the basis being as 3 : 0.596. In the other extreme member, the normal pyroxenic, the proportion between the oxygen of the acid and that of the bases (alumina, lime, magnesia, potash, soda, protoxyd of iron,) is 3 : 1.998, or as 3 : 2, almost. They are to be considered a mixture of bibasic silicates. The proportion between silica and magnesia and lime is almost always constant; but that between alumina and protoxyd of iron is subject to great variations, as shown by analysis. The cause of it is, that such parts as become more easily solid, separate first without the force of crystallization being active. For this reason there are sometimes considerable differences in a rock in short distances. The amount of the variable part changes, however, only slightly. Taking the mean of a great number of analyses, Bunsen gets the composition of the normal trachytic and the normal pyroxenic rocks of Iceland. In the rest, being mixtures of these two, the ratio of the oxygen of the acid to that of the bases varies between the given limits. Their character depends upon these proportions and the physical conditions that ruled their formation. Be S the per cent. of silica in such a mixed rock, be 5 the per cent. of silica in the normal trachytic, and

6 in the normal pyroxenic rock—then $\frac{5-S}{S-6}=a$, where a represents the quantity of normal pyroxenic rock to be mixed with one part of trachytic rock, in order to give the composition of the mixed rock. For the computation of a , B chose the silica, which is easily determined, and by the quantity of silica the quantities of the other parts are also given. Be $p_0, p_1, p_2 \dots p_n$, the quantities of the single component parts in one part of normal pyroxenic, and $t_0, t_1, t_2 \dots t_n$, the same in one part of normal trachytic rock, we may then calculate the quantities of the component parts in a mixed rock by the equation—

$$1 = \frac{(ap_0+1)}{a+1} + \frac{(ap_1+1)}{a+1} \dots + \frac{(ap_n+1)}{a+1}.$$

With the help of this formula all the theoretically possible primitive rocks of Iceland have been calculated and put in tables, and with these theoretical numbers all the analyses of Icelandic rocks agree perfectly; the law holds equally good for the volcanic rocks of Armenia and volcanic rocks generally, and its applicability to the older or plutonic rocks has been put beyond all doubt by the analysis of a great number of granites, syenites, diorites, porphyritic and hornblende rocks, from different countries.

* Comp. Annual Report by Liebig and Kopp, 1851—1853.

The compositions of the normal trachytic and normal pyroxenic rocks are:

	Norm. trach.	Norm. pyr.
Silica.....	76.67	48.47
Oxyd of aluminium.....		
Protoxyd of iron.....	14.23	30.16
Oxyd of calcium.....	1.44	11.87
Oxyd of magnesium.....	0.28	6.89
Oxyd of potassium.....	3.20	0.65
Oxyd of sodium.....	4.18	1.96
	100.00	100.00

The analysis of a rock from the Sierra Nevada, about 40 miles south of Madelin Pass, gave 50.93 per cent. of silica. According to the first of the above formulas, this rock is a mixture of 1 part of normal trachytic and 10.46 parts of normal pyroxenic rock. The second formula gives its composition as—

Silica.....	50.93
Protoxyd of iron and alumina.....	28.77
Oxyd of calcium.....	10.96
Magnesia.....	6.31
Oxyd of sodium and potassium.....	3.03
	<u>100.00</u>

The direct analysis gave:

Silica.....	50.93
Protoxyd of iron and alumina.....	29.35
Oxyd of calcium.....	10.33
Oxyd of magnesium.....	5.97
Oxyd of sodium and potassium.....	3.42
	<u>100.00</u>

The following is an analysis of a rock from the headwaters of Pitt river, by Mr. Gustavus Baumgarten, done in my laboratory and under my direction. The determination of silica gave 57.65 per cent.; the rock is a mixture of 1 part normal trachytic, and 2.07 parts of normal pyroxenic rock:

	Composition accord- ing to second for- mula.	Composition found by analysis.
Silica.....	57.65	57.65
Protoxyd of iron and alumina.....	24.97	27.56
Oxyd of calcium.....	8.47	6.53
Oxyd of magnesium.....	4.74	5.30
Oxyd of sodium and potassium.....	4.17	2.91
	100.00	100.00

These analyses hardly admit of any doubt as to the applicability of Bunsen's law to the igneous rocks of the Sierra Nevada. It would seem that the hearth of the trachytic masses was lying north, and that of the normal pyroxenic masses more south; a greater number of rocks must, however, be analyzed before we can form a more reliable opinion on that point.

In the Sierra we travelled for days over a red soil, which, according to the popular belief, is gold-bearing. This seems, however, a mistake, produced by the resemblance of its color to that of the soil in the Sacramento valley. It comes from a disintegrated red volcanic rock, of which I found occasionally pieces of six inches in diameter.

There is, however, an auriferous rock, the existence of which in California I find nowhere mentioned, which I found near the summit of one of the high peaks on the Upper Sacramento, (Pitt river.) It is a red rock, with porphyritic structure, and of excessive hardness, bearing unmistakably the signs of gold.

In the rugged Pitt river country, where Canoe creek empties into that river, and a short distance above the mouth of the creek, there is a kind of dam along the creek, made up of a white soil, which, a little remote from the creek, forms a regular stratum of considerable thickness. The rock around is a porphyritic trachyte, and no sedimentary rock of any kind could be detected. On examining this earth under the microscope, I found it to consist of the silicious coats of infusoria; and I therefore sent a specimen of it, together with a specimen of infusorial earth, found in Honey Lake valley, to Professor Bailey, at West Point, as the savan who is best acquainted with American infusoria. According to him they are both made up of diatomaceous shells; some of them are novel, and both are of fresh-water origin, containing many well known species still living all over our country. A fuller description of the new species will be given by Professor Bailey.

I am, sir, very respectfully, your obedient servant,
JAMES SCHIEL, M. D.,
*Surgeon and Geologist for Explorations for Central
Pacific Railroad Route.*

Lieut. E. G. BECKWITH,
3d U. S. Artillery, in charge of Explorations.

List and description of organic remains collected during the exploration of the central Pacific railroad line, by Dr. James Schiel, 1853-'54.

Pl. , Fig. 1.—*Fenestella*. Branches slender, bifurcating, with two rows of pores; sometimes but one row; intervals oval or oblong, with rounded angles, and variable in size.

It occurs with *Productus semireticulatus* and *Productus aequicostatus* in the limestone on Willow creek. It might, perhaps, be referred to *Fenest. patula* of McCoy.

BRACHIOPODA.

Pl. , Fig. 2, a, b.—*Terebratula subtilita*. Hall, Stansbury's expedition to the Great Salt lake, 409; Pl. 4, Figs. 1, 2. Gibbous, obovoid, valves nearly equal; beak of the dorsal valve elevated, incurved, perforated at the apex, mesial depression from centre to front; surface marked with concentric striæ and with faint, radiating striæ.

Occurs with *Productus splendens*, *Spirifer striatus* (?) *Phillipsia*, in the carboniferous limestone about six miles west of Westport. In one specimen the radiating striæ are very distinct.

Pl. , Fig. 3.—*Productus splendens*. Norwood and Pratten. The Producti in the western States, 11; Pl. 1, Fig. 5.

From the same limestone.

Pl. Fig. 4, a, b.—*Productus aequicostatus*. Shumard. Large, elongate, dorsal valve much elevated; beak small, passing slightly beyond the cardinal border; surface covered by longitudinal ribs, which bifurcate near the beak, and then continue without further division to the front, the spaces between being occasionally supplied with new ribs. These ribs are slightly sinuous occasionally, but most of them are straight from their origin to their termination.

Occurs with *Finestella* and *Productus semireticulatus* in the limestone on Willow creek. I have adopted for this shell the name given to it by Dr. Shumard, who kindly furnished me with the above preliminary description from his manuscript on the palæontology of the State of Missouri. A fuller description, and a drawing of a better and more perfect specimen, will be found in his report.

Pl. , Fig. 5.—*Spirifer*, (indet.) Most likely *Sp. striatus*, yet the specimen is too imperfect for description.

Occurs with *Terebratula subtilita* in the limestone near Westport.

CONCHIFERA.

Pl. , Fig. 6.—*Inoceramus*, (indet.) The specimen is only a cast of inoceramus from a yellowish cretaceous limestone near Fort Atkinson.

Pl. , Fig. 7.—*Inoceramus confertim-annulatus*. Roemer, Kreide, Texas, 59. Transverse, ovate, depressed, with concentric ribs and striæ; the spaces between the ribs hardly equal to their width, and marked with regular, equidistant, elevated lines.

I got this inoceramus in Salt Lake City, as coming from the Upper Green river country. It belongs to the cretaceous period.

Pl. , Fig. 8.—*Inoceramus pseudo-mytiloides*. Inequivalved, elongated, with concentric ribs and striæ; anterior part subtruncated; posterior part slightly compressed, with a wing-like extension of the posterior margin against which the striæ are bending.

It occurs in a gray limestone west of Fort Atkinson. The only difference between this shell and *Inoc. mytiloides* is the bending out of the striæ.

Pl. , Fig. 9.—*Gryphæa Pitcheri*. Shell thick, expanded, distinctly lobed, lower valve convex, upper valve thick and subconvex; beak distinctly incurved. (Morton.)

It was found on the top of a sand-hill near Grand river, where it occurs in great abundance, together with impressions of an ammonites. I am indebted for the determination of this shell to Professor Hall, who has several beautiful specimens in his collection.

Pl. , Fig. 10.—*Cardium multistriatum*. Shumard. Exploration of the Red river of Louisiana by Marcy and McClellan, 203; Pl. 4, Fig. 2. Shell subrotund, inflated, length and breadth nearly equal, truncated positively, basal and anterior margin rounded; concentric striæ on the surface.

I was given this shell, with the above *Inoceramus confertim-annulatus*, as coming from the Upper Green river. It belongs to the cretaceous period.

Pl. , Fig. 11 and Fig. 14. Fig. 11.—*Pygidium* of a *Phillipsia*. A new species, from the limestone near Westport, where it occurs with *Terebratula subsilita*, *Productus splendens*, and apparently two other new species of *Productus*, of which my specimens are too fragmentary to be described. Fig. 14.—*Phillipsia* from a carboniferous limestone west of Indian creek.

Pl. , Fig. 12.—A piece of limestone from Indian creek, the surface being covered with pieces of stems of a species of encrinites and some bryozoa.

Pl. , Fig. 13.—Impression of an ammonites found with *Gryphæa Pitcheri* on Grand river.

JAMES SCHIEL, M. D.,
Surgeon and Geologist for Explorations for Central
Pacific Railroad.

Letter from Professor J. W. Bailey upon infusorial fossils, submitted to him by Dr. Schiel.

WEST POINT, N. Y., December 14, 1854.

DEAR SIR: I have been requested by Dr. Schiel to send to you some drawings of the fossil Diatoms found by him in California. As I have a considerable amount of matter on hand which claims precedence to this, I have only had time to make the accompanying notes and sketches, which can be disposed of as you may think best.

Specimen No. 1.—Honey Lake Valley.

This is a fine, grayish white powder, chiefly composed of Diatomaceous shells, all of which are of fresh-water origin, and probably of recent date. The following are the chief species which I have noticed:

Epithemia, allied to *E. Westermanni*; several varieties of form, perhaps several species. See figs. 5, 6.

Cocconema asperum, Ehr.

Cocconema cymbiforme, Ehr.

Discoplea atmosphaerica, Ehr.

Surirella campylodiscus, (?) Ehr. Fig. 4, *a, b*.

Cocceneis. Fig. 3.

Cymbella gibba, Bailey. Fig. 1.

Cymatopleura (?) *Campylodiscus*, Bailey. Fig. 2, *a, b*.

The last two species I believe to be new, and they may be characterized as follows:

1. *Cymbella gibba*.—Bailey, (Fig. 1.) Bases somewhat triangular, rounded, and very gibbous on the dorsal side, slightly concave on the ventral side. Length, $\frac{1}{1000}$ of an inch; width, about two-thirds of the length. Locality, Honey Lake valley.

2. *Cymatopleura* (?) *Campylodiscus*.—Bailey, (Fig. 2, *a, b*.) Bases circular, or sometimes irregularly bent like a *Campylodiscus*, marked with one deep transverse undulation. Margins strongly striated. Diameter, $\frac{4}{1000}$ to $\frac{5}{1000}$ of an inch. Locality, Honey Lake valley.

Specimen No. 2.—Junction of Canoe creek and Sacramento river, California.

A fine, white powder, chiefly composed of a minute species of *Galleinella*. (See Fig. .)

It is undoubtedly of fresh-water origin, but contains some circular discs so much resembling the marine *Actinocyclus*, that a mistake as to its origin might easily be made. By careful examination of these discs, however, I have proved them to belong to the genus *Stephanodiscus*, and have found the crown of thorns preserved on some specimens, although they are commonly broken off. The principal forms I have noticed in this specimen are—

Galleinella (Fig. 7, *a, b*) forms chief portion of the mass.

Galleinella *varians*.

Stephanodiscus—perhaps new.

Pennularia nobilis, Ehr.

Pennularia viridis.

Epithemia, as in No. 1, but comparatively rare.

Surirella splendida (?) Ehr.) in fragments.

Pollen of pine.

Spongiolites, which are also present in No. 1.

There are many other fresh-water forms in both specimens, but I have not had time to study them satisfactorily.

Yours, very truly,

J. W. BAILEY.

Lieut. BECKWITH.

REPORT
OF
EXPLORATIONS FOR A RAILWAY ROUTE,
NEAR THE THIRTY-FIFTH PARALLEL OF LATITUDE,
FROM
THE MISSISSIPPI RIVER TO THE PACIFIC OCEAN.

BY LIEUT. A. W. WHIPPLE,

CORPS OF TOPOGRAPHICAL ENGINEERS.

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THE UNIVERSITY OF THE STATE OF NEW YORK

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REPORT.

CHAPTER I.

Instructions from War Department.—List of party.

WASHINGTON, D. C., July 31, 1854.

SIR: I have the honor to submit the accompanying maps and profiles of the route for a railway explored by me from the Mississippi river to the Pacific ocean, in conformity with the following orders:

“WAR DEPARTMENT, *Washington, May 14, 1853.*

“Under the 10th and 11th sections of the military appropriation act, approved March 3, 1853, directing ‘such explorations and surveys’ to be made as might be deemed necessary to ‘ascertain the most practicable and economical route for a railroad from the Mississippi river to the Pacific ocean,’ the War Department directs such explorations and surveys to be made as will develop the availability for this purpose of that portion of our territory which lies near the parallel of 35^o north latitude. The following instructions with reference thereto are issued for the government of the different branches of the public service:

“1. The party for this exploration and survey will be commanded by First Lieutenant A. W. Whipple, of the topographical engineers, who will be assisted by Brevet Second Lieutenant J. C. Ives, topographical engineers, and such civil assistants as may be required and the Secretary of War approve.

“2. The Adjutant General will detail the necessary escort, transportation for the provisions and equipage of which shall be furnished by the Quartermaster General. Second Lieutenant D. S. Stanley, 2d dragoons, will act as quartermaster and commissary to this expedition.

“3. Upon the proper requisitions, officers on duty in the quartermaster and commissary departments at the various military posts upon the route will furnish, as far as possible, all necessary supplies, which will be paid for at cost prices from the appropriation for the survey.

“4. Medical stores will be furnished by requisitions upon the Surgeon General.

“5. Ammunition and arms may be obtained from the Ordnance department.

“6. This party being organized, will collect the necessary instruments and equipments. It will then repair to the field with the utmost despatch, and proceed with the survey and reconnaissance in question. The main party will rendezvous at some convenient point on the Mississippi river, and thence proceed by the most favorable route westward towards Rio del Norte. From hasty reconnaissances, and from such information as can be obtained from other sources, it may be determined from what point upon the river Mississippi the proposed rail

way should commence, and whether it may be advantageously connected with any railway already projected by States or companies westward from that river.

"The reconnaissance will continue along the headwaters of the Canadian, cross the Rio Pecos, turn the mountains east of the Rio del Norte, and enter the valley of that river at some available point near Albuquerque. From thence westward, extensive explorations must determine the most practicable pass for a railway through the Sierra Madre and the mountains west of the Zuni and Moquis countries to the Colorado. In these explorations Fort Defiance can be made a depot for supplies, and may furnish subsistence and transportation thence for the remainder of the route. From Walker's Pass it would be advisable to pursue the most direct and practicable line to the Pacific ocean, which will probably lead to San Pedro, the port of Los Angeles, or San Diego.

"Lieutenant Whipple will immediately detail an officer, with a small party, to proceed directly to Albuquerque, in New Mexico, in order to make that place a cardinal astronomical point in the survey, and to hasten preparations for the necessary explorations in the mountainous regions of New Mexico before the approach of winter.

"Over such portions of the route as evidently afford no material obstacle to the construction of a railway, a rapid reconnaissance will suffice. This work, however, must be checked by numerous geographical points determined by astronomical observations.

"Through mountain passes greater accuracy will be necessary, in order to determine (roughly) the grades and curves to be adopted, and the probable expense of their construction. Great attention will be given to those collateral branches of science which more or less directly affect the solution of the question of location for the proposed railway: the nature of the rocks and soils; the means of obtaining water upon arid plains, whether by tanks or artesian wells; the products of the country, animal, mineral, and vegetable; its population and resources; its supply of timber and other materials for the construction of a railway; the location, character, habits, tradition, and language of the Indian tribes.

"Meteorological and magnetic observations will be attended to; the hygrometrical and electrical states of the atmosphere will be noticed; and all practicable measures will be adopted in order to develop the character of the country through which the party is to pass.

"On or before the first Monday of February next Lieut. Whipple will report the result of his investigations.

"After the completion of the field-work, the party will be disbanded in California; the soldiers no longer required will be placed at the disposal of the commanding officer of that department, and Lieut. Whipple, with such officers and assistants as he may deem necessary, will proceed to prepare for Congress a detailed report of the operations of the survey.

"The sum of forty thousand dollars will be set apart to defray the expenses of the survey intrusted to Lieut. Whipple.

"JEFFERSON DAVIS,

"*Secretary of War.*"

“WAR DEPARTMENT, *Washington, July 25, 1854.*

“SIR: You will, with as little delay as possible, furnish this department with a report of your operations, embracing—

“1st. A map exhibiting the actual line or lines surveyed by yourself and your assistants on your late exploration to ascertain the most practicable route for a railway to the Pacific; and also a table showing the astronomical points determined for checking the lineal surveys, and the data upon which these determinations are founded.

“2d. A profile of the route traversed, marking each station where a height was ascertained, and a table of the results of the observations made with the barometer or other instrument by which the relative heights of different points were determined.

“3d. A condensed statement of the character of the soil, the timber, the supply of water, and, as far as ascertained, the depth of snow in winter for every section of the line traversed.

“For the immediate use of the government, the relative longitude and the relative heights of points along any given line are required. A discussion of the absolute longitude and heights, also the preparation of the natural history, geology, &c., may be deferred without injury to the object now in view.

“The map and profile should indicate new routes or lines to be surveyed, and those heretofore surveyed, by which obstacles on the line followed may be avoided.

“Very respectfully, your obedient servant,

“JEFFERSON DAVIS, *Secretary of War.*

“Lieut. A. W. WHIPPLE,

“*Topographical Corps, Washington.*”

The following list of assistants employed upon the survey was approved by the Secretary of War.

	Name.	Residence.	Duties.
1	Lieut. J. C. Ives.....	U. S. A.	Principal assistant.
2	Dr. J. M. Bigelow....	Ohio....	Surgeon and botanist.
3	Jules Marcou.....	Mass....	Geologist and mining engineer.
4	Dr. C. B. R. Kennerly..	Virginia..	Physician and naturalist.
5	A. H. Campbell.....	Virginia..	Principal ass't R. R. engineer.
6	H. B. Möllhausen.....	D. C....	Topographer and artist.
7	Hugh Campbell.....	Texas..	Assistant astronomer.
8	William White, jr....	Penn....	Ass't meteorological observer.
9	George Gibson Garner..	Maryland	Ass't astronomer and secretary.
10	N. H. Hutton.....	D. C....	Assistant engineer.
11	John P. Sherburne....	N. H....	Ass't meteorological observer.
12	Thomas H. Parke....	Penn....	Ass't astron'r and computer.
*13	Walter Jones, jr.....	D. C....	Assistant surveyor.

* Mr. Jones was taken ill soon after leaving Fort Smith, and was obliged to leave the party to return home. Mr. Abner C. Gaines, of Oregon, was then appointed to the vacancy, but served only a short time, when, for the same cause, he was compelled to resign.

CHAPTER II.

Considerations regarding the termini of the railroad.—Explanation of the maps.

Three of the principal centres of trade upon the Mississippi river are St. Louis, Memphis, and Vicksburg. To these cities converge railroads, constructed or proposed, from harbors upon the northern lakes, from the principal ports upon the Atlantic shore, and from those upon the Gulf of Mexico; uniting the interests of the Northern, Middle, and Southern States. From the above-mentioned places railroads have been projected, and several are in process of construction, westward to the extreme limits of the States of Louisiana, Arkansas, and Missouri, each with a purpose of forming a link in the great chain of communication which must ultimately lead to the Pacific ocean.

The question immediately arises, which of the various routes shall be at first prolonged; or, can there be found a location for a main trunk that may be advantageously united with several of these branches, affording nearly equal facilities to interests so widely diffused? Nature seems to point out such an intermediate location near the parallel of thirty-five degrees north latitude, referred to in the preceding instructions.

Following the south bank of the Canadian river for nearly one-third of the whole distance to the Pacific, we pass into the valley of Rio Grande del Norte near the centre of New Mexico, where the soil is the most fertile, the population is the most numerous, and the mines are the most productive of any part of this interior portion of our possessions.

From Vicksburg to Shreveport the course of the railroad—already under construction—is nearly west. Should it be continued, as has been contemplated, to Preston, on Red river, the tendency will be considerably north of west. If prolonged, it would naturally ascend the fertile valley of the False Washita to a junction with the main branch from Fort Smith, which, in accordance with our survey, may follow that stream for many miles, to its source near the south bank of the Canadian. A reference to Captain Marcy's map of the survey of Red river and its branches, seems satisfactory evidence of the feasibility of such a connexion. Not only is the deviation from a direct line quite inconsiderable, but as neither hills nor cañons intervene, gradients will be favorable without expensive excavations or embankments.

In the report of the same officer we find additional advantages in favor of the route, with regard to the excellence of the soil upon and near the region to be traversed. He states that "the lands included within the Choctaw reservation which are not occupied or made use of by them are embraced between the 97th and 100th degrees of west longitude, and are bounded on the north and south by the Canadian and Red rivers, being about one hundred and eighty miles in length by fifty miles in width; and constituting an aggregate of about nine thousand square miles of valuable and productive lands, or one thousand square miles more than the State of Massachusetts." This section includes the whole valley of the False Washita, which we propose the railway from Preston should traverse.

Various portions of this country are more specifically described. Captain Marcy speaks of "charming landscapes; of soil remarkable for fertility; vegetation in old Indian corn-fields twelve feet high; of beautiful springs and streams; of natural meadows clothed with luxuriant grasses; broad and level bottom-lands covered with dense crops of wild rice, and of excellent timber, large and abundant." He adds: "Indeed, I have never visited any country that, in my opinion, possessed greater natural local advantages for agriculture than this." The kinds of timber he mentions are "gigantic pecan, overcup, white-ash, river-elm, hackberry, and post-oak."

A more favorable location for a railway than that described could scarcely be desired. The distance by this line to Albuquerque, as measured upon Captain Marcy's map, is from twelve to fifteen miles less than from the same point to Doña Ana by the southern trail.

Two routes leave the Mississippi river at St. Louis: one, recently opened, proceeds nearly west to Independence; the other, now in process of construction, leads southwest, through Springfield, to the Neosho, and, if prolonged, would intersect the Memphis middle branch upon the Canadian, not far from the headwaters of the False Washita. Every indication presented upon our route, and the well-known geological character of the intervening country, led to the belief of the practicability of such a line. Bridging the Arkansas and Canadian rivers might be difficult, although, doubtless, points can be found where bluffs converging to the river would greatly facilitate such an operation.

The branch from St. Louis to Independence would join the main trunk upon Rio Galisteo. Upon this line we have abundant information—the reconnaissance of Major Emory, with a profile through the Raton mountains, and the survey of Lieutenants Abert and Peck, with a profile by Dr. Wislizenus, of the Cimarron route to Santa Fé. A copy of this latter profile will accompany the map, and show the availability of that route to unite with our own upon a branch of the Galisteo river. With reference to this route, Lieutenant Abert, who traversed it in 1845, says: "I find the maximum grade to be eighty-five and six-tenths feet per mile. It occurs between Cold spring and Cedar creek. * * * There are no difficult places to bridge, but water and wood are extremely scarce." * * * Lieutenant Peck, who accompanied Lieutenant Abert, refers to this route as follows: "With reference to the railroad, I am inclined to think that a route to Galisteo can be found in the general direction of the Santa Fé trail, which will be more favorable than that by the Canadian. By keeping to the north, so as to cross the Cimarron plains and come upon the head of the Canadian at the north end of the Great cañon, the ground will be more favorable, as it is less cut up by cañons than it is where the Canadian escapes from the high table further south. Building material—that is, in the way of timber—would be scarce on the northern route from about Cotton-wood fork to the very entrance into New Mexico. The rapid falling off of the country from Santa Fé to San Felipe must have struck you; and it has undoubtedly been suggested to you, that a road once brought as far as Galisteo ought to keep as far to the north as possible, crossing the Rio Grande near San

Domingo. From this place it might rise gradually along the face of the bluff behind San Felipe, and so around the point of bluff to the village of Santa Anna; from which place a good route exists, entering the valley of Cibolleta from the northeast, and then emerging from the Cibolleta valley about five miles below Laguna. This route would save descending and again ascending several hundred feet that would be necessary were the road to pass though Albuquerque."

The various explorations above referred to, in connexion with our own, show a generally uniform slope, embracing the area in question, from the eastern base of the Rocky mountains to the river Mississippi. Over such a country several different routes for a railway, doubtless, with greater or less facility, might be selected. It would have been interesting to have prolonged these various routes to a common intersection; but to attempt it would be to hazard the completion of the main duties with which we were charged. Contenting ourselves, therefore, with such information as might be gained from extraneous sources, we hastened to Fort Smith, the most western point, near the parallel of 35° north latitude, then accessible by steam navigation.

Upon the Pacific coast San Francisco possesses all those advantages upon which a great commercial emporium depends. Its position is central with respect to our possessions there, and it possesses a harbor of unrivalled magnificence, lying at the confluence of the Sacramento and San Joaquin rivers, which drain great valleys of unsurpassed fertility. These streams are navigable, and their banks are lined with excellent timber. Dense forests cover hills and mountains; mines of gold and quicksilver yield unprecedented returns; and, to crown all, the climate is mild and salubrious during every season of the year. Such are some of the superior advantages which seem to render imperative the termination of the great Pacific railway at the port of San Francisco.

Should local interests secure the construction of the main road direct to a frontier harbor—San Diego or Puget's sound—or to other smaller ports, trade could scarcely be forced from its natural channel. By a branch through the Sacramento valley, northeast, or by the San Joaquin river and Tulare lake, southwest, a junction would probably be formed with the main railway, in order to obtain the great desideratum of an uninterrupted communication throughout. Commerce demands that this communication should be obtained by the shortest available route. Northeast and east from San Francisco, the Sierra Nevada forms an impassable barrier. Nearly all the known passes are concentrated near the latitude of 35°, where the interference of the coast range with Sierra Nevada has produced a succession of low broken ridges, with valleys between. Here was to be sought the gate to San Francisco, and an opening for the trade of the Pacific waters. Upon the same parallel west of the Mississippi, is a union of interests from eastern States. It was our duty to unite these points, and ascertain whether a route known to possess so many substantial advantages might not prove favorable throughout.

The accompanying maps, profiles, and tables, are designed to condense, as well as possible, all the facts developed by the exploration; or at least those having an intimate connexion with the question of a

railway. The full red line marks the trace of our wagons, to one of which a viameter was attached for measuring the distances traversed, accompanied by the surveying party observing courses and altitudes. The profile No. 1 gives a section upon this line. In such hasty operations it was not expected that such a profile would, in all cases, be shown favorable for a railway. To have attempted to wind around the hill-slopes, where a track should be laid, would have occupied much more time than we had at our disposal. But in order to correct the actual profile to that which the contour of the ground showed to be practicable, topographical notes and sketches were carefully made, and the concluding results are shown in profile No. 2. The dotted blue lines indicate trails of reconnoitring parties. Blue lines coincide nearly with section No. 2. Dotted blue lines represent the general direction of routes which, from indications, are supposed to be more favorable than those traversed. It would be desirable to examine them more closely.

As detailed information is given upon the profiles regarding the gradients required, I propose, in this hasty portion of my report, to give merely a brief sketch of our explorations, confining myself quite strictly to matter relating to the project for a railway.

CHAPTER III.

General description of the route traversed from the Mississippi river to the Rio del Norte.—Advantages afforded by New Mexico.

Our barometric observations were commenced at Napoleon, which, situated at the junction of the Arkansas river with the Mississippi, is but slightly elevated above high-water mark. The observations, properly reduced, give for the height of this place eighty-two feet above mean-tide of the Gulf of Mexico. The river Arkansas presents low banks and forests of timber, densely matted with vines. An unvarying evenness of surface extends ninety-eight miles to Pine bluff. This is a town of some importance, pleasantly situated upon a plateau, about ten feet above the previous level of the river's bank. This plateau extends several miles, and, bearing pines, exhibits a soil more porous and less luxuriant in vegetation than the lower bottoms; hence, doubtless, a more healthy location. Twenty miles beyond appeared another ridge, somewhat higher than the last, covered with plantations. Passing this, we returned to low banks, with moss-covered trees and tangled vines, with here and there a venturesome plantation creating a pleasant break in the monotonous wilderness.

The beauty of Little Rock, one hundred and forty-eight miles by land from Napoleon, created an agreeable surprise. Situated fifty feet above the river, upon the first swell of a metamorphic ridge that extends southwest beyond the limits of the State, its location is at once picturesque, and free from the pestilential vapors that infest the low

lands. The town itself is laid out with charming taste, nearly every house occupying a square, ornamented with shade-trees, shrubbery, and flowers. By observation the height of Little Rock was found to be three hundred and ten feet above the sea. Supposing Memphis ninety-six feet above tide-water, the difference of level between it and Little Rock is two hundred and fourteen feet, and the distance one hundred and fifty-five miles, giving an average grade of 1.4 foot per mile. From information that seems reliable, it appears that from the point opposite Memphis to the river St. Francis, thirty-nine miles, is an extensive marsh, subject to annual overflow. The present travelled road is said to be raised from ten to fifteen feet above the general level of the country. For a railway, therefore, this portion of the route would require an expensive embankment. Thence to Little Rock, one hundred and sixteen miles, a slightly undulating prairie presents a favorable location for a railway.

Above Little Rock we find the banks still luxuriant in vegetation, and finely timbered. Leaving the granite ridge, we enter the lower carboniferous formation, soon passing into coal measures, where at numerous places veins of coal of excellent quality crop out. Few villages or plantations occupy the immediate banks of the river. Healthier locations are found upon high lands a few miles inland.

The "La Fourche" and "Petit Jean," are the first mountain ranges that impinge upon the river. These are said to extend southwest twenty or thirty miles, where they slope into a plain. There, it is supposed, the railroad from Little Rock to Fort Smith will pass without obstruction, and nearly in a straight line. The "Petit Jean" is said to be nine hundred and fifty feet high.

Passing the Dardanelle Rock, a precipice apparently one hundred and fifty feet high, we proceed along banks still covered with forests of cotton-wood, with pines upon the hill-tops. The Magazin, a finely timbered mountain, eleven hundred feet in height, approaches within three or four miles of the river.

In the vicinity of Piney river—so called from its abundant supply of pine timber—coal is said to be very abundant. It is bituminous, but less soft than that furnished by the eastern markets. It burns with a clear flame, without smoke, and with little residuum. Cropping out in veins, it is easily obtained, and is generally used in blacksmiths' shops, in grates, and in steamboats of this region. Van Buren we found a flourishing village, with evidences of wealth, enterprise, and prosperity. It is the centre of trade for an extensive agricultural district. Being situated at the foot of a hill on the river's left bank, it has once or twice been flooded by extraordinary freshets of the river. These freshets have previously occurred once in about ten years. The worst was in 1833, when nearly all the bottom-lands of the river were submerged. The last, in 1844, was less extensive. It is to be hoped that floods will not again occur, as fear of the devastation they produce is doubtless one cause of the scarcity of plantations upon the soil of this fertile valley.

The site for Fort Smith, five miles above, was selected in 1817 by Colonel Long, and called Belle Point. It occupies an elevated point of land immediately below the junction of the Poteau, a small tributary from the southwest, with the Arkansas. The hill which forms the

basis of the fort, is of a dark gray micaceous sandstone, in horizontal laminae, and rises about thirty feet above the water. The country back of the fort has an undulating surface, gradually ascending as it recedes, and is covered with heavy forests of oak, tulip-tree, sassafras, &c. Towards the south, from thirty to forty miles distant, rise to the height of one thousand feet, summits of the Point Sucié and Cavanioi mountains, which stand on opposite sides of a branch of Poteau river. The spot proving in every respect a favorable one, under protection of the military, there sprang into existence a town, now grown to a flourishing city. Observations place it four hundred and sixty feet above the level of the sea. Supposing the distance from Little Rock to be one hundred and sixty miles by land, the elevation one hundred and fifty feet, will give a grade less than one foot to the mile. Should the high lands intervening offer as few obstacles as supposed, the railway to this point may be constructed at moderate expense. Such a road, even should it proceed no further, would be of incalculable advantage to the State.

The mineral resources of Arkansas are worthy of consideration. Lead, copper, silver, and iron ore, are said to be abundant. The iron mountains near the Missouri line are alone worthy a railroad. Beds of coal are of great extent, cropping out in various places near the river Arkansas. The veins are thick, and easily worked; the quality is excellent, and the mines apparently inexhaustible. Extensive quarries of roofing-slate found here, are now supplying the markets of Cincinnati and St. Louis.

Timber, of the best quality for the purposes of a railway, this country furnishes in abundance. Wheat, cotton, and maize, are staple productions of the State. With an outlet for these products, such as a railroad would afford, population would increase, and the virgin soil of Arkansas no longer lie dormant.

Dr. Shumard, geologist and naturalist upon the exploring expedition of Captain Marcy, kindly presented to me his thermometrical observations at Fort Smith, extending for a period of more than a year. These show a climate most favorable to agricultural purposes. For the year ending June 1, 1852, the mean temperature is $65^{\circ}.47$. The mean for August, the warmest month, was $89^{\circ}.4$. The least, $34^{\circ}.84$, is the mean for January. But one storm of snow is recorded during the year; that was two inches, in January. Rain occurred every month; the least in September, October, and January, averaging one and one-third inches each. May appears the rainy season; twelve and one-sixteenth inches having been measured during the month. For the year, the fall recorded is fifty-one and one-fourth inches. There were two hundred and nineteen moist days, eighty-two rainy, and one hundred and twenty-six dry days; twenty not having been noted. The mean temperature of summer is $86^{\circ}.98$; of autumn, $69^{\circ}.11$; of winter, $42^{\circ}.23$; of spring, $63^{\circ}.57$. The highest temperature recorded is 104° , in August; the least, 4° , occurred in January. The summer referred to is that on which this place was visited by the scourge of cholera.

Astronomical observations place Fort Smith in $35^{\circ} 22' 55''$ north latitude; longitude, $94^{\circ} 21'$ west of Greenwich.

Passing the river Poteau with a southwest course, we crossed the

low bottom-lands, and proceeded ten miles, to Ring's plantation, our first encampment.

The Poteau flows from the southwest, with a gentle current, averaging probably seventy-five feet in width for several miles, but increasing to four hundred feet near the mouth. Its banks are of a dark shale, indicating the presence of coal.

By spirit-level the surface of the stream, which may also represent the Arkansas, is found to be thirty feet below camp Wilson, near the fort. Timber and stone are upon the spot, and a single arch of about one hundred feet would span the stream. The country is flat nearly to Ring's house, situated upon the brow of a ridge of gentle hills, which, stretching across from Fort Coffee to the Poteau, bounds the delta included between the rivers near their junction. Upon this plantation wells forty to fifty feet deep furnish excellent water, resting upon a bed of coal.

From Ring's plantation to Choctaw agency—five miles—the road led us over hilly ground, which could have been avoided by inclining towards the banks of either the Arkansas or Poteau. The latter communicates with a narrow prairie extending almost uninterrupted west to Sans Bois creek, affording, for thirty miles, an excellent trace for a railroad.

Within this distance were several small streams—Camp creek, Coon creek, and Long Pond creek—averaging ten to fifteen feet in width, with water a few inches deep. The Sans Bois, densely wooded, like other streams, may be spanned by a bridge from eighty to one hundred feet in length. Timber and stone are abundant, and a rocky bottom forms a good foundation for the construction of a viaduct.

We ascended the left bank of the Sans Bois, crossing Cooper's creek, fifty feet wide, and several small ravines.

To the south fork of the Canadian we passed a hilly country, where ravines and heights were finely timbered, forming charming groves.

To our left the guide pointed out a prairie, which we should have followed to Gaines's creek, had not the approach to it been too densely wooded; thereby we should have saved some distance, and avoided several bad hills.

The east branch of the south fork of the Canadian, with hard, gravelly bottom, and a good foundation for piers, will require a bridge from seventy-five to one hundred feet span. The banks are high and considerably broken.

Passing onward to Coal creek, which we crossed, forty feet in width, we found the country so rough as to compel us to deviate several miles from the road in search of a more level route for the survey. The creek heads in the range of Shawnee hills, five hundred feet in height, extending from the immediate bank of the Canadian several miles south. By the much-travelled road the ascent and passage caused nearly the destruction of our wagons. After laborious explorations to the right and left, and by the assistance of a Shawnee guide, we found that by following a more southern branch of Coal creek to its headwaters below the range of hills, we could, by a direct and shorter route, pass the gently-swelling divide to the waters of Boggy river. Had we known the route in season, we could have cut out a

road to unite with the main trail, where it crosses the first affluent of Red river, in less time than it took us to perform our disastrous march and weary our mules upon the beaten track.

We are now near the termination of the coal measures, and passing to the lower carboniferous formation. Bituminous coal is found cropping out, and in many places are mines of it between Fort Smith and the Shawnee villages; especially on the Sans Bois and Coal creeks. It was used in our blacksmith forges, and found to be of superior quality. There are evidences of an inexhaustible supply for railroad and other purposes.

Besides coal in this formation, we have limestone and sandstone, excellent for the construction of bridges and viaducts. Quicklime is also easily obtained.

The whole country traversed from Fort Smith contains a soil exceedingly fertile, and by creeks and rivulets is supplied with pure and unfailing water. Its fertile prairies are frequently cut into gentle ridges and valleys, like the most favored portion of New England. Timber of superior quality abounds upon the whole of the route. The highlands are chequered with groves of various oaks, while dense forests in the wide bottoms of the streams afford a great variety of excellent timber—ash, oak, white-elm, black-walnut, and pecan. To a considerable extent, this country is already cultivated by the Choctaws, Chickasaws, Creeks, and Shawnees, that possess it. Their fields of wheat and maize are luxuriant. Potatoes, tobacco, and rice are produced. Cattle, horses, and sheep thrive upon the wild-grass prairies that nature has so strangely alternated with forests, adding to the beauty of the landscape and the wants of the Indian farmer.

Fruits, especially peaches, melons, and grapes, grow in profusion. Many fine settlements already exist in this region; that called Little River, on the opposite bank of the Canadian, is particularly flourishing. Having passed the large and beautiful basin fertilized by the branching waters of the river Boggy, which flows through a pleasant valley towards the southwest to unite with Red river, we ascended the ridge which terminates in Delaware mount, and forms the eastern boundary of the great prairies.

The ascent is about sixty feet within the distance of a mile.

Beyond, the face of nature was changed, and the undulating grassy plains appeared as if reposing upon the waves of ocean.

The carboniferous group has now given place to the extensive red sandstone formation, affording continually building material and quicklime. White amorphous gypsum also begins to appear. The soil, however, formed of red clay and argillaceous sandstone, continues fertile and well-watered.

Crossing Topofki creek, a small stream with gravel bed, thirty feet wide, and numerous smaller branches flowing towards the Canadian, we arrived at old camp Arbuckle, where now exists a flourishing settlement of Delaware Indians. Here we had hoped to obtain a guide; but the river Canadian being remarkably low, and the season universally dry, the Indians feared lest we might suffer for want of water, and declined the service.

Leaving the last vestige of semi-civilization, we crossed rolling prairies, which divide the waters of the Canadian from the affluents of Red river, and encamped on a tributary to Walnut creek. Various springs were passed during the day, affording plenty of water, while grass was everywhere abundant.

A few miles northeast from our camp, near the confluence of Walnut creek with the Canadian, is Chouteau's old Indian trading post, where, since the tragic death of the proprietor, Kichai Indians have sought a resting place, to form the connecting link between the quiet Delawares and the murderous wild bands of Kioways and Comanches.

From this point the famous forest of Cross Timbers commences. Captain Marcy remarks, that "this extensive belt of woodland, which forms one of the most prominent and anomalous features upon the face of the country, is from five to thirty miles wide, and extends from the Arkansas river in a southwesterly direction to the Brazos, some four hundred miles."

Our route for about sixty miles, following the delightful valleys of Walnut and Deer creeks, skirted the edge of this forest. The timber which it furnishes—post-oak and black-jack—though small, is exhaustless, and would serve for railroad ties. The wide and fertile bottomlands that line the creeks, however, furnish timber of larger size—oak, elm, black-walnut, and hackberry abounding throughout the region.

Bountiful nature has here supplied all the advantages that the agriculturist would require—abundant crystal streams of purest water, luxuriant valleys for cultivation, extensive prairies of nutritious grama for pasturage, and unfailing forests of oak for fuel.

Passing the headwaters of Deer creek, in longitude $98\frac{1}{2}^{\circ}$, we leave the big north bend of the Canadian to our right, and pursue a course nearly west. Soon, rising upon the swelling prairies which support the celebrated natural mounds, the scene was changed, and for the first time appears, for a day's march, a nearly treeless, barren waste.

Gypsum, which has been occasionally seen since leaving camp No. 29, in the valley of Deer creek, has now become exceedingly abundant. Extensive veins of it, beautifully crystallized, frequently occur, sometimes containing caves ten to twelve feet in diameter.

Among the uncouth ravines, red clay predominates, and gathers the waters into numerous small springs and streams slightly impregnated with salts of magnesia in solution. These communicate at times a disagreeable taste to the waters.

Beyond the natural mounds, a mile west from camp No. 30, we approached a beautiful stream flowing towards the Washita. It is finely timbered with post-oak, alamo, and elm. It contains fish; and we call it Gypsum creek, because its waters are tinged with salts derived from the decomposition of that mineral. This was our entrance into the fertile basin, where numerous, unfailing rivulets, with luxuriantly wooded valleys, form the headwaters of the False Washita of Red river. We cross the pretty rivulets Bear creek and Elm creek, and make our encampment (No. 31) on Comet creek. All of these streams have timbered banks and fertile valleys.

Continuing to traverse the rolling prairies, which divide the streams,

fine views of beautiful valleys, fringed with rich foliage of trees, constantly delight us.

Near camp No. 31 we found oolitic sandstone, limestone, and shells, indicating the lower bed of the cretaceous formation which overlies the gypsum. This proves that the sandstone we have been passing is the new red, like that of Lake Superior. The nutritious buffalo grass first appeared in this region, and here we had the first chase for the noble game from which it was named.

From camp No. 30 to camp No. 33, a distance of about forty miles, our route lay wholly in the basin, watered by numerous affluents of the False Washita. To our surprise, beauty and fertility were among its chief characteristics.

Red marl and gypsum characterized the soil. Grass was everywhere abundant. Red-oak, post-oak, black-jack, cotton-wood, and elm fringed the streams with dense, dark-green foliage.

To have followed the fine valley of the False Washita to its junction with Red river, would doubtless have developed the same general features throughout, with a route for a railway to Preston direct, and of the most favorable character.

A few hours' march took us across the low dividing ridge which separates the waters of Red river from the Canadian. As we ascended the hills, the country became more arid and sandy. From the crest, toward the north, at a distance of a mile, appeared the wide valley of the Canadian, with here and there patches of forest or a fringe of alamos. Abrupt ravines showed pools of water and foliage of refreshing green.

Elsewhere, the parched hills wore the sombre aspect of a dreary waste, with which the deep carmine hue of the Canadian seemed in unison.

The bed of the river we found about six hundred yards wide, with streams a foot deep coursing through it in a network of channels. Though saturated with red marl, the water was pleasant to taste, and, when clarified by pieces of mucilaginous cactus, afforded a more grateful beverage than the slightly saline waters we had left behind.

The valley of the Canadian possesses alluvial bottoms, covered with loamy soil, and occasional patches of grass.

To cut off a bend of the river, we passed through the Antelope hills, and struck the dry bed of a stream, which we followed to the Canadian to find water for camp.

These hills consist of coarse friable sandstone, cemented by lime. They are the last mesa remnants of an elevated plain now worn away, by diluvial and atmospheric causes, to gentle hills and abrupt ravines. Occasional fields of sand, the absence of water, the scarcity of the verdure of grass and trees, rendered this march of eighteen miles the most dreary of our route.

On reaching the Canadian the country improves; the valley grows wide and more fertile; herds of buffalo are occasionally seen grazing upon the hill-sides. Turkeys congregate under the dark-green foliage of scattered copses, that form an agreeable contrast to the pale red tint that is spread over the landscape of river and plain. As we proceed,

the Canadian becomes deeper and less muddy. Numerous streams bring down their tribute from the hills, but disappear beneath the surface where they unite with the valley of the Canadian.

Many of these rivulets are well wooded, and will furnish a small supply of timber.

The alluvial bottom-lands of the Canadian, as well as the narrow belts of its tributaries, which increase in length and importance as we recede from the vicinity of the headwaters of the False Washita, produce natural vineyards and orchards of plum trees. The grapes, unlike wild varieties in the eastern States, possessed a thin skin and a soft pulp deliciously sweet.

Colonel Long, in 1817, and Lieutenant Abert, in 1845, noticed upon this part of the river the same general characteristics: "The valley of the Canadian, twenty miles from its issue out of the mountains, appeared twenty-five miles in width; and, though not so fertile as some lands in the Mississippi valley, might, by proper cultivation, support a numerous population. At the junction of Tucumcari creek the river bed was found to be sixty yards wide, forty yards being covered with water ten inches deep. On the 8th were found grape-vines loaded with fruit. Descending the Canadian, the country became more plain and fertile. The river valley opened wide, and was bounded on both sides by low and rounded hills, instead of abrupt and perpendicular precipices. The general surface was but little elevated above the river, and nearly unbroken." * * * "The immediate valley of the river had now become little less than ten miles in width, and had in some places a fertile soil." * * * "The next camp was on the southwest side of the river, under a low bluff which separates the half-wooded valley from the open and elevated plains. The small elms along this valley were bending under the weight of innumerable grape-vines now loaded with ripe fruit; the purple clusters crowded in such profusion as almost to give a coloring to the landscape."

To such testimony of the adaptation of this country to the culture of fruit and the manufacture of wine, it is scarcely necessary to add the coincidence of our own observations.

This portion of our route being so well known to be favorable to the location of a railway, we left the Canadian valley, and, passing several pleasant brooks and springs, gradually ascended to the Llano Estacado. That apparently boundless plain, without a shrub or tree as far as sight could penetrate, is covered with a thick carpet of buffalo grass, cropped by numerous herds of antelope and deer. The formation of the Llano is of the cretaceous period, overlying trias. The upper stratification is chalky limestone, upon marl and red sandstone. Numerous clear rivulets of pure water issue from the base of the cliffs, and fertilize narrow belts of the valleys leading to the Canadian. Upon these little streams grow a border of trees, and a profusion of vines loaded with purple fruit.

The northern slopes of the Llano, under the bluff edge, one or two hundred feet above the base, are covered with a dense forest of cedars. Protection from the prevailing southwest winds has enabled these trees to obtain a moderate size. It is possible that some may be found suitable for railroad ties. The supply of fuel from this source would

be abundant. The wood is exceedingly hard and durable—inferior only to mezquite, with which our route abounds. Among the ancient ruins of fortifications, upon Pueblo creek and elsewhere, erected previous to the conquest of Mexico by Cortez, were found cedar beams or ties which remain nearly perfect. A specimen, now deposited in the Smithsonian Institute, was procured at the ruins of "El Moro," where are Spanish inscriptions, dated 1606, testifying to the existence of these ruins at that early period.

The remarkable durability of the prairie and mountain firs of this region give them a value for timber above what has usually been awarded them. For fuel, the traveller of the prairies has long held them in high estimation.

Leaving the Llano Estacado, we pass a belt of forty miles in extent, with numerous woodless chocolate-colored streams, and reach the well-known Rio Tukumcari, called by Mexicans, on account of its wide and fertile valley, "Plaza Larga."

Although it is nearly two hundred miles distant from Rio del Norte, flocks of sheep are frequently driven to graze for a season at this favored spot. The creek is a permanently flowing stream, fringed with trees, and fertilizing a wide belt of country which extends to the Canadian river.

The Tukumcari hills, near by, are remnants of the great Llano Estacado, and their slopes likewise contain many large cedars. Throughout this region artesian wells could be resorted to, with advantage, to increase the supply of water.

From this point to Anton Chico our route was constantly upon the upper part of the trias-red clay and sandstone. The summits of the bluffs are of white sandstone, forming a good material for constructions.

Passing over a gently rolling country, with here and there a stream gliding through woodless valleys of red marl, we cross Laguna Colorado, Pajarito, and other creeks flowing into the great valley of the Canadian below the cañon.

Then, ascending a low range of hills, we pass the divide, and encamp on Hurrah creek near where it pays tribute to the Gallinas, a branch of Rio Pecos. Water and grass were plenty, but wood was scarce.

The next day, having passed several shepherds' huts, many herds of cattle and flocks of sheep feeding in green pastures, we went down into the valley of the Pecos. A border of cultivated fields, with wheat, oats, and maize, extends along the valley.

Anton Chico rests near inviting orchards upon the brink of the stream, enclosed between two steep banks four hundred feet in height. A gentle slope along a smooth hill-side renders the descent to the river comparatively easy. To ascend its western bank was the first great obstacle encountered upon the route.

Mr. Campbell, the principal railroad engineer, was sent to explore, and found two routes by which the object could be accomplished. The first descended to the valley, and followed the course of the river to a ravine, through which, winding with curvatures of half a mile radius, the bank could be ascended with a grade of eighty feet per mile. The other proposed to keep the top of the eastern bank to a point above

the town where the cañon is narrow enough to allow a viaduct to be constructed reaching the crest of the opposite bank. The saving of several miles in distance and thirty feet per mile in grade would probably compensate for the great expense of such a structure. Stone of the best quality for such purpose exists upon the spot. Magnificent pines are found fifteen or twenty miles distant in the mountains, such as are considered in this country to afford the best and most durable timber for "vigas" (beams or rafters) of houses.

The excavation that will be required is in coarse gravel, easily removed.

Once upon the western bank of the Pecos, the railway may follow the route surveyed through Cañon Blanco to La Laguna, or, I believe, ascend along the crest of the Cañon, Pass la Cuesta, to Pecos Springs, and thence by the summit marked on the accompanying profile proceed to the headwaters of Rio Galisteo. No mountains, but a high table-land merely, appearing to intervene, and the distance from stream to stream being but a few miles, it seems quite probable that this course might prove available.

By Cañon Blanco there is no difficulty, except at the point of leaving it. There, to diminish the grade, it will be necessary, at considerable expense for cutting and filling, to ascend by the side of the cañon. Beyond this point the route is plain, with light grades and gentle curvatures, to a branch of Rio Galisteo east of the Gold mountains. Following its gentle stream through a wide puerto of the Rocky mountains, we pass within twenty miles of Santa Fe, and strike Rio del Norte at Pueblo de San Felipe, where formerly a bridge spanned the river. This route leads directly by the rich placers of gold and other precious metals which are said to abound at the junction of the eruptive and metamorphic rocks.

The more direct route, *via* Carnuel Pass, would require labor of excavation and steeper grades. It passes, however, through an out-crop of coal, and leads to Albuquerque, or to the remaining narrow gorge of the Del Norte at Isleta, where the river cuts through banks of diluvial drift, which, rising perpendicularly twenty feet above the water, form natural abutments for a bridge.

The valley of Rio Grande del Norte is well known. The bottom-land that can be irrigated is very extensive. One-fifth of it is probably under cultivation, producing wheat, maize, fruits and vegetables. The soil and climate seem particularly adapted to the culture of grapes, which grow luxuriantly and to perfection. The wine produced is finely flavored, and, with an easy communication with a market, may become an article of commerce and a source of wealth to New Mexico. But the resources of this Territory are not confined to the belt which may be flooded by the waters of the Rio del Norte. Numerous springs and streams chequer this region, with fertile spots among the mountains.

Colonel McCall, inspector general of the army, in his report dated July 15, 1850, estimates "the land now cultivated" in New Mexico at about two hundred square miles. "Land cultivable now vacant," exclusive of the vast regions occupied by the Navajoes, Moquis, Zunians, and wilder tribes of Indians, is estimated at about four hundred and ninety square miles. He asserts "with confidence" that "the figures

are not too high." Judging from those portions I have myself visited, I am inclined to the opinion that the estimate falls below the actual amount. Seven hundred square miles, however, watered by acequias and cultivated as usual like one vast garden, will produce supplies sufficient to support a numerous population.

The high mesas, which extend in various directions from the foot of the Rocky mountains and Sierra Madre, although from the want of sufficient rains unfit for cultivation, are by no means valueless. They are covered with a thick carpet of curled grama—the most nutritious grass that grows—affording abundant and unfailling pasturage, during every season of the year, to unlimited herds of cattle and flocks of sheep. The expense of raising them is but a trifle. Within the past few years merchants have transported wool to St. Louis, and made handsome profits. Heretofore it was esteemed nearly valueless. With an improved breed of sheep and railway transportation, wool-growers of New Mexico might control the eastern markets.

Colonel McCall, in relation to Indian depredations, states that, "as far as" he "could ascertain positively, by summing up individual cases, forty-seven thousand and three hundred sheep were driven off by these Indians" (from New Mexico) within eighteen months prior to the 1st of September, 1850. Doubtless, the Indians took many flocks from shepherds in the mountains that were not officially reported.

"Some twenty or twenty-five years ago, before the hand of the red man had fallen so heavily upon them, the people of this State, as well as of Chihuahua, sent annually to the city of Mexico vast numbers of sheep, as well as cattle and mules. At this day, not one thousand are sent from districts that formerly furnished their hundreds of thousands, such has been the rapacity and the relentless spirit of the Navajoes and Apaches."

Notwithstanding the extent of these depredations, and the drain since 1846, for the support of the army and of emigrants, vast numbers of sheep have been annually driven to California markets.

I believe we are beginning better to understand our "red brethren," and soon will accord to them some of the rights due to true "native Americans." Based upon such principles, it would not be difficult to civilize all the wild tribes I have ever met with in my wanderings. They would then, like the Pueblo Indians of New Mexico, have a community of interests with the whites—tilling patches of fertile soil among the mountains, and grazing flocks and herds upon the illimitable plains over which they roam; thus acquiring a surplus with which to trade for such clothing and other necessaries as they may need. Savage warfare will then cease, and the resources of New Mexico—agricultural, pastoral, and mineral—will be developed, and, if they choose, the people may build cities and aqueducts in the deserts, as did the Spaniards two centuries since at Gran Quevira.

Notwithstanding the richness of her mines of gold, of silver, of copper, and of iron, the deposites of coal that have been discovered in New Mexico have probably a more direct and practical bearing upon the project of a railway. The mountains east and west from Rio Grande—the Sandia and Manzana ranges, as well as the Sierra Madre—furnish a large supply of superb firs for timber. Near the

base of the mountains, on gravel ridges and in dry ravines, are found cedar and mezquite, furnishing for the people sufficient fuel.

But the excellent coal, which is said to crop out in the Carnuel Pass and in the famous basin of Cibolleta, would, with railroad transportation, afford a large supply of this necessary commodity.

Hence, with the increase of population, the development of the precious metals, the manufacture of wine, and the produce of wool and other articles, will afford rich freights, east and west, in exchange for fabrics of every kind, and luxuries required from the older States.

Such seem a few of the considerations that will have an influence upon the prosperity of the Pacific railway.

CHAPTER IV.

General description of route traversed from Rio del Norte to port of San Pedro.—Remarks upon the Valley of Rio Colorado.

West of Rio del Norte, a ridge easily crossed brings us to Rio Puerco. A branch called Rio de San Jose, passing beds of coal, leads by a gradual ascent, near to the summit of Sierra Madre. Two passes here were examined—both practicable; one leading by the Camino del Obispo, the other by Ojo del Oso. The latter, by report of my principal assistant surveyor, A. H. Campbell, esq., who examined it, scarcely needs excavation to prepare the way for iron tracks. The Obispo Pass would probably require a maximum grade from eighty to ninety feet per mile, and a tunnel of perhaps three quarters of a mile, through soft limestone rock, at the summit. But nature has modeled the slope upon each side of the pass; and, beyond, the route glides quietly into the extensive, well watered, and beautiful valley leading to Zuñi. The route across the Sierra Madre passes extensive forests of excellent pine timber.

It is a singular fact that, throughout New Mexico, Pueblo Indians are universally conceded to be the most sober, honest, and industrious portion of the inhabitants of this Territory. My own observations would tend to confirm the fact. The Indians of Zuñi cultivate a portion of an extensive valley, in the midst of which their pueblo is built. Without irrigation, depending only upon occasional rains, they produce abundant crops of grain and vegetables. Even though they had furnished forage for Fort Defiance, their supply of maize seemed inexhaustible. These Indians are more shrewd and more enterprising than the lower class of Mexican population. They comprehend the advantage of trade which the opening of a railway through their country would afford, and are eager for its accomplishment. The Caciques met in council, and delegated three of their best men to show us the excellent route due west to Rio Colorado Chiquito, below the junction of Rio Puerco of the West. The service was accomplished to our

complete satisfaction. The route was excellent, nearly devoid of hills, with frequent springs and streams of water, and grama grass abundant.

Here is where the route through Campbell's Pass, at Ojo del Oso, unites with the main line. It possesses the advantage of a low summit and easy grades along the channels of the two streams it follows. But the waters of Rio Puerco of the West, being generally lost below the surface, fail to produce the fertility that distinguishes the Zuñi route.

The Colorado Chiquito is a stream smaller than the Gila, but similar in many respects. The banks are fringed with cotton-wood; the valley is wide, the soil rich, and the gravelly ridges are covered with fragments of pottery, among ruins of ancient Indian pueblos. Drift-wood here is very abundant, indicating occasional freshets, and plenty of timber near the sources of the river. This stream we followed nearly west about sixty miles. Here the river turned northwest. Desiring to continue as we were, upon the parallel of 35° , a small reconnoitring party advanced to explore the low pass, where a spur of the Mogoyon mountains is broken by the volcanic peaks of San Francisco.

We had sent to Moqui, hoping to obtain Indian guides through this country also, but the messengers returned unsuccessful. They brought tidings that, by hundreds, the Moquis were dying by small-pox. Only three men could be found in health, and they were insufficient to throw the dead over the walls.

Without a guide, therefore, we moved onward about eighteen miles to a cañoned stream, with sides so precipitous and deep as to obstruct our march. Following north for a passage, fifteen miles brought us to its junction with the Colorado Chiquito. Again we explored westward, and with complete success. By an almost uniform grade, we ascended the wave-like swell of the Mogoyon spur, and, at the southern base of the San Francisco mountains, reached the headwaters of the San Francisco river. Here were vast forests of excellent timber, cedar, oak, and pine, covering the plains, and stretching southerly, over a region watered by San Francisco streams, to the furthest limits of vision. North of us rose the volcanic mountains, white with snow, and covered with new varieties of magnificent firs.

It was now between Christmas and New Year, and we were upon one of the most elevated parts of our whole route, seven thousand and two hundred feet above the level of the sea. The winter we knew to be unusually severe, as Mr. Leroux, for three previous winters, had seen these mountain peaks devoid of snow. Now, even at the base where we encamped, snow eight inches deep was lying upon the surface. But we were in a region where curled grama was everywhere abundant, and our mules fared well upon what they could glean from the rocky hill-sides. A thermometer immersed in Leroux's spring read $48^{\circ}.4$ Fahrenheit. This is undoubtedly the mean temperature of the place.

Continuing our explorations west-southwest without difficulty, we found a route leading to a stream marked by Captain Sitgreaves, upon his manuscript map, "Bill Williams fork," and represented as flowing into Rio Colorado forty-five miles below the Mojave villages. Following its course, we soon overlooked a vast region of charming country, which we called the "Black Forest." Notwithstanding the

depth of winter, and the snowy mountains not far behind us, here nature had put forth spring flowers and green herbage.

To our regret, the drainage of this region was to the southeast, and Bill Williams fork took the direction toward Rio San Francisco and the Gila. Disappointed, but not discouraged, we turned west, crossed streams, and, having made a circuit of one hundred and fifty miles, sent back messengers to bring up the train by a favorable route we had discovered. Our reconnaissance still continued in advance of the main body of the surveying party, communicating by signal-smoke or messengers the proper course for it to pursue.

Partridge creek we now followed until it entered an extensive basin, so abundant in curled grama that we called it "Chino valley." This appeared like a branch of that to which we had previously traced Bill Williams fork, and our hopes were again chilled by finding Partridge creek also turning east of south.

Thus far we had found no want of water, grass, and wood; no difficulty in the progress of our train of wagons, and scarcely an obstacle to the construction of a railway. But a continuous range of mountains seemed to deny our westward progress.

We ascended Chino valley northwest two days' march, finding no puerto for a passage through the mountain range, and no water among the ravines for our animals. The whole country to the northwest and north looked extremely unpromising; plains, barren and waterless, flanked upon the west by the still unbroken chain of mountains. In fact, it was the region over which Captain Sitgreaves passed two years before, finding no water for eighty miles, and crossing, beyond, two ranges of mountains whose steep declivities were practicable only for pack-mules.

We were now nearly five thousand feet above the level of the Rio Colorado, distant, in direct line, about one hundred and twenty-five miles. That would give an uniform grade, the whole distance, forty feet to the mile. It was therefore necessary to avoid ascents, and seek a route where a declivity might commence at the earliest moment.

Retracing our steps, we explored the same range south. Fifteen miles from Partridge creek we found flowing, through a dark grove of overhanging ash and hickory, a limpid stream, where ducks, turkeys, and deer were abundant. Five miles beyond Turkey creek we came upon Pueblo creek, so called on account of extensive ruins of houses and fortifications that lined its banks.

Thinking that this stream might change its southeast course and flow westward, we proceeded near to the base of Mount Hope. There ascending an elevated peak, the drainage of the country still appeared east of south, over the same great tract of fertile country we had previously seen from Bill Williams fork.

Thirty miles south, at the base of Black mountain, seemed a low summit. But there were surer indications of a break in the mountain chain where cut by a branch of Pueblo creek. So, returning thither, we ascended its finely-timbered banks nearly due west. In six miles we gained the summit of a pass where two streams found their sources within five hundred feet of each other; one flowing eastwardly into

Pueblo creek, the other westwardly along the course we sought. This cut through the sierra seemed formed by nature for a passage. Wide Indian trails and ruins of extensive fortifications, constructed centuries since upon the heights to defend it, showed that not only present tribes, but ancient races, had deemed this "Aztec Pass" of great importance. Upon the northern side the mountain slope was regular, and followed in a spur parallel to Pueblo creek, enabling the engineer to commence his ascent so as to pass the summit with a favorable grade. A deep cut, or perhaps a tunnel of two or three hundred yards, might be required through the narrow hill which forms the divide. Leaving "Aztec Pass" behind us, we gently descended fifteen or twenty miles along the rivulet, which flowed sometimes above and sometimes below the surface. Our stream now turning northwest toward Yampai creek, in that direction appeared a valley uninterrupted even to the horizon. The reconnoitring party again turned westward over a rolling prairie, and, somewhat to our surprise, in ten or twelve miles we found our course cut by the creek we had left. It now flowed west of south, with cañoned banks fifty feet high. The general surface of the country was gently rolling. Following our stream—which now we call Cañon creek—we found that the country became more rough, the cañon deeper cutting through, and a few miles below emerging from the eruptive barrier that once opposed the flow of its waters. Although no extraordinary difficulty may be apprehended in constructing a railway through the channel formed by the stream, it was no natural road for our wagons. Turning westward, we crossed the Aquarius range of mountains, and found a favorable passage, which our train followed through "Cactus Pass" to "White Cliff" creek. This was a fine mountain stream that fretted upon its rocky shores, shaded by cotton-wood and willows. It emptied into Big Sandy, the latter flowing south, and seldom showing water above the surface. Twelve miles below we again joined Cañon creek. The stream of transparent water, probably fifty feet wide and two feet deep, glides upon a pebbly bed, and nourishes upon its borders reeds and rushes of vivid green. Budding alamos line its banks, and mezquites cover the fertile valley. It is early in February, but the thermometer at midday stands 80° Fahrenheit, giving the climate of advanced spring. Following the creek for about thirty miles, to our regret it flowed nearly south, crossing three successive ranges of eruptive mountains, whose barriers were occasionally broken into cañons. There, having received an affluent from the last, it turned westward to the junction with the Rio Colorado.

This stream, indicated upon old Spanish and English charts, is designated Rio Santa Maria. Captain Sitgreaves, supposing when he saw its mouth that it was the same he had already named at its source in the mountains, calls it "Bill Williams fork." Already has been mentioned our disappointment that the little creek, which we left flowing east of south through the Black Forest, should be an affluent of the Rio San Francisco; and therefore, to avoid confusion of names, it seems proper to restore to the tributary of Rio Colorado the original appellation, Rio Santa Maria. It is an important stream, draining an extensive tract of country heretofore unknown. Alternate sections of its

valley furnished scenery of strange contrasts. For five or six miles we follow marl-bottoms luxuriant with vegetation, with a stream rapid, clear, and two feet deep, shaded by dense groves of alamo, mezquite, and willow; then, gradually yielding to a sandy soil, the water passes beneath the surface, and for an equal distance we traverse a blank and dreary desert. There the quaint *cereus giganteus* and humbler *cactacæ*, with occasional *yuccas* and curious shrubs, form a landscape extremely singular, but of which one soon wearies. Fortunately, these barren wastes seldom extend uninterruptedly above a few hours' march with the train.

Although our route equalled all we had reason to anticipate, it yet seems probable that the main eastern branch would lead through a more favorable country, by the Black mountain to "Val de Chino." Thence a reconnaissance eastwardly might discover a passage through the Black Forest across the headwaters of Rio San Francisco, and unite with our trail upon Cañon Diablo, near the Colorado Chiquito.

What we saw of this country was full of interest to each department of science. There were extensive forests, abounding with game; wide grass valleys, affording pasturage to innumerable herds of deer; crystal brooks alive with trout, their fertile banks once cultivated and now lined with ash and walnut timber. From the heights were frequently seen, looking down upon us, the fleet cimaron, or mountain goat. That this solitude had not always been unbroken by man, was shown by the numerous ruins of stone houses that lined the borders of the streams, and the still high walls of extensive fortifications that covered the heights surrounding.

We traversed this region in winter, but the climate was that of spring, and vegetation was already rapidly advancing. Unpropitious as was the season, the botanist found much to delight him. New species of trees and tropical shrubs were collected; rare and beautiful plants were obtained; strange forms and unknown species of *cactacæ* were gathered.

It was a beautiful view that burst upon us, as we ascended a hill and first beheld the Colorado sweeping from the northwest to unite with Rio Santa Maria, almost beneath our feet. One long and loud huzza burst spontaneously from the men, sending a thrill through every nerve. Their dreamy forebodings were cast upon its waters, and all felt relieved from a burden of anxieties.

The river appeared three or four hundred yards wide, with a dark and reddish hue, flowing with a swift current between bluff banks worn through the midst of wide alluvial bottoms. The valley was sprinkled with large alamos, and bounded by hills leading back to sharp ridges of mountains, by which below the junction it was contracted to a cañon. Upon the opposite side seemed a succession of mountains, which, receding from the river towards the northwest, terminated about ten miles above. There a wide plain seemed to extend indefinitely westward, and possibly might lead in about one hundred miles to San Gorgonio Pass, the fine puerto discovered by Lieutenant Williamson, to the valley of Los Angeles.

Ascending the left bank of the river about twenty miles over soil evidently rich, and in some places showing evidence of having been

cultivated, we reached a point where spurs from the mountain impinged upon the river, forming an unexpected obstacle to the progress of our wagons. Labor for a few days, perhaps for a few hours, might probably have cut around their points a practicable way. But our time was precious; it was doubtful whether, with the utmost diligence, we could reach the settlements before our supply of subsistence should be exhausted. Therefore, abandoning our wagons, except a light vehicle to which was attached the viameter and in which the lighter instruments were carried, we packed upon mules our collections, provisions, and necessaries, and cached such things as we could spare. Then, crossing the spurs, we entered the fine valley of the Chimehuevis Indians. They are a band of the great Pai-ute ("Pah-Utah") nation, but live separate and distinct from the mountain robbers, whom we shall have occasion again to mention. This band contains probably two hundred warriors—short, but robust and well-formed, with regular features, and a pleasing air of activity and intelligence. They received us kindly, and flooded our camp with a portion of the surplus produce of their fields for trade. The principal articles of traffic were bears, squashes, maize, and wheat—the latter usually ground to flour. Although the season was the latter part of February, when their winter's store had been consumed and the quantity for seed reserved, still the supply seemed limited only by the demand. Their villages were mostly upon the west bank of the river, and covered considerable space; yet of the fertile soil thus occupied not one acre in a hundred seemed cultivated.

We were now met by Mojaves, who, acting as guides around the next spur that formed a cañon, conducted the surveying party through a pass, invisible from the river, where not a hill intervened.

We now entered that great basin of the Colorado, several miles in width, and probably forty miles in length, which for ages—since the first visit of the Spaniards—has been the home of the Mojave tribe.

Successively, as we approached their several villages, five principal chiefs, each with his own particular band of warriors, met us in state, with all the forms and ceremonies with which they are wont to dignify great events. When informed of the object of our visit they were greatly pleased. They met in council, and determined to do all in their power to advance the interests of the Pacific railway survey.

They loaded us with provisions of flour and beans in return for cast-off clothing, and sent two guides, Ir-i-te-ba and Cai-rook, to conduct us to the intersection of the Salt Lake road with Mojave river.

The valley of the Rio Colorado forms a distinguishing feature in the topography of the western portion of the continent. It is the recipient of all the waters that drain the basin between the Sierra Madre and Sierra Nevada, or coast range, and extends, from its sources in the Rocky mountains, to the Gulf of California. This region abounds in barren hills, naked plains, and wild cañons; yet it has frequent fertile spots, where water and timber are plenty, and where valleys of considerable extent have narrow belts of fertile soil. As instances, we may mention Rio Gila, Colorado Chiquito, Santa Maria, and Rio Mojave. All contain, to a greater or less extent, soil favorable to agriculture. The southern bank of the Rio Gila, lately acquired by treaty

from Mexico, contains large tracts of land capable of being irrigated and of producing excellent crops. Pimo Indians from time immemorial—certainly since they were first visited by Coronado, in 1542—have cultivated cotton of excellent quality. Specimens, which I showed to gentlemen in Texas, were pronounced nearly equal to the best Sea Island cotton of South Carolina. Tobacco, maize, wheat, beans, and melons, are also cultivated by Pimos and Maricopas upon the Gila. The soil upon all the rivers above mentioned would, doubtless, produce similar crops.

But the valley of Rio Colorado itself affords a large extent of fertile bottom-land, which may be perfectly irrigated and easily cultivated. The soil is pronounced to be far superior to that of the Del Norte, and being elevated at the Mojave only three hundred and fifty feet above the sea, the climate is milder and more tropical. As the Mojaves, Chemehuevis, Cuchaus, and Cocopas, all cultivate without irrigation, it is probable that more rain falls here than in New Mexico. Judging from our own experience, and the robust health and fine personal appearance of all the Colorado Indians, no climate could be more salubrious. There are probably from one hundred and fifty to two hundred square miles of arable land in one tract occupied by Mojaves. The Chemehuevis, a band of Pai-utes, possess a tract of about thirty square miles. Below, near the junction of Santa Maria, is a basin containing about thirty square miles. Thence, to within a short distance of the mouth of Rio Gila, I have no personal knowledge. The map of Capt. Sitgreaves indicates an extensive valley there, not less than eighty miles long, and averaging, at least, five miles in width, making four hundred square miles. It is occupied by three bands of Indians—"Ya-tapais," "Cu-chaus," and "A-mac-haves." From ten to fifteen miles above the junction of Rio Gila to the mouth of Rio Colorado is a wide strip of bottom-land, averaging, for ninety or a hundred miles, from ten to fifteen miles in width, giving at least one thousand square miles. Looking from the desert south, an extensive tract of country, from fifty to sixty miles in width, appears the bed of an ancient lake, now possessing a fertile soil, and capable of irrigation from the Colorado. Without this last, we have already estimated sixteen hundred and sixty square miles of arable land upon the Colorado. Beside maize, wheat, beans and melons, which, without irrigation, Indians now cultivate so abundantly, the soil and climate are remarkably adapted to the cultivation of cotton, sugar-cane, and rice. There can be no doubt that the valley of the Colorado is destined, at some future day, to be divided into plantations, supporting a numerous population.

The river itself is worthy of some consideration. From the Mojave villages to near its confluence with the Gulf, the average width of the stream is from three hundred to five hundred yards. When at the junction of the Gila with the Colorado, in October and November, 1849, no change was apparent in the height of the stream; this is the driest season of the year, and no ford was known upon the river. From the mouth of Rio Santa Maria to Mojave villages, no place occurred where the depth of the channel was less than five or six feet. The current is rapid, but apparently not more so than that of the Ohio. The height, at the confluence of Rio Santa Maria, is two hundred and seventy feet

above the level of the sea; distant, by course of the river, three hundred miles. This estimate would give an average inclination to the stream of nine-tenths of a foot per mile, slightly exceeding that of the navigable waters of the Arkansas. Steamboats navigate already as high as the mouth of Rio Gila, eighty miles from the Gulf, furnishing supplies to Fort Yuma. Captain Sitgreaves states that, at his camp No. 51, a large rock occupies the middle of the channel. This is supposed to be the principal bar to the navigation of this river to the Mojave villages. The rock could be removed by blasting; and then, should the railroad follow the route that has been indicated, this navigable river would bear to and from the Mojave depot commerce of no inconsiderable value.

About forty miles above the junction of Rio Santa Maria we left the Colorado at the mouth of a dry arroyo, heretofore supposed to be the bed of Rio Mojave. Gradually ascending the barren slope of the hill-side ten miles from the Colorado, we found several small springs of good water. Twenty miles beyond, we encamped upon a pretty rivulet, which watered a small valley that had been converted by the mountain Pai-utes into a luxuriant garden. Passing the crest of a hill, and leaving to our right the wide valley supposed to belong to Mojave river, by a gradual ascent over wide prairies of rich grama grass, we reached a rocky glen, where were springs abounding in excellent water. No timber was here, although low cedars afforded plenty of fuel.

From Rock spring, five miles led us to the summit, fifty miles beyond and four thousand and nine hundred feet above Rio Colorado; the grades, however, by detours upon the ascending slopes, need not exceed seventy feet per mile.

We then passed into a dry ravine leading to Soda lake, which seems to absorb the waters of Rio Mojave. Turning from the valley of the ravine referred to, we ascended the hill-side, where, nineteen miles from Rock spring, were oozing, from an outcrop of marl, small rills of water. Should deep holes be dug, or tanks be constructed at this place, an abundant supply of water might doubtless be obtained.

The vegetation of this region consists of beautiful palm-like yuccas, cactacæ, larrea, and patches of grass. From "Marl Springs" we ascended the mountain, to cut off a detour made by the surveying party, through a fine-looking valley to our left. Crossing granitic hills, we soon saw upon our right a row of volcanic butts and metamorphic mountains, beyond which appeared a deep and wide valley, probably that of the veritable Mojave.

In the far horizon north is seen a snow-white peak, said to be on Rio Virgin, or Santa Clara. Northwest, stands in high relief the lofty range of the Sierra Nevada, between which and Rio Colorado have been counted nine distinct ranges of mountains.

Passing on, we soon came to a ridge and commenced our descent; at first steep, then more gentle, along an arroyo, to a puerto at the foot of a large metamorphic mountain, where we had a view westward to the great valley before seen. In the midst seemed a lake, supposed to be mirage; to the left, however, curled a tall column of smoke, where, undoubtedly, were the camp-fires of the advance party, and water.

Having travelled about fourteen miles, we made a noon halt. The

country traversed looked dreary—a mass of rock and gravel without useful vegetation.

At 5 p. m. we proceeded two miles down the arroyo and entered a field of drifted sand. By moonlight the effect was beautiful; it seemed a fairy scene, with the bright and placid firmament above, and the earth beneath covered with snow-white sand. The air was fresh, not cold, and all seemed to enjoy the march. Mexicans and Americans were singing, each his favorite song, as easily we trod the hard surface of drift. Even mules and the carretela had made but light impressions upon the compact surface. Two or three miles of this interesting but dreary prospect, which, sweeping from the southwest, seemed to extend indefinitely towards the north, brought us to a puerto in a low rocky ridge of hills, upon the northwest side of which, sand, piled nearly to the top, left bare the summits only.

Soon we struck the smooth bottom of a lake of efflorescent salts, probably sulphate of soda. Traversing this with a good road for about six miles, at 10 o'clock in the night we reached the camp of Lieutenant Ives, where water and grass were abundant; the latter was salt and the former brackish. Mules drank freely, but the water was unpalatable to men. By viameter, our distance from Marl springs is thirty-one miles, the greatest jornada upon our route. For nearly half the distance the soil is hard gravel; ten miles are sandy, the remainder being upon the hard clay forming the bed of the lake.

By results of the survey, Soda lake is found to be seven hundred and twenty feet above our crossing of the Colorado, the distance by trail being one hundred and three miles, and the average descent seven feet per mile.

Whether a channel exists by which the Mojave river finds its way to the Colorado, is a problem not yet solved. We regretted exceedingly that time for a closer examination was not at our disposal. Our trusty Indian guide, however, assured us that the dry channel of that stream passed uninterruptedly north of our route to the Colorado, and that wagons could pass through it without encountering a hill.

Such a route as he describes, with water found by digging, is undoubtedly the most favorable for a railway that exists across the desert west from the Colorado river.

The true channel of Mojave river, where it enters Soda lake, is but a bed of sand, which we ascend thirteen miles before finding running water. There it is a rapid rivulet, its clear waters making melody with the pebbly shore. A few miles higher up on the stream barrenness gave place to fertility; tularas, grass, alamos, and willows, covered rich meadows.

The river here is fifty yards in width and knee-deep. Mezquite trees, tornillas loaded with fruit, form occasional thickets.

For seventy-five or eighty miles above our course followed the gentle meanderings of Rio Mojave. The soil of the valley is rich, and there is plenty of water for irrigation, although occasionally it disappears for a short distance beneath the surface. There are cotton-wood and mezquite for fuel. Timber is scarce and small, except near the sources of the stream in the San Bernardino mountains, where magnificent oaks, pines and spruce occur.

At the point of leaving the river we found it one hundred and fifty yards wide and two and a half feet deep; its alluvial bottoms still fertile and densely covered with alamos and willows. Mounting the left bank we found large springs gushing from the verdant slope. The air thermometer reading $15^{\circ}.9$ Cent. the temperature of the spring water was $19^{\circ}.1$ Cent. = $66^{\circ}.4$ Fahrenheit; which, probably, is the mean temperature of the climate in this region.

Ascending the wide-swelling prairie which leads to all the passes near the junction of the Sierra Nevada with the coast range, our course was directed south 38° west towards an apparent gap in the mountains east of the snow-capped peaks of Sierra San Bernardino. Grass is thinly scattered over the plain, and beautiful yucca trees about thirty feet in height. Sweet-berried cedars began to appear, affording excellent fuel. The Mojave river not far upon our left divides into three branches, heading in the mountains; the most eastern said to take its rise near Cajon Pass.

Proceeding through groves of yuccas beautiful as cocoanut and palms of southern climates, and dense thickets of cedars, by a gradual ascent, averaging probably sixty feet to the mile, we reached the summit of Cajon Pass, where the mercury measured $25^{\circ}.4$. Standing upon the crest, one could look far towards the north and northeast over immense prairies of gentle inclination. This pass appears the most truly difficult part of our route. It seemed however, possible, by winding from the Pacific side around the slope of the mountain, thus increasing the distance, to locate the route upon a spur bounding the valley of Cajon creek, to the foot of the crest of drift over which passes the road. Here may commence a tunnel of about four or five miles in length and seven hundred feet below the surface at the summit; thence becoming gradually less, until it issues upon the prairie slope near the Mojave river. The material is easily excavated, and would be useful in forming embankments required to cross a ravine leading to the spur referred to above. The termini at least will require arching; within, the rock may be firm enough to support the superincumbent weight.

In Cajon creek are boulders of marble crystalline, white and pure as possible. This would form building material of incomparable beauty; there are also, probably, in the mountains, veins of it affording good quarries. Auriferous quartz has also been found in this vicinity. The botanist was delighted with the western slope of the Sierra Nevada, affording a class of vegetation new to our route. Four different species of cactacæ were found upon the first mile of our descent—a new piñon, a new and magnificent oak, two new species of firs or pines, a currant, sycamore, and cowania. The hills are covered with a verdant red-barked shrub; the mountains with oaks and pines of many varieties. Here we find abundant material for the construction of a railway. With a few exceptions, this range of mountains must be our main dependence for supplies of pine timber until we may meet the forests of San Francisco mountains.

We descended about twelve hundred and fifty feet in eleven miles from the first point of striking the arroyo at the foot of the ridge. As we proceeded the valley opened finely; mountain torrents swelled the

creek, that boiled and fretted with granitic rocks. The descent became less steep, and the sides of the valley were regular slopes, where a railway might ascend so as to rise far above the bed of the creek, and diminish the grade to one hundred feet per mile in the cañon above.

This development diminishes the obstacles of Cajon Pass. The work will not be so extremely difficult nor expensive as at first seemed probable. Our greatest regret is, that it leads not directly to a port as safe and commodious as that of San Francisco.

Having descended the Cajon creek about five miles, we left the way to San Bernardino, and keeping the road west, under the base of the mountain, entered a region of great beauty. We travelled twenty miles along a descent inappreciable to the eye, and arrived at Cocomengo rancho, where we encamped upon the beautiful stream that waters it.

We continued our course west-southwest, by a road nearly as level and smooth as if graded for a railway, twenty-four miles to "El Monte." The valley traversed is continuous from the Cajon, fifteen to twenty-five miles in width, with soil abundantly rich, fertile, and at present well watered. Some of the streams crossed—Cocomengo, San Jose, and Rancho de Chino—are fed by permanent springs. Many others owe their origin to melting snows of the mountains. All were charmed by the beautiful scenery and heavenly climate. Fine spreading oaks and sycamores were sprinkled in pleasing variety with flowering shrubs through the valley.

From El Monte, passing a few hills, we enter the valley of Los Angeles. The stream upon which it is situated is about fifty yards wide and two feet deep. There were numerous acequias irrigating vineyards, orange and olive groves, peach orchards, gardens, and corn-fields. Even as early as March 21st, full-grown oranges were seen ripening in the open air.

The town had the sombre cast of a Spanish pueblo, relieved, as it were, by innovations of American comforts. There was the bustle and activity of a business place. Many new houses were in process of construction. Everywhere was indicated a thriving population and a land of intrinsic wealth. Los Angeles is said to number five thousand inhabitants.

Our course from Los Angeles was twenty-four miles nearly south, over the low plains and a slight ridge, to the port of San Pedro. The town is situated on a bluff thirty feet above the ocean. Spring tides here rise nine or ten feet—neap tides from four to five. Small vessels, by crossing the bar with ten or twelve feet at high water, enter a basin at the mouth of San Gabriel river, where they are perfectly secure. A city has there been laid out, but its success is problematical.

At the plaza, shipping is said to be completely sheltered except from southeast winds, which seldom occur, and only in winter. During the last season but one such storm occurred, and a ship in port rode it out at anchor. A breakwater, it is said, of about a mile in length, would afford complete protection even to a fleet; and wharves could be extended to deep water, so as to afford every advantage of a first-rate harbor.

For a great portion of the route from the Mississippi we followed natural channels, where streams flow nearly east and west. The river Arkansas and the Canadian lead us to the base of the Rocky mountains. Thence crossing table-lands to Rio Pecos, we ascend to the head of the Galisteo, which is followed to Rio del Norte. Descending Rio del Norte to Albuquerque, we cross to the Puerco and join Rio San José, which leads to Ojo del Oso, near Campbell's Pass, the summit of Sierra Madre. We now reach Rio Puerco of the west, which furnishes a valley to Rio Colorado Chiquito. The latter carries us to Chevelon's fork, where we turn westward, crossing the final spur of Mogoyon mountain and the headwaters of Rio San Francisco, to a branch of Rio Santa Maria, (Bill Williams fork,) which leads to the Colorado. Thence we would propose to ascend to the mouth of Mojave river and follow the bed of that stream to the base of Sierra Nevada. The route should traverse, thence, the northern slope of the San Bernardino spur, which is said to furnish numerous rivulets, bearing clear waters into the sandy plains below. Approaches from the east to the various passes in this range—"Walker's," "Cañada de las Uvas," and "Tejon"—are known to be favorable. To examine these passes minutely, in order to determine that which shall be available for a railway to San Francisco, was a duty intrusted to another, whose labors, it is hoped, will be crowned with success.

As the shortest line to the Pacific ocean, we proceeded to San Pedro through the Cajon Pass, which is, indeed, difficult; but, should no better be found, ought not to be esteemed a barrier to the construction of a Pacific railway.

More specific information regarding the feasibility of this route for a railway, I beg leave to present in the form of reports from my principal assistants upon the survey.

That of the railroad surveyor is designed to speak more definitely upon the most favorable curves and grades available upon this line, and the labor required to construct the railway.

The geologist and mining engineer notices the rocks, and their adaptation to the purposes of construction; also the positions of beds of coal and mines of precious metals.

The botanist describes the forest-trees, the quality and amount of timber, the produce of the soil, and its adaptation to agricultural purposes.

The zoologist refers to the game noticed upon the route; their habits and means of subsistence.

The details of our operations, with the results of the scientific investigations to be deduced from them, are necessarily deferred to the subsequent part of this report.

CHAPTER V.

Remarks of A. H. Campbell, Principal Assistant Railroad Engineer, upon the grades and curves required.

General Description.—From Fort Smith to the Pecos there is very little to impede the construction of a railway. But I think the opinion that has been pretty generally expressed throughout the country that a railway may be located anywhere, in whatever direction, across the prairies, between the western frontiers of our States and the Rocky mountains, other things being equal, as cheap or cheaper than in the United States generally, is erroneous—particularly so with reference to that portion of the plains passed over by our exploration. These extended prairies being devoid of trees, affording an almost unlimited range of vision, became softened by the effect of distance, and present the appearance of one uninterrupted surface as wild, and as wide, and as smooth as the ocean; but in detail they are exceedingly uneven, being cut up by deep ravines, with elevated spurs and ridges between them, some of them impracticable except by heavy summit cuttings and enormous embankments across the valleys. There are, however, many favorable streams which take their rise under the Rocky mountains, and flow eastward to the Mississippi and its tributaries, and it is in the valleys of these streams that the cheapest and best railway routes are found; the passage from one valley to another requiring the same system of ascents and descents as most of the locations in the States.

Among the most remarkable and most favorable of these streams in point of length and directness, and easiness of occupation, is the Canadian. The valley of this stream is practicable from its mouth to one of its sources near the Pecos, being, with but few exceptions, broad and free from obstacle. A shorter and perhaps cheaper line may be had south of this river, from Fort Smith to the Antelope Hills, near the 100th meridian of west longitude, thereby cutting off the great bends and avoiding the earthy bluffs which are worn away by the action of the waters. These bluffs occur at intervals as far west as the Shawnee settlements.

From Fort Smith to Antelope Hills.—The principal cut-off would be from Fort Smith to Chouteau's old trading post, and from this point to the Antelope Hills. From Fort Smith a good route extends up the Poteau river some ten or twelve miles, where it can be crossed more favorably on account of its high banks; thence up the valley of a small creek, one of its tributaries, called Basil creek. This valley heads in a small range of mountains, or hills rather, which extend nearly parallel with Sans Bois creek. Passing this summit with a grade of about fifty feet per mile as a maximum, we get upon the waters of the Sans Bois creek, down which we descend to its great bend near Cooper's creek, thence up the main branch to the divide between it and Gaines's creek. This summit is an inconsiderable one, requiring about forty-five feet per mile as a maximum grade. Following down Gaines's creek to its junction with Coal creek, the main branch of the south

fork of Canadian; thence up the valley of Coal creek to its head, crossing the divide between the Boggy, a tributary of Red river, and the Canadian, about nine miles south of Shawnee village; continuing along the slopes of this ridge, across the gently rolling prairies, with occasional strips of woodland heading one of the leading streams of the Boggy, crossing Marcy's wagon trail about ten miles west of Shawnee Town to a low place in the Canadian "divide;" thence down the slopes to that river, near the mouth of Topofki creek. From the head of Coal creek to this point it is believed there will be required no grade exceeding fifty-two feet per mile.

From Topofki creek to the mouth of Walnut (Simpson) or Chouteau's (Marcy) creek the route lies up the Canadian; keeping up Walnut creek to its source in the "divide," along the "divide" for several miles, descending by a gradual slope to Deer creek; thence up this creek to its source; thence for several miles along the divide; thence down to one of the valleys of the Washita; up this inviting stream to its source in the sharp "divide" about twelve miles east of the Antelope Hills; thence by a gentle descent to the Canadian. The advantages of this over the river route is, that it will save about thirty-five miles of distance; and, besides, it passes a well-watered and timbered region as far as the Cross Timbers. The valleys of the Walnut and Deer creeks and the Washita are well timbered, and afford an abundance of good land, and a constant supply of water.

From near the Antelope or Boundary Hills the valley of the Canadian is the proper route, from its directness, gentle ascent, and ready supply of water. Its general course is nearly due west to the mouth of Tecumcari creek, and the ascent of these (the one I believe the tributary of the other) very gradual to the summit between them and the Pecos.

From Fort Smith to the Antelope Hills the cost of the graduation, bridging, and masonry, other things being equal, would not, I am of opinion, come up to the average cost of the railways of New England. The soil is loose and gravelly, and the rocks of coarse sandstone, but very little rock-cutting necessary, and fine timber of oak, maple, hickory, walnut, pecan, and pine, is abundant as far as Deer creek; and there is some timber, principally cotton-wood, upon the Washita. It may be said of the whole route from Arkansas to the Pecos, that it will compare most favorably with any similar extent of railway east of the Mississippi in point of grade, curvature, and ease of construction.

Passing the divide between the waters of the Canadian and the Pecos about one and a half mile north of our encampment on "Hoorah" creek, with light excavation and easy grades, the most favorable route extends over a nearly level prairie to the Gallinas valley. The valley of this stream is easy of access and egress, there being suitable valleys for occupation; and indeed from this point to the Pecos, about four or five miles above Anton Chico, the ground is exceedingly favorable. The maximum grade from the Canadian divide to this point it is believed will not exceed forty-five feet per mile—the graduation light, the soil being loose and gravelly.

From the Pecos to Albuquerque via Rio San Antonio, or Cañon Carnuel.—

The problem of leaving the Pecos is a more difficult one than we have yet had to solve. There are, however, two methods which are practicable in the vicinity of our exploration, and I doubt not that by following the river to one of its valleys heading with the Galisteo, a very easy mode of crossing the Rocky mountain range can be accomplished. To determine a suitable point for crossing near Anton Chico, and to even approximate to its cost, would require very careful surveys with the level and the compass. The approach from the east is not so difficult. The river can be crossed with a single span of 150 feet at Anton Chico, or about half a mile below with a less span.

Proceeding then from either of those points, one route would lead up a small valley south of the town, which heads in the elevated plateaux through which the Pecos cañons, as at Cuesta; pursuing a westerly course thence, over a rolling region, to Cañon Blanco. The average ascent per mile to this point is but forty-three feet, but the maximum grade for the first ten miles will be at least eighty feet per mile. The other route from the Pecos would cross the river some four or five miles above the town by a viaduct, at an elevation of from one hundred and fifty to two hundred feet; thence to a point some ten or twelve miles from Anton Chico, connecting with the other route to the summit between Cañon Blanco and the Pecos. This route would be several miles the shorter, and the maximum grade probably not exceed seventy feet per mile. The great cost of a viaduct on this route, however, would render it a question as to which of these routes would be preferable. From the entrance to Cañon Blanco the line explored pursues that cañon to near its western limit; thence over the divide, into the basin between the Rocky mountains and the Pecos. For several miles the ground descends in the cañon to about half-way through; thence ascends to the divide above mentioned. The drainage of this cañon is southeasterly, probably to the Pecos, the main cleft opening and descending in that direction. The grades through Cañon Blanco will be light, not exceeding twenty feet per mile, except at the western limits, where it will require at least sixty feet grade, and from thirty-five to forty feet cutting to attain the summit. From this summit, a little south of Las Lagunas, to the main summit of the Rocky mountains, at the San Pedro mountain, the line traverses a rolling country, descending at an average rate per mile of about thirty-three feet to the lowest point of this basin, which drains, it is supposed, into or towards Las Salinas. From this point the San Pedro Pass can be approached with a grade of about thirty-five feet per mile. This pass divides the waters which flow into the Rio Tuerto from those that flow into, or towards, Las Salinas. About nine miles further is another pass or summit, which divides the waters of the Tuerto from those of the Rio San Antonio, in the Cañon de Carnuel, with a forty-feet cut at the San Pedro summit, and a descending grade of about eight feet per mile for seven miles. We pass the second summit with only about forty feet cutting, and thence descend at the rate of about eighty-two feet per mile for thirteen miles; thence down the sloping mesa to the Rio Grande, opposite Isleta, at a rate of about from twelve to fifteen feet per mile. At Isleta the Rio Grande contracts through a comparatively

narrow gorge, presenting a most favorable point for crossing. Three spans of from one hundred and fifty to two hundred feet will effect this object, there being a bluff on both sides favorable for landing without embankments.

From Isleta the line continues across the elevated spur which lies between the Rio Grande and the Puerco. To attain this summit without excavation, the rock being basalt and lava, a grade of fifty-three feet per mile ascending, and of forty feet per mile descending, will be required.

We are now, as it were, at the base of the Sierra Madre, at the mouth of the San José, which heads on its summit, affording three points for crossing, viz: one point near the Zuñi road, or Camino del Obispo; the other by the Cañon del Gallo and Zuñi Pass; and the third by Campbell's Pass, on the Fort Defiance road. The valley of the San José extends uninterruptedly to the summit of the mountains, heading in the last named pass, with the Rio Puerco of the West. This pass lies about due west from Sierra de San Mateo, or Mount Taylor, and is entered by a wide and beautiful and apparently level valley, the narrowest point at the summit being about three miles. Its northern side is composed of high, red sandstone bluffs, surmounted by escarpment of yellow sandstone; the former appears to have assumed every fantastic form in Gothic architecture. The south side of the pass is formed by the great spurs of the Zuñi mountains. The Zuñi group of the Sierra Madre trends northwesterly from the Camino del Obispo, and terminates in this pass. The Rio Puerco of the West heads east of, and turns the point of these mountains, and extends southwesterly, with a uniform descent, to its junction with the Colorado Chiquito. The average ascent of this valley of the San José from its mouth is about twenty-three feet per mile, but the maximum grade, it is believed, will be only about thirty-five feet per mile to pass the mountains. A light cut through the loose and gravelly soil at the culminating point, and we descend to the Colorado Chiquito, by the Puerco of the West, uninterruptedly, at an average descent of thirty feet per mile.

At a point called the "Hay Camp," on the San José, this valley divides, one branch heading near the Camino del Obispo; and several miles above, another valley, the Cañon del Gallo, occurs, which begins in the Zuñi Pass. This latter valley was not explored, but it is much lower than the Camino del Obispo, and is represented by intelligent Mexicans and others who have passed it as being very favorable for a railroad, presenting no very great obstacle to its construction. A trail for pack-mules from Zuñi to the Ojo del Gallo, at the mouth of Cañon del Gallo, threads through this gorge. From all I learned and all I saw when in the vicinity of this pass, I am of opinion that a grade of between sixty and seventy feet per mile will suffice to cross the mountain at this point; the descent thence to the Pueblo de Zuñi is very gradual.

The route by the Camino del Obispo is more difficult and will require an ascending grade of eighty feet per mile, and a tunnel at the summit of about three-quarters of a mile in length. Descending to Zuñi, this route traverses a gently-sloping and well-watered valley, with a grade not exceeding sixty feet per mile. From Zuñi to the Rio

Puerco, at camp No. 74, (Navajoe spring,) the line passes over the rolling country between Zuñi creek and the Puerco, with undulating grades, the maximum not exceeding twenty-five feet per mile. From the mouth of the Puerco of the West the route continues down the Colorado Chiquito for seventy-five miles, with an average descent of only six feet per mile, thence striking west to the pass south of the San Francisco mountain. By the route surveyed the distance from the river to this pass is forty-two miles, with grades of forty, forty-six, and forty-five feet per mile. By leaving the Colorado Chiquito further east than the point of survey, this grade may be materially modified. Passing this summit, the route continues west for thirty miles over an undulating region north of Bill Williams mountain, through thick pine forests, with undulating but descending grades, the maximum being about thirty feet per mile. Here a small summit is passed which divides the waters of the San Francisco from those flowing northwesterly towards the Little and Great Colorado. With light work here the proper route turns southwesterly towards the Val de Chino, a tributary of the San Francisco river, a distance of forty-five miles, with a maximum grade of forty feet per mile. Crossing this valley to reach Pueblo creek, an ascending grade of fifty feet per mile for fourteen miles, thence an ascending grade of forty-five feet per mile for fifteen miles, enables us to make the Aztec Pass with forty feet cutting.

The Aztec Pass divides the waters that flow into the San Francisco and Bill Williams fork, the former flowing to the Gila, and the latter to the Great Colorado. From this pass the best route would continue down this stream to near camp No. 108; thence over a small divide between Cañon creek and White Cliff creek; thence down the latter to its junction with Big Sandy, the main branch of Bill Williams fork. From Aztec Pass, for fifteen miles, the descending grade will be sixty-five feet per mile; thence across the Cañon and White Cliff creeks summit, with light work, and down White Cliff creek thirty miles to the mouth of Cañon creek, with a descending grade of fifty-one feet per mile, the descent via Cañon creek from camp No. 108 would be about seventy-five feet per mile, through a deep cañon of basaltic rock. From the mouth of Cañon creek the valley of Big Sandy and Bill Williams fork presents no obstacle that cannot easily be overcome, either in grade or curvature, to the Great Colorado. In the Striped Cañon there are several salient points which it will be necessary to tunnel to the extent of from one hundred and fifty to two hundred feet, in order to maintain a workable curve.

Between camps Nos. 120 and 121 Big Sandy unites with Bill Williams fork, which comes from the northeast. From a careful examination of my topographical notes, triangulations, deductions, &c., I feel confident in stating my opinion as to the source of this fork—that it is in a pass which we saw some few miles to the south of us, between the Black mountain and Mount Hope. By a slight detour in the Val de Chino, this pass can be attained, and the valley of Bill Williams occupied for the route there, by saving about fifty miles of distance and the probability of an uninterrupted descent of about twenty-eight feet per mile.

Following up the left bank of the Great Colorado, whose ascent for thirty-four miles is about one and a half foot per mile, a suitable point

for crossing was found among the "Needles," a series of porphyritic and trap dikes, through which the stream forces a passage. Notwithstanding the formidable appearance of the rocks at a casual glance, there are but three points where they infringe directly upon the river, and these points are quite narrow and easily perforated or blasted off entirely. To cut off a large bend of the river in the Pah-Utah valley, grades of about sixteen feet per mile will be necessary to pass the gravelly spurs of the plain. At the crossing, the rocks afford enduring abutments, and the river, being one hundred and fifty yards wide, easily spanned. From this point a proper location will be found, by leaving the river and commencing the ascent of the high table-lands that lie between the Great Colorado and the Mohave rivers, through the pass hitherto supposed to be the *embouchement* of the latter, but which was found to be but a dry bed of a stream heading in the elevated rim of the Great Basin, which undoubtedly extends thus far south. Thence turning southeasterly to a junction with the Sierra Nevada, at the San Bernardino mountain, the exploration continued west and through a pass in the highest point of this river, there being much lower ground both to the north and south of this point, as shown by the map. This pass is attainable, however, by practicable grades, the maximum being about sixty-four feet per mile.

The distance from the "Needles" to the pass is about ninety miles. Cutting thirty feet at this summit, we have an uninterrupted descent for fifty-six miles (following the *detours* of a great valley) to Soda lake—an immense dry and sandy basin, in which the Mohave loses its waters, at a maximum rate of only seventy-five feet per mile.

From Soda lake to the point on the Mohave at which the Spanish trail leaves that river, a distance of ninety miles, the average ascent of the stream is but eighteen feet per mile. Leaving the river near this point, a route is practicable up the dry gullies which lead to the summit of the Cajon Pass, at the wagon-road, the narrowest point of the divide: the distance to the pass is twenty-four miles. For nearly twenty miles the maximum grade will be about sixty feet per mile; thence through the divide by a tunnel of two and a half miles, (rock, white conglomerated sandstone,) and grade of ninety feet per mile. A more favorable approach to this pass is believed to exist at the head of the Mohave, close under the San Bernardino mountain.

The stream which heads in the Cajon Pass, and flows to the Pacific, is very rapid in its descent; but the slopes on the right bank are regular, and are broken but in few places by narrow gorges of tributary streams. This being the case, by descending with a grade of one hundred feet per mile for about twenty miles—keeping up on the slopes of the mountain, passing, by means of a short tunnel or heavy cutting, the salient spur which forms the right bank of the stream below—the valley of Los Angeles is reached. From the foot of this grade, keeping upon the slopes, for twelve miles the grade is lessened to sixty-three feet per mile. This point is about half a mile east of Cocomengo rancho; thence to the crossing of the Rio San Gabriel, near the village of Monte, thirty miles, with a maximum of thirty-eight feet per mile; thence to the city of Los Angeles with about the same light grade, or

from the Monte to the port of San Pedro, thirty miles, with a descent of about twelve feet per mile.

To make a minute estimate of the probable cost of a railway from the Mississippi to the Pacific, cannot come within the province of this exploration; it being well known that, for such a purpose, the most accurate and detailed measurements are required. The barometric observations, however, have developed a most interesting profile, and are sufficiently reliable to determine the great question of *practicability* beyond a doubt. There are but three points on the entire route explored at which the work may be said to be difficult; these are the Pecos, the Cañon de Carnuel, (at Albuquerque,) and the Cajon Pass in the Sierra Nevada.

And these sections will not differ by a comparison with the Baltimore and Ohio railroad from Cumberland to Wheeling, or any of the railroads which cross the Alleghany mountains, in point of grade, curvature, and boldness of graduation. There is but one point on the route where it will be necessary to employ less than a 1,000 feet radius; this point is in Striped Cañon, on Bill Williams fork.

In conclusion of this hasty statement, I desire to state that the few hours taken at intervals from the calculations and arrangements for the barometric profile, and the superintendence of and plotting of the topography on the general maps, have not been sufficient for a full consideration of this important matter; it is due, therefore, that proper allowance be made for its hastiness.

Respectfully submitted:

ALBERT H. CAMPBELL,
Engineer and Surveyor.

Lt. A. W. WHIPPLE, *U. S. Top. Engrs.,*
In charge of exploration for a railroad route near 35th parallel.

CHAPTER VI.

Resumé of a geological reconnaissance extending from Napoleon, at the junction of the Arkansas with the Mississippi, to the Pueblo de los Angeles, in California: By Jules Marcou, Geologist and Mining Engineer.

BOSTON, July 26, 1854.

DEAR SIR: In obedience to the instructions contained in your letter of the 2d July, dated Washington city, D. C., I have the honor to send you the *resumé* of the geological reconnaissance that I made in connexion with your survey for the southern Pacific railroad, extending from Napoleon, on the Mississippi, to the Pueblo de los Angeles, in California.

Having in my possession, as yet, neither the specimens which I collected, nor a good map of the country passed through, and the time being very short which is left me to make my report, I trust you will excuse the brevity of this *resumé*; in which, however, I will endeavor to show the principal geological results of my exploration, in order to

give a general idea of the mineralogical resources of the route with regard to the construction of a railroad.

Napoleon is situated on the alluvium of the Mississippi; which extends on the two banks of the river Arkansas as far as Little Rock, and is composed of a very fine-grained, reddish-yellow earth. This alluvial deposit forms the richest agricultural portion of the State of Arkansas, and as it constitutes the whole of the basin which extends from Little Rock to the Mississippi, and is always in horizontal beds, these rocks, it will be seen, offer no obstacle to the construction of a railroad.

At Little Rock the alluvium is replaced by rocks, forming a line of mountains, whose direction is from west west-south to east east-north.

These rocks continue for three or four miles along the river, and are formed of black slates, of gray quartz-ore, metamorphic masses, traversed by veins of white quartz, having the same direction as the mountains.

On the left bank of the Arkansas, two miles higher than Little Rock, the sandstones and limestones of the carboniferous period begin to appear, resting horizontally upon the metamorphic rocks. Here begins the fine coal-basin of Arkansas, which is only a continuation of the immense coal-field of Iowa, Missouri, Kansas, and which extends even to Fort Belknap, Rio Brazos, and to the Rio San Saba, Texas. Our survey has traversed this basin from the vicinity of Little Rock to Delaware mount, a distance of more than four hundred miles, coal being found almost everywhere from Petit Jean mountain to Coal creek and the Shawnee mountains. It forms a vast reservoir for the sustenance of industry and commerce along the whole line of the Pacific railroad. This carboniferous basin contains, in addition to the coal, an abundance of excellent sandstone for building bridges and embankments, good beds of limestone for the manufacture of lime, and also iron. Artesian wells will give an immense supply of water for agricultural or other uses, and it may be predicted that this region will be one of the richest portions in the southern States of the Union.

Immediately after crossing Delaware mount, which is formed of upheaved and dislocated beds of carboniferous limestone, whose direction is from south-southwest to north-northeast, we meet with horizontal beds of red and blue clay that belong to another geological epoch. This new formation, corresponding to that which European geologists have agreed to call the *Trias*, holds a very important position in the west; and it may be said, with some few exceptions—such as being sometimes covered by a more modern formation, or replaced by carboniferous, devonian, or modern rocks—with these exceptions, the *Trias* may be said to form the whole of the immense square comprised between the 96th and 114th degrees of longitude, and the 32d and 48th degrees of latitude; extending one arm to the Sault St. Marie, at the entrance to Lake Superior, of which it forms a part of the contour.

This formation, which I was the first to notice and recognise in the west, (a Geological Map of the United States and the British Provinces of North America, page 42,) attains a very considerable development, and, according to my observations, has a thickness of four or five thousand feet. The few observations as yet made on this American *Trias*, and its

great extent of surface, prevent the establishment of very certain divisions; but, from what I have seen, I will establish provisionally three principal divisions in these rocks.

The lower division is composed, especially at the base, of red and blue clay; the red predominates as you ascend, and becomes of a vermillion color; then red sandstone, with green spots and a very friable texture, a massive and sometimes schistose stratification, intercalates with the clays, and finishes by entirely replacing them; but this sandstone is very fine-grained, like sand; but some beds are quite coarse, and resemble a species of conglomerate.

This lower group, which attains from two to three thousand feet of thickness, forms our whole route from Topofki creek to Rock Mary. I connect with this lower group the red sandstone that forms more than half the contour of Lake Superior, as well as that which forms the shore of the Bay of Fundy, (Nova Scotia and New Brunswick;) and also a part of the sandstone forming Prince Edward and the Magdalen islands. In Virginia and New Jersey that part of the red sandstone which is without fossils and does not contain any gypsum belongs to this lower division, which closely corresponds to the *beenter sandstein* of the German geologists, the *grès bigarrés* of the French, and to the *upper new red sandstone* of the English.

The second group, or middle division, is formed of beds of red clay, containing very often immense masses of white gypsum, amorphous, furrowed with veins of crystallized gypsum, with interposition of strata of magnesian or dolomitic limestone, and frequently beds of rock-salt or saliferous clay are found superposed upon the gypsum. The height of the beds in this middle group is about fifteen hundred feet. We met with it on our route from Rock Mary to the arroyo Bonito, or Shady creek, with the exception of two points, where the direction taken by our expedition, near camp No. 31, crossed strata of neocomien, and at Antelope Hills whitish-gray sandstone, which belongs to the upper division of the Trias. I connect with this middle group the gypsum found in the red sandstone of New Jersey; at Windsor, Nova Scotia; at Plaster cove, Cape Breton; and at Prince Edward island. As to its synchronism with European formations, I regard it as corresponding to the *muschelkalk* of Germany. It contains, like the *muschelkalk* of Wurtemberg, rock-salt and dolomite. The first fossils which I found in the Trias were in this division. It was near camp No. 33—a full-grown tree with branches, very much resembling the pinites fleuratii of Dr. Mougeot, which is found in the new red sandstone of the Val d'Ajol in the Vosges; and this establishes a connexion between the new red of France and that of America.

The third division, or upper group of the Trias, is subdivided again into two parts. The lower is formed of thick beds of whitish-gray sandstone, often rose-colored and even red; and the upper consists of beds of sandy calcareous clay, of very brilliant colors, violet, red, yellow, and white—in a word, of variegated marls. This upper portion presents a striking resemblance, as to the rocks, with the *marnes irisées* of France, or the variegated marls of England. With the exception of the amaranth yellow color, which I have never seen in Europe, I could have imagined myself transported to some points in the Jura or the

Vosges. These rocks having very little consistency, have been carried away almost everywhere by denudations. It is only where they are capped by the jurassic strata that they can be observed. The sandstone of this third division is very much developed, with rather an indistinct and very massive stratification. Its thickness is one thousand feet, while the variegated marls are only four or five hundred feet thick; making a whole of fifteen hundred feet for the upper group of Trias. Upon our route this sandstone forms the summits of the table-lands or mesas, which extend on each bank of the Canadian river from Antelope Hills to the Llano Estacado; then it forms the bottom of the valley from Rocky Dell creek and the Plaza Larga to Anton Chico and the Cañon Blanco. In this group of triassic rocks, numerous remains of petrified wood, and even of whole trees, are often met with.

On the western declivity of the Sierra Madre, between Zuñi and the Rio Colorado Chiquito, there is really a petrified forest of trees thirty and forty feet long, divided into fragments from six to ten feet in length, with a diameter of three or four feet, some being still upright enclosed in the sandstone. These trees and remains of petrified wood belong nearly all to the family of the conifers, and some to that of the ferns with arborescent stems, and to the *calumodendron*.

I connect with this third division the red sandstone, containing foot-prints and fishes, of the Connecticut valley, as well as the coal-basin of Chesterfield county, in Virginia, and the red sandstone in North Carolina, contrary to the opinion of Messrs. Rogers and Hall, who call it liassic, and even oolitic. Its equivalent in Europe is, without doubt, the *marnes irisées* of France, the *keuper* of Germany, and the variegated marls of England.

The easy decomposition of the sandstone of this third group has given it all sorts of curious forms, which have been compared to ruined temples, natural fortifications, natural mounds, or to the forms of gigantic statues, rivals of those of Karnac and Nineveh. The celebrated Chimney Rock, on the route to Fort Laramie, is entirely of this formation.

The strata of American Trias comprise valuable rocks for building a railroad. There are found in abundance sandstone, for embankments and bridges; dolomite, which produces an excellent hydraulic lime; gypsum in incalculable quantities, for exportation; and, finally, salt.

I have mentioned two points between Topofki creek and Anton Chico, where the triassic rocks are covered by more modern formations. The first of these points is upon one of the tributaries of the Washita river, near our camp No. 31, where, upon the heights, are found the remains of beds of a limestone filled with shells, which I connect with the neocomien of Europe; or, in other words, with the lower division of the cretaceous rocks. This limestone is only five feet thick; it is of a whitish-grey color, containing an immense quantity of *ostracea*, which I consider (provisionally) as the *exogyra ponderosa*, Roemer; having the closest analogy with the *exogyra* of the neocomien of the environs of Neufchatel. As it is the first time the neocomien has been recognised in North America, where, until now, only the green-sand and chalk-marl, or lower chalk, have been found, I will add that these strata are

much more developed at Fort Washita, where Dr. G. C. Shumard has made a large collection of fossils, such as *peeten guingue costatus*, *panopea toxaster complanatus*, and another species of *toxaster*, all fossils or genera characteristic of the neocomien of Europe. Further, at Fort Washita, the neocomien is covered by the green-sand, containing very fine *hemiasiter*, large *ammonites*, &c.

This neocomien has been almost wholly destroyed and carried away by denudations, for it is only found on the summits of the hills, resembling the remains of ancient buildings; it occupies actually only a width of three or four miles. Probably at the time of the deposit it covered more space; but, as at Fort Washita, where it has been very little denuded, it is only twenty-five or thirty miles wide. This shows it to have been but a narrow bend in the immense basin of the prairies:

The second point where the expedition has quitted the strata of the Trias for a more recent formation, is at the place where we crossed the Llano Estacado. The base of the Llano is formed wholly of the upper strata of the *keuper*, which reaches half way up the height of the plateau. These strata, which are of a red color, are suddenly replaced by white sandstone, containing numerous calcareous concretions, then by a compact white limestone, sometimes oolitic, that forms the summit of the Llano. These beds are superposed in concordant stratification upon those of the *keuper*.

The Llano Estacado consists of two table-lands of different elevations. We crossed the lower one but forty miles further west. Near Fossil creek and Tucumcari mount there is a second steppe, one hundred and fifty feet higher than the first, also forming a vast mesa, which extends to the Pecos. This second mesa is entirely formed of blue clay at the base, then yellowish sandstone; and, finally, the summit is again a very compact, white silicious limestone.

In the whole, this formation of the Llano Estacado does not exceed four hundred feet in thickness.

This formation is not limited to the Llano, but it forms the summits of all the plateaux that are seen to the north, in the direction of the Canadian river, and between the Canadian and the Raton mountains, as well as the majority of the mesas, which extend from the Rio Pecos to the foot of the Sierra de Sandia. Our survey has also met with it on the other side of the Rio Puerco, forming with volcanic lava almost the whole road between Covero and the Sierra Madre, and finally between Inscription Rock and the Pueblo of Zuñi, where it again forms mesas, which extend in the direction of Fort Defiance and the Cañon de Chelly. It will be seen that these of the Llano Estacado occupy, geographically, a large place in the geology of the Rocky mountains; but as regards their relative age, they are still more important, for they fill a void until now left in the series of stratified rocks of North America; these rocks belong to the jurassic or oolitic epoch. Fossils are very rare in the sandstone and limestone; but the beds of blue clay which are found in the middle of this formation contain in abundance a *gryphæa* which has the greatest analogy with the *gryphæa dilatata* of the Oxford clay of England and France, and which I call provisionally *gryphæa tucumcarii*, and a very large *ostrea* having much resemblance to the *ostrea marshii* of the inferior oolite of Europe. I found also *trigonia* and a

species of *cardinia*. This American jurassic presents, at least thus far, one point of considerable difference from the jurassic of Europe and Asia, where such large quantities of *cephalopods* are found, such as *ammonites* and *belemnites*; while here the *ammonites* are only found in the green-sand, and the *belemnites* in the marly chalk; and even there these fossils are never so abundant as in the corresponding strata of Europe.

In a practical point of view the jurassic rocks are rather poor.

The limestone will furnish lime; the sandstone can be used for embankments and bridges, and with some advantage over that of the Trias, for it is harder. Finally, in some locations, as at El Ojo Pescado, near Zuñi, in the neighborhood of Fort Defiance, at the cañon of Chaca, there are beds of bituminous coal in the clay, but only three or four inches thick, so that probably they would not be rich enough to be successfully worked.

Continuing our itinerary, we find that from Anton Chico to near San Antonio we are almost constantly on white and yellow jurassic sandstones. Three miles before reaching San Antonio the Trias is met with again, which now is found upheaved and dislocated, the strata dipping to the east; and for a space of five miles, all the strata are passed through with the gypsum, dolomite, sandstone, and red clay—exactly the same sort of rocks that were seen before in the Trias of the prairies. Immediately on leaving the village of Tigras, which is situated in the middle of the pass that crosses the Rocky mountains, called here Sierra de Sandia, and also Albuquerque mountains, black schistose clay is seen, belonging to the coal measures, then grayish-blue limestone, containing a great quantity of fossils. These last beds of schist and limestone are very much upheaved, dipping to the east at an angle of 30 or 40 degrees; they rest on metamorphic rocks. The principal fossils found in the limestone which belongs to the mountain limestone or lower carboniferous, are the *productus semireticulatus*, *punctatus et flemingi*, the *spirifer striatus et lineatus*, *terebratula*, *crinoids*, and *polyps*, which are all fossils very characteristic of the mountain limestone of Arkansas, Missouri, Iowa, Illinois, Indiana, Kentucky, Tennessee, Virginia, and Pennsylvania, as well as in Europe, and even in Australia and South America.

We have not met upon our route with beds of coal; but the presence of the black slate between the mountain limestone and the red clay of the Trias, indicates the existence of beds of coal on several points of the Rocky mountains; and, in effect, the inhabitants of New Mexico pointed out to me, in several places, beds of bituminous coal belonging, without any doubt, to the rocks of the coal measures.

On quitting the last beds of limestone that rest upon the quartzose metamorphic rocks, we find serpentine; then we come upon masses of granite, a little sienitic, which form the centre of the line of dislocation of the Rocky mountains. After going through the pass, which is fifteen miles long, we come out in the plain of the Rio Grande del Norte, where the granite is found covered with drift and alluvium, which form the whole plain as far as the right bank of the river, where the formation is sandstone. This sandstone is white, friable, horizontal in stratification, and forms almost the whole of the bottom of the

valley which lies between the Rocky mountains and the Sierra de Jemez, and Mount Taylor or Sierra de San Moteo. On some points, as at Galisteo, it is covered by a grayish schistose clay, containing nodules of iron and numerous *plaquettes*, composed of the scales and fragments of bones of fishes, belonging to the genus *Ptychodus*. In this sandstone and clay, which rest horizontally on the upheaved beds of the Trias, the jurassic and the carboniferous, are found the remains of *ammonites*, *scaphite*, *inoceramus*, and the teeth of *ptychodus*, which indicates, for the relative age of this formation, the cretaceous group, and, further, the white chalk of Europe. This fact is a new one in the geology of America, where, until now, the true chalk has not been recognised; and now the cretaceous is here found to be composed of four divisions, precisely as in Europe: the *neocomien*, which I have found on the Canadian, the False Washita, and at Fort Washita; the *green-sand* of Timber creek, near Philadelphia; the *marly chalk*, of Bordentown, New Jersey, of the Bad Lands, Nebraska, and of Fort Washita; and finally the *white chalk*, or *craie blanche* of New Mexico. Besides, the discordance of stratification of the upper cretaceous of New Mexico, with all the *sedimentary rocks* found there, indicates that this formation was deposited after the principal dislocation of the Rocky mountains, which took place at the end of the American jurassic period.

From the Rio Puerco to the Sierra Madre, our route was constantly upon beds of Trias and jurassic, which are often covered in this region by immense overflowings of lava, coming from the ancient extinct volcano of Mount Taylor, that is seen some distance to the north. These streams of lava which spread over the bottom of the valleys are exactly similar to the streams from volcanoes in actual activity, and, like these, are destitute of vegetation, and give to the country, where they are found, an arid and desolate aspect, named by the Mexicans, very appropriately, *Mal Pais*.

Near the culminating point of the Sierra Madre the Trias is replaced by the carboniferous limestone; then, for a distance of twelve miles, the rocks are eruptive granite, gneiss, and mica schist. Beyond, on the western declivity of the Sierra, comes the carboniferous again, the beds of the Trias, and finally the white and yellow sandstones of the jurassic, with streams of volcanic lava in the valleys. Inscription Rock, and the whole mesa that extends nearly to Zuñi, are formed of the jurassic rocks. A stream of lava spreads itself in the valley of the Ojo Pescado, and terminates three miles from the pueblo of Zuñi.

The valley of the pueblo and river of Zuñi is of triassic rocks, formed here, as in the prairie, of sandstone and red clay, with dolomite and gypsum. On the plateau which we cross from Zuñi to the Colorado Chiquito, and from there till we arrive at a distance of five or six miles from the secondary Cones of the great volcano of the San Francisco mountains, we are constantly upon the Trias. These rocks are nearly horizontal upon the table-land, after having dipped to the east and west near the Sierra Madre, where they are very much upheaved. As we approach the Rio Colorado Chiquito, the strata incline to the north at a varying angle whose maximum is fifteen degrees; the heads of the strata looking towards the Sierra of Mogoyon, which is seen forty miles to the south.

Shortly after quitting the Colorado Chiquito we found herewith the last beds of the red clay of the Trias, and, in concordant stratification, a magnesian or dolomitic limestone, with very regular strata from half a foot to one foot in thickness. Several beds contain fossils badly preserved, among which I recognised, however, a *nautilus*, a *pteroceus*, and *belemnites*. This formation, which is placed between the carboniferous and the Trias, corresponds, without doubt, to the magnesian limestone of England, and is a new member which I add to the series of secondary rocks in North America.

This magnesian limestone has only four miles of extent in the place where we crossed it, and disappears beneath lava and volcanic ashes. I have observed it further to the west, and it appears also eastward to occupy one of the lesser chains of the Sierra de Mogoyon.

From the Sierra of San Francisco to Cactus Pass, the geology of the country we passed through is very complicated, on account of the immense extinct volcanoes, which have covered with their lavas and basaltic streams the sedimentary and granitic rocks that primitively formed this region. The study of this part of our route was rendered still more difficult by the snow-storms, that covered the ground with an immense white sheet during nearly the whole time of our exploration.

I will only say, in general, that there are four or five large extinct volcanoes over this space, the largest being that of San Francisco, which is twelve thousand feet above the level of the sea. In places where the lava does not entirely cover the ground, we find magnesian limestone, the sandstone of the coal measures, and the carboniferous limestone—the last containing fossils in abundance, the principal ones being the *productus semireticulatus* and *punctatus*, and the *spirifer striatus*.

These stratified rocks are upheaved, and dip generally to the north-northeast, following several lines of dislocation which belong to the chain of mountains called Sierra de Mogoyon, or Sierra Blanca. In several places, and especially at Pueblo creek, beds of old red sandstone are seen below the lower carboniferous, and in contact with the gneiss and granite, similar to the old red of the Catskill mountains.

This system of dislocation of the Sierra of Mogoyon, the direction of which is east east-south and west west-north, is anterior to the apparition of the Rocky mountains and the Sierra Madre, and I put it at the end of the triassic period, and before the deposite of the jurassic.

From Cactus Pass to the junction of Bill Williams fork with the Rio Colorado, we cross successively three or four chains of mountains running from north to south, and crossing the chains of the Mogoyon system. These mountains, which belong to the system of the Sierra Nevada, and which we called the Cerbat mountains, are formed entirely of eruptive and metamorphic rocks, with some beds of conglomerate and red clay belonging to the tertiary epoch. I have recognised along the course of Bill Williams fork several veins of argentiferous lead—an indication that silver is common in these mountains.

From the Rio Colorado to Monté, we cross a country of mountains, formed almost wholly of granite rocks, with the exception of three plateaux, which are occupied by sandstones or limestones, and modern

sand. From the point where we quit Mojave creek to Cajon Pass, there is a plateau formed by a white conglomerate sandstone of diffuse stratification, and much upheaved by the Sierra Nevada. This sandstone is evidently tertiary and posterior to the eocene.

From Monté to Los Angeles, and at San Pedro, the road is constantly over modern alluvium, which probably conceals beds of the tertiary epoch.

In the Cajon Pass I found sienite, trap, and serpentine, exactly similar to those found between Rough and Ready, Grass valley, and Nevada City, and which contain the veins of auriferous quartz.

As specimens were given to me at Los Angeles, very rich in gold, coming from the Cajon Pass, it is more than probable that this point will, one day, be one of the richest places in California.

In an economical point of view, the eruptive rocks which form almost the whole country between Cactus Pass and Cajon Pass will furnish excellent materials for construction, for bridges, roads, and houses; there are also very beautiful marbles, red porphyry, and especially, I think, will be found there, mines rich in silver and gold.

Before concluding, I will say that the relative age of the Sierra Nevada is much less than that of the Rocky mountains, although the direction of the two chains is the same—that of the meridian. The coast range was raised at the end of the eocene epoch, whose beds it has upheaved and dislocated, as may be seen in the environs of Monterey; and the Sierra Nevada was raised later, at the end of the miocene, or pliocene; I have not been able to determine to which of these two this system of dislocation corresponds.

Accompanying this will be found a geological section of the country passed through, as correct as possible, for the short time I have left to make it.

I am, dear sir, your most obedient servant,

JULES MARCOU,

*Geologist and Mining Engineer of the Southern
Pacific R. R. Survey*

A. W. WHIPPLE, 1st Lieut. Top. Eng., U. S. A.,

In charge of exploration of route near 35th parallel.

CHAPTER VII.

Economical Zoology.—Game, and their means of subsistence: By C. B. R. Kennerly, M. D., Physician and Naturalist.

WASHINGTON, D. C., July 1, 1854.

SIR: I have the honor herewith to present a general account of the game animals of the country traversed by you in surveying a route for the railroad to the Pacific. I do not propose here to go into much detail, as the description of the individual species, with an account of their characteristic habits, is reserved for a subsequent report. For convenience of reference, I shall divide the line into several portions,

and express, as briefly as possible, the peculiar features in the economical zoology of each.

From the Rio Grande to the Pueblo of Zuñi.—Although this district is hunted very closely by Indians and other persons traversing it, yet in some places we found game abundant. Before reaching the pueblo of Laguna, however, animals of the larger kind were rarely observed. Still, along the road, the large rabbit of this region (*lepus callatis*) was often seen springing and hurrying off towards some neighboring hills or clump of cedars, while the smaller species, (*lepus artemesia*), less swift than its long-eared companion, but not less abundant, darted from its form in the grass and disappeared in its burrow; and along the Rio Rito, ducks and geese in large flocks supplied us with many delicious meals. But it was not until after leaving this village that we were enabled to enjoy the more noble sport of hunting the black-tailed deer (*cervus macrotis*) and bears, that we found upon approaching the Sierra Madre. This district has long been celebrated for its game, and the accounts that we had heard proved not to be exaggerated. Even in the small grassy valleys that we crossed were seen herds of the above-mentioned deer, while among the piñons on the hills were found the resting-places of the bear of several species.

Descending the western slope of the mountains, we again met with rabbits in great numbers. Besides these, we occasionally found the timid and graceful antelope; but being much hunted, they were here scarce and wild, and when seen were far off in small herds upon the plain. Along the valleys that stretch towards the pueblo of Zuñi, and which are generally hemmed in by rough and rugged hills, we found the grizzly bear (*ursus ferox*) abundant. When impelled by hunger they become very fierce, and, descending into the valleys frighten off the *pastores*, who, in their terror, abandon their flocks to these huge monsters.

A part of this country abounds in birds, whose glad notes cheer the traveller on his way. Among the lofty pines and thick cedars of the Sierra Madre we were enabled to collect many valuable specimens of new and otherwise interesting species.

From the Pueblo of Zuñi to the Little Colorado river.—Leaving the village, we continued our march for a short distance along the Zuñi creek, making, as we went, interesting collections of fishes, mostly new and undescribed species. Leaving the creek then to our left, we passed through a succession of cedar groves and grassy valleys, abounding in black-tailed deer and antelopes, (*antilo capra Americana*.) In this region we first saw signs of the panther, (*felis concolor*), which, leaving the wooded hills, occasionally descended into the valleys to hunt the hare or chase the antelope. At night, while the cheerful camp-fires were blazing around, the coyoté, (*canis latrans*), approaching near, would serenade us with his loud and varied notes, while afar off the large, gray wolf (*canis gigas*) would utter his dismal howl, mingled with the piercing cry of the panther. The latter animal would become silent at the approach of dawn, while the bolder coyoté, removing further from the camp, and seated upon some eminence, would continue his bark sometimes until after sunrise.

In many places birds were scarce, yet we were enabled to collect some very interesting specimens. The weather being cold, the reptiles had all disappeared.

From the Little Colorado river to Pueblo creek.—Passing down the Little Colorado, we sometimes saw ducks of the commoner kind, mallard and teal, flying swiftly over our heads, or calmly reposing on the bosom of the stream, and frequently encamped near the home of the beaver, (castor fiber,) where he had felled the groves of young cotton-wood trees, and trimmed off the limbs with such smoothness as to resemble the work of human hands. Now and then the Canada porcupine (hytrin Canadensis) was seen as a dark bunch resting upon the projecting limb of some leafless tree, or awkwardly crawling among the bushes.

Turning towards the snowy peaks of the San Francisco mountains, we bade adieu to the Little Colorado. Ascending the gravelly mesa, our train passed slowly, occasionally turning from a direct line to avoid a small hill or little cañon. As we gradually approached the mountain, the chilly blast, sweeping over its whitened crest, painted our cheeks, while it made us draw more closely around us our thick and heavy coats. The little valleys skirting its eastern base, supplying good grass, were now the homes of hundreds of antelopes, who were here sheltered by the neighboring hills from the piercing winds.

A little further on and we found in great numbers the beautiful tufted squirrel, (sciurus aberti,) and admired its gracefulness as it leaped from tree to tree, or passed swiftly over the frozen snow; while the stillness of the evening was sometimes broken by the heavy flaps of the wild turkey's wings as he ascended to his roost in some lofty pine. Spending the Christmas here, we enjoyed much the sport of this wild region; often ascending high into the mountain to track the big-horn, (ova mentara,) whose timidity causes him to dwell in the most inaccessible places.

A few short marches through the dark pine forest and deep snow brought us near Mount Sitgreaves, which lay like a huge monster wrapped in the unspotted mantle of winter, while from its base stretched beautiful valleys covered with grass and dotted by clumps of cedars. Ascending the mountain, we found it the deserted home of the grizzly bear, which, chilled by the drifting snow that had also buried his food, had passed towards the south in search of more comfortable quarters. The number of trails of this animal that we found here, all leading towards the south, is almost incredible. Indeed, before the falling of the snow, it seemed to have been the peculiar home of this animal. But now he was gone, leaving the tufted squirrel and wolf the sole proprietors of his former domain.

From this point our journey lay, for some days, along beautiful valleys, and often through thick and dark forests of cedars; and as we marched along we reaped a rich harvest of the smaller quadrupeds, such as pouched rats, mice, &c. Nor were we compelled to lay aside our rifles for want of larger game; for although we saw no antelopes, the black-tailed buck, accompanied by his graceful doe, frequently darted before us. Reaching soon a handsome valley, with its surface

cut by a serpentine cañon, at some seasons probably containing a running stream, but now only watered by a succession of cool and clear pools, we found in great numbers Gambel's partridge, (*callipepla Gambelii*.) While encamped here this beautiful bird afforded us fine sport with our shot-guns, while frequently in the distance was heard the keen and sharp report of the rifle, or the hoarse bellow of the musket, from some party in search of deer. Along this cañon were many deserted wigwams, the Indians having probably retired to the south at the approach of winter.

But we had not bid a last adieu to the antelope, though we did not find it here among the hills and thick bushes. This species prefers the open valley, or wide and unbroken plain, where it can descry an approaching enemy in the distance. Descending into the Chino valley, we found this interesting animal very abundant. Large herds could be seen afar off moving away rapidly in alarm at the unusual sight of our train. Occasionally, impelled by curiosity, they would approach quite near, as if to see what creatures they were that had thus unceremoniously invaded the country of which they had remained the unmolested proprietors for so many generations.

After leaving the Chino valley, we entered again the cedar forests, where we found wild turkeys again very abundant, dwelling for the most part along the little brooks that we found in this region, and feeding upon the berries of the rough-barked and other species of cedar. It was pleasant, afar off here in the wilderness, to hear the familiar voice of the male as he gathered his flock to roost in some tall tree.

In the thick underbrush along these creeks the grizzly bear sometimes made his bed, and watched with careless air the ducks that floated on the stream. In this vicinity we caught some interesting fishes, and collected many handsome specimens of birds, the smaller species particularly being quite numerous.

From Pueblo creek to the Big Sandy.—Following up Pueblo creek nearly to its source in the mountains, we passed through Aztec Pass, with faces turned still towards the setting sun. This was a beautiful little stream, and we were sorry to leave it, as in this region one seldom sees such cool and limpid water.

Passing through the mountain, we again descended into a beautiful valley to hunt the black-tailed deer and chase the antelope, both of which animals we found quite abundant. Continuing our march, we crossed from time to time deep cañons with their pools of clear water, though containing no fishes, yet affording a sporting place for many ducks, which were at night frequently molested by the stealthy lynx (*lynx rufus*) that made its home in the neighboring rocks. The caves also among these rocks often afforded a shelter for the wild Indians of this region, who gather here the maguey plant and store it away for winter food. This plant we found very abundant, but the Indians do not depend upon it alone for subsistence, combining with it the smaller quadrupeds, as well as large game, which they are sometimes able to capture.

The distance from Pueblo creek to the Big Sandy is probably much less than the distance embraced between any other divisions that we

have assumed; but it was a country throughout particularly rich in deer. It was a country also pretty well wooded with the various species of cedar, which, in addition to its affording a shelter for the larger animals, supplied also, in their berries, food for various species of the smaller birds, some interesting specimens of which we were enabled to collect. We frequently passed the burrows of the smaller quadrupeds, with their heaps of spiny cactacæ piled over them to prevent the coyoté from destroying them and their habitations. The long and barbed spires of this plant are sufficient to deter the wolf from committing his depredations; but the small rabbit, (*lepus artemesia*,) not understanding as it would seem the science of fortification so well as its more humble companions, often falls a victim to the rapacity of this animal, by being chased or scented to his burrow and then dug out. The jackass rabbit, (*lepus callotis*,) being much more swift than the small one, is less liable to be overtaken by its untiring enemy.

From the Big Sandy to the Great Colorado river.—We entered here upon a district of a new character and of much interest. Descending into the valley of this stream, and travelling along its banks to its confluence with Bill Williams fork, we had an opportunity of seeing, as well as collecting, many new and interesting objects; among the larger game recognising many old acquaintances whose forms had now become very familiar. While the antelope sported on the wide mesas, and the black-tailed deer fared sumptuously in the little grassy dells, the big-horn looked down with astonishment from his position on the rocky peaks at the scene beneath him.

Entering upon Bill Williams fork with these interesting animals still for our companions, we continued our march towards the Great River of the West. This beautiful stream sometimes emerged suddenly from the earth a bold rivulet, leaping playfully over its gravelly bed for several miles, and then would as suddenly disappear again beneath the sand. Whether creeping slowly among the bushes, or passing through the open valley, we ever found something to please and interest us. The myriads of ducks frightened from the stream or neighboring lagoons made the valley echo with their cries, while we were ever cheered by the pleasing notes of the little songsters from the bushes. The warm rays of the midday sun invited from their holes and hiding-places many interesting reptiles, which sported on the sandy beach or crawled among the bushes.

Dipping our net into the stream, we seldom failed to find fishes presenting new forms, distinguishing them from any that we had seen before. The birds, however, of this region were especially interesting on account of their variety. Some new species were procured, among them a very singular swallow, constituting probably a new genus. It may be well also to mention, in this place, that along the fork we frequently saw the tracks of a species of *Geococcyx*, a bird that we had not seen since leaving the Little Colorado river; as also of what was supposed to be a species of raccoon, (*procyon*.) These animals themselves, however, we never saw.

From the Great Colorado river to the Pacific.—Travelling up the Colorado for some distance, we found its shores peopled by hundreds of Indians, whose friendly manifestations made us soon feel quite at home

among them. Besides assisting us in many other ways, they also enabled us to procure some species both of fishes and birds, which, without their aid, we probably could not have captured. Thus our stay among them was made both pleasant and profitable. The birds and fishes constitute the most important features of natural history immediately in the vicinity of our route. The larger animals being closely hunted, were scarce.

Crossing the river, and accompanied by several Mojave Indians as guides, we bade adieu to the Great Colorado and hurried on towards the Pacific. Rising an eminence some miles off, we cast a last look back to see the smoke curling up from the many wigwams in the valley, and the surface of the stream shining in the sun, bearing its muddy tribute onwards to the Gulf. From this point we saw but little of interest before reaching the Mojave river. Grass being scarce, except in the vicinity of the few watering places, we had but few companions, during our long and tiresome marches, save the raven, which hovered over our now fast-failing mules, and added to our dreary feelings by his hoarse croaks. Occasionally, too, the jackass rabbit would spring from his hiding place among the stinking larræ and hurry off. Frequently we found this animal far away from any water known to our guides. Sometimes also, while encamped in this less-favored region, the coyoté, attracted by our camp-fires, would approach and serenade us as he had done before.

Near the watering places on our route we frequently saw signs of the big-horn and other animals, where, watched by the Indians when coming to slake their thirst, they had been slain. It was not until after we had reached the Mojave river, however, that we met with much success in collecting specimens. Here, in addition to the many small birds that were continually singing around us, and the numerous ducks that were scared from the marshes, we found the stream itself inhabited by several species of fishes. Many of these we added to our collection; as also of the reptiles which here abounded.

Approaching the mountain, we once more found the black-tailed deer and grizzly bear; one feeding in the green valleys, the other among the pines on the rugged slopes.

From this point our route lay along the beautiful valley of the San Gabriel river. Here we found the green pastures dotted by flocks of sheep and herds of cattle. Game of the larger kind was of course scarce through this region, being closely hunted by the inhabitants; but we found birds here of almost every variety of plumage, and many quadrupeds of the smaller species. Many of these we added to our collection before reaching Los Angeles, where we ceased our labors for a while, and enjoyed those comforts of which we had been so long deprived.

In conclusion, I would state that we were agreeably disappointed in regard to the abundance and character of the game of the country traversed. It will be seen from the foregoing statement that we were almost continually within reach of deer, antelope, and hare. Still, it would not be safe to depend upon game for subsistence in passing over the line, especially in the case of a large party. As is well known, all the animals just mentioned are easily driven off from their usual range

by frequent interruptions, and at all times a skilful hunter is required to capture them. The case is different with the buffalo, whose presence in a certain region is more to be calculated upon, and when seen is more readily captured, affording at the same time a much larger amount of food to each head.

Very respectfully, your obedient servant,
C. B. R. KENNERLY, M. D.,
Physician and Naturalist to the Expedition.

A. W. WHIPPLE,
*First Lieutenant Top. Engineers, U. S. A.,
In charge of exploration for railroad route near 35th parallel.*

CHAPTER VIII.

*General description of the soil and productions along the route traversed—
Remarks upon timber and fuel: By J. M. Bigelow, M. D., Botanist.*

WASHINGTON, D. C., August, 1854.

SIR: In compliance with your instructions, I have the honor of submitting to you a report on the forest trees, the productions of the soil, and its capacity for sustaining a civilized population, upon the middle railway route from the Mississippi to the Pacific ocean, over which you had command.

Very respectfully,

JOHN M. BIGELOW.

Lieut. A. W. WHIPPLE, *Top. Engineers, U. S. A.,
In charge of exploration for railroad route near the 35th parallel.*

SECTION I. *Napoleon, on the Mississippi, to Fort Smith, Arkansas.*—From Napoleon to Fort Smith, our way being on board steamboat, I could of course give but a limited account either of its forests or soil. The banks of the river were densely lined with timber trees of great variety. Among the varieties observed, I particularly noticed the black walnut, sweet gum, (liquidambar styraciflua,) pecan, white ash, three kinds of elms, five or six species of oaks, osage, orange, and sasafra, with their dark green foliage—all most luxuriant and beautiful. At Little Rock, among those just mentioned, I saw the American holly, (ilex opaca,) spice-wood and June berry, (amelanchier canadensis.) Near Piney Point, at the Sugar Loaf mountain, as well as on our route in the Indian territory, I find a pine which I take to be *Pinis mitis*, the common yellow pine of the southern States, quite different from the one in New Mexico known there by the same common name. It is unnecessary to extend the list beyond a few seen from the boat, as this country has been visited by Nuttall and other well-known botanical explorers.

In passing, I observed witch hazel, hop-horn beam, birch, Kentucky coffee bean, honey locust, black locust, sour gum, red bud, box elder, mulberry, dogwood, hackberry, &c., &c., all indicating a soil of the utmost fertility.

SECTION II. *Fort Smith to Valley river.*—The scope of country embraced between these two points is about 475 miles. The western limit of this section is some distance west of the Indian territory line. It consequently embraces the entire limits of that territory from east to west. It constitutes a most natural division, being in its whole breadth a beautiful and fertile country, of vast agricultural capacity. The eastern portion is densely covered with timber, of the same varieties and qualities as those enumerated between Napoleon and Fort Smith. The western section has not nearly so great a variety, being mostly grassy plains, with intersections of timber along the streams, arroyos, and ravines. The celebrated cross-timber is situated along and crosses our line of survey, extending some distance to the north and south of it. The streams are Sansbois creek, Gaines's creek, Deer creek, False Washita, Walnut creek, Dry creek, Valley creek, &c., with their various other tributaries, as also others of the Canadian and Washita rivers. Near old Fort Arbuckle, and in the vicinity of the cross-timber, the scenery is most beautiful and picturesque. Belts of timber, crossing the more elevated plateaus in various directions, many times at right angles with each other, give it the appearance of being formed on a scale of the utmost magnificence, stretching away in every direction as far as the eye can reach. The same beautiful views were remarked in the vicinity of Delaware mount, near the centre of the Indian territory. The first appearance of the celebrated *grama grass* was noticed opposite the mouth of Little river, on the other side of the Canadian, in about longitude 96° west. This important grass is found in greater or less abundance from this point across the entire continent, or until we reach the mountains of the Sierra Nevada near the Pacific shore.

The great importance of these western prairie grasses, of which we have several species besides this and the buffalo grass, consists in their retaining their nutritive qualities the whole year round, thereby sustaining the life of the traveller and his beast at all seasons of the year. When the top has become dry, the stem near its root retains its vitality and nutritive properties, until the plains are again renovated with a new crop. Many of our farmers express a wish to introduce the culture of these grasses at home; but I presume they are only well adapted to the arid climates, where they are found in their native state.

The trees in the western portion of the section consist of several species of oak, black walnut, cotton-wood, buckeye, elm, mulberry, and a few cedars; helianthi, convolvulaceæ, with shrubbery and herbaceous mimosæ, are common in this region. Sapindus and nyctigenaceæ plants, common to lower Texas, are also found. Ambrosias, golden rods, evening primrose, rosin plant, (silphium,) &c., grow on the plains, and, with the American and Chickasaw plums, on the banks of the Canadian also. I find here on the plains a very small shrub bearing what is called a prairie plum, which I think is undescribed.

A considerable number of cactacæ, the great indicator of a dry climate, begin here to make their appearance, especially when we come into what may be termed the grama-grass region. The little *Cereus cuespitosus*, so common in lower Texas, we find here in great abundance. I was sorry to be unable to secure a flower or fruit of this pretty little plant, by which we would be enabled thus to elucidate many obscure points in the natural history of this unique and interesting tribe of plants.

The whole of this region, from Fort Smith to Valley river, is eminently calculated to sustain a large population. Although the soil itself may not be as rich as that of Arkansas, yet the ease of raising stock, and the exemption from sickness, will greatly counterbalance this difference. Water, in most places, will be found abundant for agricultural purposes. In some places, especially on the headwaters of the Washita, it is quite brackish, being impregnated with the salts of magnesia; but not sufficiently strong to prevent it from being used for economical and domestic purposes.

SECTION III. *Llano Estacado*.—It would seem proper to include in this section the space on our route between Valley river and Fossil creek, near Tucumcari hills. This is a dry and generally treeless region, extending over a distance of one hundred and eighty-eight miles. Over this region range great numbers of buffaloes at certain seasons, but I presume they make no prolonged stay here, passing from the waters of the Canadian south to those of Red river and its tributaries. Along the beds of arroyos, or dry creeks, may be found a few alamos; and under the northern and eastern bluffs of the Llano Estacado, and detached surrounding hills, may be found cedars of two kinds and piñon pine. They are, probably, too much stunted and shattered by the prevailing winds, however, to form very useful timber. It is to be remarked that the wind blows with tremendous fury over these immense plains, which I think is one great cause of the destitution of timber in this region. This is indicated by the fact that, wherever the least shelter by a bluff or a rock is had, the modest cedar will rear its head, thankful for the partial shelter. The statue of the tree appears to be limited to the height and amount of shelter it thus receives. The timber for railroad purposes here will probably have to be supplied from either way—the Indian territory on the east, and the valley of the Pecos on the west; at each of which places abundance can be easily procured. Although grass is abundant, yet the scarcity of water will greatly lessen its value as an agricultural district. Very little is to be had except along the courses of the larger rivers.

This is more emphatically the region of cacti than the one just left on the east. The singular, and rather pretty, but dangerous *Opuntia arborescens* described by Dr. Engelmann, is first found here. It extends as far west as Zuñi, and in southern Texas as low as Presidio del Norte. In this region I found several new and undescribed species, which will be submitted in another and more appropriate form. The piñon or wet pine of New Mexico here first makes its appearance, and I presume is its eastern limit, extending west as far as the Sierra Nevada range of mountains. The real grassed-leaved dasyliion was first seen here on the bluffs of the Llano Estacado. It is the same

species as that on Devil's river, in Texas. There is another species, with leaves and habit somewhat of a yucca—and by those unacquainted with its relationship frequently called yucca—named *D. graminifolia*, I suppose, because it does not resemble a grass. Both are common about the mountains of the Mimbres. A rosaceous shrub, named *Cercocarpus*, is also common under the bluffs; but whether it is the same as the one in lower Texas and New Mexico, I am unable to determine. Eriogoniæ, another characteristic subdivision of plants peculiar to dry climates, begin here to make their appearance quite common. Mentzeleas and asteroid composites are also here abundant. An ephedra, much used as a diuretic, especially for horses, was first met here. It is also quite common in lower Texas, where I know two or three distinct species.

SECTION IV. *Tucumcari and Pecos valleys*.—Although the waters of these two valleys flow into the Gulf by widely-separated channels, they may well be considered in one section; being included in a space of about one hundred and seventy-five miles from Fossil creek to the dividing high-lands between the Pecos and the Rio Grande del Norte.

At Tucumcari we had a broad, beautiful, fertile valley, the limits of which we had not time to explore. Although the timber is somewhat scarce, yet, as you ascend into the hills on either side, cedars and piñon both begin to attain a much higher stature than on the Llano Estacado. Along the beds of the streams there are plenty of cotton-wood and box elder, of very pretty size. The Gallinas, which debouches into the Pecos near our line, is a beautiful, bold, clear-running stream; while the Tucumcari and Pajarito creeks, in the immediate vicinity of the Tucumcari hills, flowing into the Canadian, will afford water doubtless the whole year. I found here, first, another shrubby cactacæ, (*Opuntia frutescens*), which is so abundant and ornamental, with its loaded scarlet berries, all over Texas, as far south as Eagle Pass and San Antonio. On the hills in this region I found several new mammillariæ—beautiful, flowering, and fruiting specimens of which I have now growing in the Congressional garden. *Opuntia Engelmannii*, which is probably the most wide-spread of the whole tribe of American cactacæ, was first detected here.

Fallugia paradoxa and *Fendleria supestris*, two beautiful shrubs, are common here; both of them common to Texas also. There are likewise several other Texan plants here, among them a *Parthenium*, *Thymophylla greggii*; and a great variety of leguminous and asteroid plants. Several species of eriogoniæ here also make their first appearance. As their geographical limits extend westwardly, most of the eriogoniæ which I detected here will most probably be found to be figured, and well characterized, by Dr. Torrey in Capt. Sitgreaves's report. As we proceed a little further west, we come to the Pecos valley, where, in addition to the piñon and cedars already mentioned, we meet with pines, (*P. brachyptera*), as valuable for timber as any in the world, of a majestic size. The Pecos river is here clear and rapid, with its fertile banks dotted with innumerable small plantations, in true New Mexican style.

This river with the Gallinas will form a never-failing supply of

water, for the erection of all sorts of mills and machinery, when the time has arrived for such wants. These considerations, in connexion with the fact of its forming a sort of connecting link between the waters of the Atlantic and Pacific, give it a predominant interest at this time. The region is large enough for a State of the first magnitude, and contains all the natural elements of self-sustenance, excepting probably commerce. The quality of the soil, though not equal to that of the Indian territory west of Arkansas, is superior to the Rio Grande, either in New Mexico or Texas. I have no doubt but it will prove equal to any other country in the world as a resort for consumptive invalids when properly settled and communication can be easily had with the great eastern States.

SECTION V. *Rio Grande valley*.—What I have to say of this valley will be brief, because it is an old and well-known region, having been settled by the Spaniards some three hundred years since. Gregg's Commerce of the Prairies gives a vivid and truthful view of this country, and its capabilities for agricultural improvements. I have not time now to enter into a comparative view of the adaptation of this country to consumptive invalids with those of foreign countries, or with other places in the United States; but I believe I hazard nothing in asserting my belief that in no long time it will become one of the most important and eligible in the whole world for such purposes.

As soon as communication with the eastern States and California becomes cheap and regular, without the danger with which it is at present attended, the ordinary means of living cheapened, and easily procured, so as to come within the reach of the yeomen of the country, it will form one of the most pleasant recreative excursions in this country.

The summer heat is greatly temporized by the peculiar aridness of the atmosphere, which by rapidly carrying off the perspiration before it has time to accumulate to any sensible degree, thus cooling the surface of the body, makes the summer truly delightful, more especially to an invalid. The winter is mild, being screened from the penetrating winds of the north by intervening mountains. The terrible *norther*, so well known and dreaded by inhabitants and travellers in lower Texas, is not known here. Many invalids, who at present resort to San Antonio for their health, experience many bad effects from the sudden changes of the weather resulting from those northers.

The width of the Rio Grande valley, at the point we crossed it at Albuquerque, from the dividing ridge between it and the Pecos, and that between its waters and those flowing westward into the Pacific, is about one hundred and sixty-five miles. Its length in the Territory of New Mexico is embraced between about the thirty-second and thirty-eighth degrees of north latitude, which with its tortuous course would give it a length of about four hundred and thirty miles. This of course embraces a great variety of climates, independent of that produced by the highly-elevated ranges in the neighborhood and north of Santa Fe.

The soil is well adapted to the cultivation of all the finer fruits and vegetables, as well as cereals, but it requires irrigation. Grapes,

peaches, apricots, pears, and melons, are produced in the utmost perfection and abundance. Beets, sweet-potatoes, and pumpkins, do better than in the eastern States. But the Irish potato does not succeed, excepting in the mountainous regions. On account of the cost of irrigation, wheat and corn cannot be raised as cheaply as in the western Atlantic States; but by irrigation they do very well.

SECTION VI. *Valley of Zuñi*.—In this section I would embrace the scope of country between the summit of the Sierra Madre and Mount San Francisco, the principal and pervading stream of which is the Colorado Chiquito, a tributary of the Colorado Grande, or, as it is more aptly termed, the Colorado of the West. The general aspect of this valley is to run northwest and southeast an indefinite distance. Its width, by the path we crossed it, is about 255 miles.

At Zuñi the Indians raise corn and many other vegetables without irrigation; but from the appearance of the soil on the river bottoms of the Colorado Chiquito, I should judge irrigation to be necessary. In the immediate vicinity of the mountains there is evidence of a moisture in the soil wanting in the centre of the valley, and more remote from their influence.

The water of the Colorado Chiquito is sufficient to irrigate a large portion of the central part of the valley, but, I imagine, not enough to make all the tillable lands available for agricultural purposes. There are many beautiful and living streams of water on both ranges of mountains looking into this valley, which, in their neighborhoods, afford everything necessary for the existence of man or beast; the supply of which, in its limited extent, is never-failing. But these streams, on descending into an almost unlimited arid plain, are lost by the absorption of the soil and rapid evaporation by the dry atmosphere. The valley of the Mimbres, on which Fort Webster has been situated, southeast of the Mogoyon, which has otherwise been made well known by the operations of the Mexican Boundary Commission, is a good illustration of these facts. Such is the case with nearly all the mountain streams in this region.

Grass throughout this whole region is most abundant, and of a most excellent quality, especially around the mountain bases and more elevated plateaus. Large herds of cattle and sheep might be sustained here were it not for the depredations of the Indians. I am told, by Mr. Leroux, that the wild Indians of this country, in their blind eagerness to get the flesh of mules, have been known to shoot mules down with their arrows while the traveller was yet seated on his back, for which the poor savage had to pay the penalty of his life.

Unfortunately for me, we passed this region between the 18th November—when we crossed the crest of the Sierra Madre—and the 25th December, when we were encamped at the base of the San Francisco mountain. This was the most unpropitious of the whole year for the collection of herbaceous plants, and must account for the meagreness of my collections.

The entire eastern, southern, and part of the western angles of this region, are well timbered with Douglass's spruce, New Mexican yellow pine, piñon and balsam fir. The Rocky mountain white pine grows on the San Francisco mountain, and, I have no doubt, in the higher ranges of the Mogoyon and Sierra Madre. Oaks and black walnut

also grow there. The beds of all the streams we crossed contained cotton-wood and mezquite, in some places in great abundance. Three kinds of cedar abound in this region at the base of the mountains, and extend in more limited quantities down to the banks of the Colorado Chiquito, wherever the surface appears to be broken by dry rivulets or arroyos.

On the slopes east and south of San Francisco mountain, looking into this valley, as also that of the San Francisco valley, are vast forests of piñon, intermingled with the cedars, perfectly black with their density. I was informed by our guide, Mr. Leroux, who has had much experience, and even hard knocks, with the Indians of this neighborhood, that at the proper season of the year large parties of the Yampai, Touto, Ganatero, and other sub-tribes of the great Apacherian race, resort here for the purpose of collecting the fruit of this pine. It probably forms one of the most important items of their subsistence. In an economical view of this country, it should not be overlooked.

Immediately on entrance into this valley, November 19th, I find a new species of opuntia, with prostrate nearly terete joints, entirely devoid of woody fibre; and at Zuñi, soon after, another, with a woody stem, low and prostrate, characteristically distinct from arborescens, to which it somewhat approaches in its reticulated woody stem. The fruit, seeds, spines, and general habit, however, separate it widely from that well-known and widely-disseminated species. I obtained very pretty specimens in fruit, but none in flower, which is much to be regretted. As this tribe of interesting plants were almost the only ones we could study at this late season of the year, every one of our party rivalled each other in daily bringing me something we had not heretofore seen. Sometimes one would come in a little ahead of the others, but more frequently several would come at the same time with something new, and then we had a great hurrah in deciding the claims of priority. Lieutenant Whipple to-day, however, succeeded in carrying off the palm, bringing the first specimen of our new—what we were pleased in calling cacto dendron. I saw this same species afterwards growing six to eight feet high, retaining all its peculiar characteristics, with the exception of its prostration. While on the banks of the Colorado Chiquito, and only in that locality, I find a new echino cactus, the first of this genus I had met with on our route. It however was neither in flower nor in fruit. It is quite limited in locality, having found it only along the bottom lands of the Colorado Chiquito. Along the rocky ravines, soon after leaving the river bottoms, we find a densely-aggregated cereus, growing in large oval masses, containing hundreds of heads from one root. Dr. Engelmann has made several species of these forms of cerei, which it is difficult to identify, in the absence of flower or fruit, on account of the great variety of spines in the same species, with regard to size and color. The spines in this are angular, like those characterized as *Cer. enneacanthus*, but very much resembles his *C. polyacanthus*. It is my opinion they can only be well characterized by their inflorescence and general habit. *Opuntia fragilis* is very common in this valley, offering many varieties of shapes, sizes, and colors of the species. Indeed,

all cactacæ assume quite a red appearance at this season of the year. *Cereus fendleri*, very common about the Picos and Rio Grande, makes about its western limit here, soon to be replaced by *cereus chloranthus*. Among the shrubs peculiar to this region is the beautiful and very aromatic *cowania stansburiana*. I observed, in Captain Sitgreaves's report, Dr. Woodhouse mentions having seen the aromatic *fallugia paradoxa* at this place. It is this plant, although they somewhat resemble each other. The *fallugia* is never aromatic and balsamic, like the *cowania*. The *cowania* grows on much more elevated positions than the *fallugia*, and is considered by the Mexicans as a most valuable medicine, many times selling at the rate of half a dollar per ounce, under the name of *Alousenel*. It is highly esteemed as a styptic and astringent in hæmorrhagic discharges. The blue-berried *berberis*, spoken of before, is here called by the Mexicans *lena amarillo*. The berries are very pleasant and grateful to the taste, possessing a very slight acidity, with a pleasant saccharine taste. *Fallugia*, *cerocarpus*, and another thornless rosaceous shrub, probably a *crætagus*, is abundant along the arroyos and low places. The *obeoni cemescens*, and other species of the same genus, though not peculiar to this region, are found here in great abundance. It is called by the Mexicans *chamizo*, and by our people *grease-wood*. It belongs to the chenopods, and I noticed our sheep were very fond of browsing upon it, choosing it in preference to grass. It is an unsightly weed, with a shrubby stem, but withal very useful when we could get no better material for fuel.

SECTION VII. *San Francisco valley*.—I scarcely know whether it is strictly proper to characterize this region by this name. I embrace in it a part of the waters which flow southwardly into the Rio San Francisco, a tributary of the Gila; and a part flowing in the other direction into the Colorado Grande. Between Leroux's springs, at the base of the San Francisco mountain, and Cactus Pass, the western limit of this division, is a space of one hundred and fifty-five miles, so interesting, that a volume could easily be made of the materials we collected in it without exhausting the subject.

In general terms, we could say it was well timbered, although there were large plains situated between the hills and mountains where there was little or none. Between an elevated plateau extending some seventy-five miles westward from San Francisco, and on which this mountain stands, and a low range of mountains which we named Aztec mountains, there is a wide valley, (eighteen miles where we crossed,) averaging some fifteen miles in width, so densely covered with the best grama that we named it "Val de China." This valley was illimitable as regards our explorations, extending northwest probably to the Colorado Grande, and southeast to the Gila. Partridge and Pueblo creeks, uniting in this valley from different directions, form what we suppose must be an affluent of the Rio San Francisco, constituting one of its heads, draining this valley to the south. We explored it north some forty miles, where it retained its characteristic appearance, with the exception that there appeared to be less water-courses in that direction. So we turned our attention further south. The hills bordering this valley, especially on the west, are densely covered with

cedars, pines, spruces, oaks, &c., which are abundant to serve all the purposes of agriculture, domestic economy, and railroad purposes. Much of the timber is of the most valuable kind, consisting of the yellow pine of this country (*P. brachyptera*) and the Oregon pine or Douglass's spruce, (*abies Douglassa*), of the value of which I shall treat more fully hereafter. Besides Partridge creek, which enters this valley with permanent water from the east, we have a beautiful little stream from the mountains west, before alluded to, entering from the other direction a little further south. The remains of broken pottery, and the ruins of stone buildings and ancient fortifications, give evidence that it has once been inhabited by an enterprising and warlike race of men. These remains exhibit the symptoms of extreme antiquity. Mount Hope, one of the highest peaks in this range, situated some fifteen or twenty miles south, appears to be the receptacle of the moisture of this region, no doubt opens up many such little valleys as that of the Pueblo, although we had not time to explore as far south as we could have desired.

The importance of this point is still further enhanced from the fact that from this place railroad timber will have to be supplied westward as far as the Colorado Grande, a distance in a direct line of about sixty miles; but by the route we travelled, through the valley of the Santa Maria, or Bill Williams fork, it is about one hundred and twenty miles.

My opportunities for collections on this section were about as unpropitious as on the preceding section. We passed through it from the 8th to the 31st of January. In the valley west of Aztec Pass, and between it and Cactus Pass, (25th of January,) I found the first spring plant in bloom. It is an umbeliferous plant, with a spindle-shaped, parsnip-like root, but much softer, sweeter, and more tender than that excellent esculent. It is much sought after by Mexicans under the name of *gamote*, a name also applied to the sweet potato. Mr. Leroux informed us that Indian females in this region, especially the Utahs, spend much time in the early spring, when this root is soft and tender, collecting it in quantities—slicing, drying, grinding on matats, and storing away for future use when it cannot otherwise be procured. They make a soup of the meal. The root becomes hard and cortical as it advances in age.

Besides the grama grass, so abundant, which I have mentioned while describing the "Val de China," we had a grass peculiar to this region called by our woodsmen "bunch grass." This grass was quite green, and our animals were immoderately fond of it. I was unable to secure it, either in flower or fruit, and am therefore unable at present to determine its name and botanical relationship. Mr. Leroux says it is well known and prized in the Great Salt Lake valley, fattening animals faster than the grama, but is not so retentive, or rather it does not afford their stock the same amount of strength and suscle.

I found, near Picacho, a narrow filamentose-leaved yucca, and brought home with me specimens of the young plants. It was not in fruit. It is quite different from the two species found east of the Rio Grande; but whether different from the one similar in habit in Texas, can only be determined by an examination of the flower and fruit.

In the waters of Partridge creek I find *Polygonum amphibium*, which, although it grows on land as well as in water, is nevertheless a sure index of the permanency of the water in the stream.

Although I had heretofore seen much of the piñon, I never, until we came into this valley, saw a loranthaceæ or mistletoe growing upon it. Here it is very abundant, and quite distinct from the one growing on the other pine, (*P. brachyptera*.)

At the foot of Bill Williams mountain we first met the celebrated Mexican magey, (*Agave Mexicana*.) This is probably one of the most important plants to the wild Indian tribes of the whole interior of the continent south of the 35th degree of north latitude. It is a matter of much curious interest to know how much further north it does grow. I suspect, however, it will be found very little further north of our line. It flourishes on the roughest, rockiest, and apparently most inhospitable spots that can be found, and, as a general rule, only in such places; an allied species, common in our country under the title of century plant, so named from the popular notion that it blooms every hundred years. Our plant is a long time (not near a hundred years, I presume) in coming to maturity. It then blooms, bears fruit, and dies. Every year branches and offsets are produced, coming to maturity yearly, performs its great duty of fruiting, and dies in its turn, making way for its successor. The great value of it to the Indian is, that it forms a never-failing source of subsistence at all seasons of the year—summer or winter, spring or autumn. At the proper season, about the 1st July, the scape that bears the flower shoots and grows with amazing rapidity. This scape is then very juicy, tender, and sweet; and the Indians now devote their time to preparing their mezcal, which will keep some months. When the time for preparing food from the scape is passed, they then resort to the heart or central portions of the plant, the most tender portion being the base of the inner leaves. These can be found in different stages of development at all seasons of the year. They roast it in temporary ovens made of earth and stone, requiring some two days to cook it sufficiently. I have used the juice of the plant successfully, as an anti-scorbutic, while I was on the Mexican Boundary Commission, my attention being first called to it by a circular from the surgeon general of the United States army, recommending it on the authority of Dr. Perrin, of the United States army.

Besides the trees already mentioned, we have two species of cedars, one with a large, sweet, edible berry. In times of great scarcity of food, I believe this is resorted to by every living thing in this region, man and beast. *Pinus edulis* (piñon) grows in great abundance nearly the whole length of this section. The high lands which form spurs to the San Francisco and Bill Williams mountains are covered with these trees—their dark green foliage giving the forests a peculiarly dark and sombre aspect.

Two very distinct species of oaks occur, one of which I have marked on the profile as *Quercus Gambelii*; the other is probably new.

In the deep ravines of this district I find an ash common to the copper-mine region, and, associated with it, also a cherry. I am not prepared to say whether it is a new species or not. Willow-leaved poplar

is found along the dry arroyos where water has been lately standing. Among the shrubs abounding in this region, I find the blue-berried berberis—a species of currant, (*Ribes*)—and a species of very thorny solanaceæ, genus undetermined.

A most interesting new shrub, on account of its botanical relations, I find here, belonging to the garryal alliance, containing three species of as many different genera, and divided into two natural families. Mine is nearly related to the garrya found by Douglass on the American continent—the only one heretofore known. This, if not a new genus, is a very distinct species from Douglass's plant. Another genus, with a single species, is known in the West Indies. A second order, with a single genus and a single species, has been found in Japan.

I find in this region a walnut, collected heretofore in the region of the copper-mines of New Mexico, very nearly related to the black walnut of the eastern States. Dr. Torrey has figured it in Captain Sitgreaves's report as a variety under the name of another species collected on Devil's river, in Texas. A description of this was read by Dr. Torrey before the meeting of the American Association of Science, in August, 1851, under the title of *Juglans Whippliana*. He has named our present plant, provisionally, a variety of that species; the distinctions between them, however, are greater, in my opinion, than those between this variety and *Juglans nigra*; so that I think they will all ultimately come to be varieties of each other, when still other and more closely connecting varieties are found. A *Ptelea*, closely related if not identical with the shrubby trefoil of the States, and a *Condalia*, is found here. The condalia is a rhamnaceous shrub, having small dark-colored berries, some species of which are eaten by Mexicans and Indians. A spiraea, or some nearly allied genus, was met with here, forming a beautiful shrub, which I have little doubt will prove something new.

Along the beds of Turkey creek, Pueblo creek, and the streams we first passed after crossing the Aztec mountain, we met with large quantities of willows. For the first time, to-day (January 17th) we met with the beautiful shrubby arbutees, called by the Mexicans *Manzanita*; the bark of it being handsomely polished of a dark-mahogany color. From here on, and in California, we have several species, most of them bearing an edible berry similar to a whortleberry. In California a most valuable timber tree of this genus exists all along the coast range of mountains, which bears a large edible berry, much sought after by Mexicans and Indians, under the name of *Madrona*. It is a beautiful tree. The wood is very hard, taking a polish equal and much resembling *lignumvita*.

Near Bill Williams mountain I find the aggregated cereus in considerable quantities; but the species I cannot well determine, on account of the want of blossom and fruit. It is very nearly allied to Dr. Engelmann's cereus polyacanthus, which yields an edible fruit, called by Mexicans pitahaya, and grows in immensely dense masses.

The little arborescent opuntia, first found near Zuñi, which, to distinguish from the true *O. arborescens*, we called cacto dendron, finds

its western limit at the termination of this section. We also find here a mammillaria, very common, and the only one between this point and the Rio Grande.

At the southern base of Bill Williams mountain I find an opuntia never before seen on our route, and, from its appearance, I have little doubt of its being new. It is an upright appanate jointed species, thickly beset with yellow spines, having a much lighter-green color than most other species. Lieutenant Tidball, of our escort, kindly sketched it for me, and I have provisionally given it his name. *Opuntia fragilis* occurs here, as also *cer. pendleri*. We have an opuntia in this region, very near if not identical with the one very common on the Rio Grande, with long brown spines, called by Dr. Engelmann *O. phæacantha*. As we proceed westward into the neighborhood of Picacho and the "Val de China," I find the new *O. Tidballii* becoming much more frequent, and I also observe it is never found on the northern and western exposures of the hills and rocky arroyos, but mostly on the southern, (the same where I first found it,) and more seldom on the eastern exposures. In the Aztec Pass I find an opuntia, in size and appearance of the spines, very similar to *Opuntia Engelmannii*; but, unlike the *O. Engelmannii*, it remains always spreading and prostrate. In Cañon creek, near the western extremity of this section, the *O. Tidballii* I find grows seven or eight feet high, branching so as to form an immense head, with upwards of one hundred joints branching from a single stalk.

SECTION VIII. *Santa Maria valley*.—I embrace within this section the space between Cactus Pass and the Colorado Grande. Cactus Pass is the last highlands we cross before reaching the Colorado. The distance from this point, in a direct line to the Colorado, is but about sixty miles; but by the road we travelled, through the valley of the Santa Maria, it is one hundred and twenty-seven miles to the great river.

The timber of this valley is composed almost exclusively of cottonwood or alamo, mezquite, "green-barked acacia," curly mezquite, two other leguminous trees, (whose names I have not been able to learn, not having studied my collections,) and willows. The alamos grow to a good large size, and are quite abundant; the two mezquites are rather small in this valley, seldom attaining more than fifteen to twenty-five feet in height. The other two leguminous trees, as well as the "green-barked acacia," grow fully as large as the mezquites, and I presume, in an economical point of view, they will prove equally useful for domestic purposes. Although willows grow in many places quite large and abundantly, yet for anything but firewood they appear to be nearly useless.

In the lower portions of this valley, as we approach the Rio Colorado, grass of all kinds becomes quite scarce; mules then resort to the twigs of the willow as well as the alamo, upon which they are known to exist the whole winter. Grass, in the upper portions of this valley, is sufficient to support numbers of mules and stock in passing through.

The water of the Santa Maria, in many places, flows in a bold stream, but like the Mimbres, and many other streams in this country, it sinks

again in the sand, sometimes within a very short distance. It rises and sinks this way, alternately, until it reaches the Colorado. This valley, generally narrow, cannot be worth much in an agricultural point of view, yet there are several places where it widens, so as to form places for very pretty settlements. We passed through this valley from the 1st to the 20th February, when the weather was warm and genial, like the month of May in the East. It appears to be two or three weeks earlier here than at the Mojave villages. I am unable to say, from observation, whether the soil can be cultivated without irrigation, because we had no experience nor time to make any experiments on this subject in our rapid reconnaissance. From the fact that the Mojave Indians do cultivate corn, wheat, beans, pumpkins, and melons, without this process, in the Colorado valley, one can have little doubt but the same will hold good also in this valley. Should this prove the fact, there are several places, especially in the vicinity of White Cliff creek, which will be of great importance on this account. The valley spreads out here to quite a wide space, and is moreover quite convenient to good timber, besides the cotton-wood and mezquite in its immediate valley.

This may emphatically be called the region of cacti of our route. One of the first we met, after entering this valley, was the *Echino cactus Wislizenii*, called by the Mexicans "visnada," the juice of which is said to serve as a substitute for water when it cannot otherwise be procured. Instances have been known among the white trappers of this wild region where the lives of man and beast have been saved by it. This morning (February 3) we found one left by the Yampai Indians the night previously, with the spines burned and the inside two-thirds scooped out, so as to form a sort of kettle. Mr. Leroux informed us that they scoop a space of its centre, introduce other vegetables, and, with the introduction of heated stones, cook the whole together. These vegetable boilers are not transported from one camp to another, but, on account of its abundance, new ones are formed at every camping ground where they are required. A cereus was recognised to-day, very nearly akin if not the same as one very common around El Paso, (*Cer. chloranthus*), and heretofore only known in that region. I was unable to get flower or fruit to compare with the El Paso plant, as the spines of these plants vary so much as to form but poor distinctive characteristics. I find here also a globose mammillaria, with central-hooked spines, quite different from the one on the Picos, by its having red clavate fruit.

We find here a new arborescent opuntia, very nearly allied to *O. arborescens*, the last of which we left at the ruins near the Pueblo de Yuñi. This differs from that in having spring fruit and a larger seed; but in other respects it resembles that plant very much. The beautiful scarlet-berried *Opuntia frutescens*, so abundant and ornamental about Eagle Pass and San Antonio, I find in this region. I saw it also at Laguna Colorado, sixty miles east of the Rio Picos, showing it to have a much wider geographical range than the *O. arborescens*. This last is supposed by Dr. Engelmann to be the widest spread of any North American cacti. In addition to those already mentioned, I find a beautiful opuntia in this region, quite different from any I have here-

tofore seen. It is a flat-jointed, spineless variety, growing in handsome rosette form, covered with a beautiful velvety bloom or pubescence. The little pulvilli, or bristles of the eye, are very annoying and disagreeable when handled. It is even said to be fatal to the eyes if permitted to touch that delicate organ.

By far the most interesting cactus here, and probably of the whole world, we first saw in this valley on the 4th of February. It is the *cereus giganteus*, about forty-five feet high, although about the valley of the Gila it is said to grow to sixty feet in height. Among the skeletons of wood, I observe in the old trees there is a perfect net-work of bundles of woody fibres, arranged on a large scale, much after the manner of the woody fibres of the *opuntia arborescens*, contrary to the descriptions given by Dr. Parry and Dr. Engelmann, who had probably taken theirs from younger plants, before the interlacing process had been carried to any extent. I have often seen the skeletons of young plants which exactly corresponded with their description. The fruit of many cerei are edible, with something of the flavor and shape of an immense gooseberry. It is covered with sharp thorns, but as soon as the fruit ripens, the spines can be brushed off with ease. By peeling the rind, there is left a large, sweet, delicate pulp, that will rival any gooseberry which an amateur English gardener might have spent pounds in nurturing. The top of this tree, however, yields a pitahayce far sweeter and more delicious than those met on more humble stems. The Indians collect large quantities, tying a fork to the end of long poles, by which they can reach and bring them down without injury. The Indians make a syrup, or *mel*, from the juice of these fruits, which serves them for luxuries as well as sustenance, and which can be preserved to an indefinite period of time. The Mexicans call the tree "suwarrow;" the Indians, "har see," and the syrup manufactured from the juice, "sistor." The juice of the flesh of the tree is quite bitter. The tree frequently grows to the height of twenty-five or thirty feet, perfectly simple, or without a single branch.

I find (February 7th) a new species of *opuntia*, with a reticulated, woody stem, the joints, before hardening into wood, very fragile, and armed with spines worse than a porcupine. It is called by the Mexicans "chug." They are the horror of man and beast. Our mules are as fearful of them as ourselves. When coming inadvertently in contact with them, the barbed spines become so fast in the flesh that the joint of the plant is separated from the main stem before the spines can be drawn. I find them growing ten and twelve feet high, branching very fantastically, in consequence of the fragility and decay of the younger stems or joints. In a landscape plate, No. 16 of Major Emory's report, by Mr. Stanley, in the foreground is the figure of a plant of which, in the text, there is no account. There is a faint resemblance in it to our plant; but Lieutenant Whipple, who has travelled and explored much in that region, is pretty confident it represents a different plant, which he has also seen. It is too regular in its outline and curves to represent the peculiarly-angled and irregular appearance of our plant. I find here what I suppose is the *Opuntia ramosissima* of Dr. Engelmann, collected by Dr. Parry on the desert be-

tween the Colorado and San Diego. In places favorable to its growth I find it six feet high, as robust and tree-form as the *O. arborescens*.

In proof of the forwardness of the season, I refer to the fact that on the 7th February I collected a draba, a thelopodium, and a vesicaria—genera well represented in Texas and lower New Mexico. Some of them, however, are different from those collected below. February 11th, collected a lepidium and a hosackia along the beds of the Santa Maria.

SECTION IX. *Valley of the Colorado*.—From the mouth of the Santa Maria to the point where we crossed the river is about sixty miles; and from thence to Soda lake, the first place on the Mojave creek where water is found, is about one hundred miles further west. Along the valley of this river, alamo, mezquite, and willow form the principal and almost entire kinds of trees. The Mojave Indians make use of willow twigs in forming granaries, where they store away mezquite beans and various other vegetable products for winter consumption, or times of scarcity. They are built in a circular form, four or five feet high, and about the same in diameter. After being filled it is covered with willow bushes, over which is another cover of earth. The climate is so dry, I suppose they have no difficulty in thus preserving their winter gran. We passed their villages the last of February, and found them in the possession of plenty of corn, wheat, beans, pumpkins, &c. They brought us one watermelon, which had been preserved fresh from the last year. We passed about sixty miles through their territory without seeing any signs of irrigation, so that we may safely infer that they cultivate their crops without having recourse to it. I have no doubt, however, but it would add very materially to the amount of agricultural productions if irrigation had been employed.

Very little grass is to be seen in this valley. Our sheep ate readily of the *obione canescens*, (grease-wood,) growing abundantly throughout this whole region. Our mules were very fond of an aromatic shrub, of quite a low stature, which grows in considerable quantities on the gravelly ridges. It had shed its seed, but I accidentally found sufficient to determine it to belong to a subdivision of *compositæ* named *ambrosiæ*, representatives of which we have in the eastern States, which yield nourishing weeds.

I consider the value of the Colorado valley, in affording subsistence to a civilized population, nearly equal to that of the Rio Grande valley. The soil is better adapted to the cultivation of cereals than that of the Rio Grande, where it can only be done by irrigation, which, in this country, is a costly process. On leaving the valley of the Colorado, we ascend very rapidly some four or five thousand feet above the level of the sea, where the change of climate is very strongly marked; at the Colorado being very warm and summer-like, while at our camp, (March 6th,) on the northern slopes of the hills, and in deep ravines, there is snow. Here we met with cedar (*juniper us occidentalis*) and pine, (*P. edulis*), which only greet the eye, however, a short distance. It may be possible that the New Mexican yellow pine (*P. brachyptera*) grows on still higher points in this neighborhood, but, on account of our necessarily rapid movements, I had not time to determine. In addition to the trees already mentioned, we have vast quantities of the tree

yucca, met with heretofore in the Santa Maria valley, but it grows here thirty to thirty-five feet in height, and eighteen inches or two feet in diameter, with a bark on the trunk very similar to that of white oak. Although not good for fuel, we are sometimes obliged to resort to it for camping purposes. Besides these, we have a variety of shrubs, the principal of which are two species of rhus, (one of them I have never before seen,) blue-berried berberis, cowania stansburiana, fallugia, shrubby artemisia, obione, &c., &c. I find at this place a shrubby amygdus, which very much resembles one common about Devil's river, in lower Texas. A species of chilopsis, a begoniaceous shrub or small tree, with flowers much resembling those of a catalpa, is frequently found in the dry ravines here, as also all over the western wilds. Lycium sp. un., a solanaceous shrub, with an edible berry, was also collected in this region. Besides some new cactacæ, which I will mention soon, I find many here supposed heretofore to be peculiar to the Rio Grande valley; among them are opuntia clavata and fragilis. A flat-jointed opuntia, with brown spines, collected as far back as the Llano Estacado, which I considered very near to Op. phæacantha of the Rio Grande valley, is also here, as well as an aggregated cereus, which I cannot distinguish, in the absence of flower and fruit, from those on the Rio Grande. Besides the Echinocactus Wislizenii, which is quite common here, I find a new species of the same genus, aggregated in large globose or ovate heads, and a very woolly fruit, which I have little doubt is a new species.

After crossing the dividing ridge between the Colorado and Mojave creek, we met the celebrated but rather worthless *Larrea Mexicana*, giving the surrounding scenery a most beautiful and verdant appearance; but the vegetation is in reality the most repulsive to man and beast that can well be imagined.

SECTION X. *Mojave valley*.—This section extends from Soda lake to Cajon Pass—a distance of about 126 miles. With the exception of the last twenty-five miles, it is entirely within the Mojave valley. There are beautiful grassy plains in this valley near running water, where, I am told, it was a great resort to graze those mules, horses, and cattle, before the California gold-fever broke out, which were sent from Los Angeles and its vicinity to Santa Fe. Immense herds were brought out and grazed for that purpose. Since the revolution in California, New Mexico now sends large flocks of sheep by the Salt Lake valley, thence up this valley to California. After crossing the deserts of the Salt Lake valley, they are permitted to stop and recruit here and at the Cajon Pass, so as to make them saleable in California. The stream of the Mojave is not continuous, but sinks and rises every few miles, in the same manner as the Santa Maria, which we passed, and the Rio Mimbres, in New Mexico. In many places the stream is large and bold—running with a swift current like the Mimbres. The soil in the widened valleys is rich, and appears to be capable of being cultivated without irrigation. In such case it will make a most valuable territory, and well suited to settlements and military posts. The timber of the valley is much like that of the Colorado, consisting of cottonwood, (*populus monilifera*), mezquite, (*algaroba glandulosa*), curly

mezquite, (*stromboxcarpa pubescens*;) and willow (*salix*) of several kinds.

On arriving near the Cajon Pass, we have cedars, two kinds; pines, three or four kinds—Oregon pine, (*abies Douglassii*;) and in the mountains near, the sugar pine, (*Pambertiana*;) all in great abundance and of the best quality. On arriving at the Cajon the vegetation changes like magic—many of the shrubs such as I have never before seen, and consequently new to me. Among the most beautiful, I find several species of ceanothus, represented at home by the New Jersey tea, ornamented with bright, cerulean blue flowers, in charming contrast with the blank we had just left. I collected at this place specimens of the *Fremontia*, nearly related to the family of malvacæ and the “hand plant” of Old Mexico, figured by Dr. Torrey in *Plant. Frem.*, plate 2. The whole tree has the habit of a *hibiscus syreaca* very much.

A species of *yucca*, different from five or six other Texan and New Mexican species I have heretofore seen, was collected at this place. A large, beautiful evergreen oak, with very large cupules and acorns, I found first at this pass. Not having books to refer to, I am unable to say what species it is. But the acorn is the one on which the Root-digger Indians of California are known to subsist for large portions of the year. When standing in an open space it forms one of the most beautiful trees of the forest.

SECTION XI. *Los Angeles valley*.—From Cajon Pass to the sea at San Pedro is a distance of about eighty miles through a beautiful valley, requiring very little to be said by us, as it has been long known. It was first settled by the Spaniards, soon after the discovery of this part of the continent. It is well wooded and watered. I had not time to examine the timber of the mountains in this vicinity, however, on account of our hasty march. In the preceding section I have mentioned those at Cajon Pass, and as we passed down Cajon creek we met with sycamore, alder, and cotton-wood, and as we proceeded on to the plains, two other species of oaks in great abundance. Neither of them were in fruit when we passed. The base of the mountain to our right was covered with this timber. Grass and wild oats are abundant from one end of the valley to the other. Nature has peculiarly favored this region with a succession of plants, which come on one after the other in regular succession; so that no trouble or expense is had in grazing and rearing cattle and horses, except salting and keeping them tame. The first crop is called “pen-grass,” of the genus *erodium*, belonging to the family of *Geraniacæ*. After this come wild oats, mustard, &c.; after which, a crop of leguminous plants of the genus *medicago* occurs, as also several species of clover. All of the above enumerated are considered among the most nutritious plants for stock known growing in a wild state.

At the Cajon there are several species of cactacæ, flat-jointed and cylindrical, with a woody axis, somewhat different from those passed in the Colorado valley. As we pass down the valley we find vast and dense patches of an *opuntia* nearly akin to *O. Engelmannii*, having the appearance of being introduced; whether really so, is more than I can determine.

The Spanish tuna (*Opuntia tuna*) is cultivated for its fruit; it forms

hedges fifteen or twenty feet high. Indians and Mexicans are very fond of the fruit, which serves them for food during its season.

At the mission of San Gabriel I saw large orchards of orange trees laden with its golden fruit, ripening perfectly in the open air, (22d May.) This fact should speak volumes in favor of the climate of this delightful region. The grapes cultivated here are said to be equal to any in the world, and I have no doubt but there are many exotic plants that would succeed with very little trouble. The tea plant, I have no doubt, would do well, and richly deserves a thorough trial.

CHAPTER IX.

Description of special forest trees along the route—Douglass's spruce or Oregon pine, New Mexican yellow pine, Piñon, &c.: By J. M. Bigelow, M. D., Botanist.

PINUS (abies) DOUGLASSII, commonly called here *Douglass's spruce*; in some regions it is simply called *spruce*; about San Francisco, *Oregon pine*, and by others, *hemlock*. The first place I find it is at the Sandia mountain, east of the Rio Grande, between it and the Rio Pecos. It grows here abundantly. It next occurs on what is called the Sierra Madre, about ninety miles west of the Rio Grande, quite abundant also. We again meet it, but rather more sparingly, in the mountains around Zúñi.

After crossing the Rio Chiquito Colorado, we come to a range of mountains, the most prominent peaks of which, near where we passed, were San Francisco, Bill Williams, and Mount Sitgreaves. Here was a belt of some forty-five miles in width, stretching, in a southeasterly direction, to the Mogoyon or Sierra Blanca, probably as far as the headwaters of the Gila. These highlands, as far as explorations have been made, abound with this timber, associated with the other pines of this region. At the copper-mines near the Gila I found it in abundance in 1851, while connected with the Mexican boundary. At Aztec Pass, one hundred miles west of San Francisco, it grows again, but not so abundantly as at the latter mountain. As soon as we reached the Sierra Nevada, and along the whole coast range as far as Los Angeles, it appears again in the greatest abundance. It also grows in almost every region of California that I visited, from the coast to the highest range of the Sierra Nevada. In the mountains of Sierra Madre, east and west of the Rio Grande, at San Francisco and its vicinity near the two Colorados, it grows from ninety to one hundred and twenty feet in height, and from three to six feet in diameter. In California, however, it grows much larger, frequently attaining the height of two hundred and fifty feet or more, and some eight or ten feet in diameter.

Unlike most pines, the wood is coarse-grained, tough and hard; so much so as to preclude its use as fine lumber. But it forms most excellent building timber. At San Francisco, Sacramento, and other cities of California, this timber is used almost exclusively for making

plank-roads, sidewalks, and piling. Probably one-fourth of the city of San Francisco is thus built, on piles driven some ten or fifteen feet. The wharves at the latter place are built exclusively of this timber. From its wide and extensive diffusion, it will be seen that this will form one of the most valuable timber products of the line; and from what I have seen of its applicability to purposes of this kind, I have no hesitancy in affirming that it will make railroad ties equal if not superior to any others in the West.

This tree has been well characterized, and a good figure of the fruit, cone, and branch, made in Hooker's Flor. Boreali Americana.

PINUS (abies) BALSAMIA, called here *balsam*, or *balsam fir*. It is identical with the one growing in the eastern States in such abundance. I find it only on the more elevated ranges of the Sandia, San Francisco, and Sierra Nevada mountains. I did not see it at the Cajon Pass of the Sierra Nevada, but I have no doubt it exists on the more elevated points of that region. Near Sonora and Downieville, in California it grows to a great height, equalling that of the sugar and yellow pines. It forms a beautiful tree, but from the perishable nature of the wood can scarcely be used for railroad purposes, except in places where it is protected from the weather. The process of kyanization would probably have the effect to make it more valuable. It is an old and well-characterized species. In places where it abounds it is used for various building purposes, where not exposed to the weather, for which it is admirably adapted, by its straight axis and beautiful taper. The balsam, which is an exudation from the bark, is medicinal, and held in high esteem as a remedy for burns and various other diseases.

PINUS BRACHYPTERA, called in some regions *yellow pine*, and in others *pitch pine*. It is quite different, however, from either of the pines so called in the eastern States. It is very common all over New Mexico and California. This tree is most generally associated with Douglass's spruce, first making its appearance at the mountains between Pecos and the Rio Grande. It grows abundantly about Santa Fe, and was described by Dr. Engelmann, from specimens collected in that region by Dr. Wislizenus. Dr. Torrey (Report of Sitgreaves's Expedition, p. 173) mentions that Dr. Engelmann's *P. macrophylla* was found at the Zuñi mountains. He says, however, it does not agree well with Dr. E.'s description. I found only this one so common in all that region, and suspect this is the one he has reference to. It occurs at the Sierra Madre, Organ mountains near Dona Ana, Mimbres mountains, Sierra Mogoyon, San Francisco, Aztec Pass, and Sierra Nevada, near mount San Bernardino. In every region of California, also, where I find the Douglass spruce to exist, this tree grows. I think, however, it grows more abundantly back in the interior of California, along the spurs and heights of the Sierra Nevada, than it does along the coast range, where the Douglass spruce is the most abundant. In all these places it forms a beautiful timber tree, rising east of the Sierra Nevada to the height of one hundred and thirty feet, and the diameter of five or six feet. On the western slopes of the Sierra Nevada, like the spruce and other pines, it grows much larger and taller. In favorable situations it equals in height that of other pines in those regions. The wood of this tree is soft and easily worked; varieties of it are equal in

beauty and utility to that of any other pine. About Anton Chico, Santa Fe, Albuquerque, and all the towns on the upper Rio Grande, it forms their principal lumber. It grows so abundantly on the Mimbres, Organ, and the mountains further east bordering the Pecos, as to supply San Elezario, El Paso, Dona Aña, and all the lower towns of the Rio Grande with lumber. It is also used in every part of California, for building and other domestic purposes. On account of the softness of the wood, I imagine it would not answer as well for railroad ties as the Douglass spruce. A reference to a profile on which I have attempted to illustrate the relative range above the level of the sea, will approximate pretty nearly to the truth. Although the range of this pine is pretty intimately associated with the Douglass spruce, yet, on reference to it, we shall see that it is found at a greater altitude, although frequently overlapping each other on the sides of mountain slopes—the Douglass spruce occupying the lower, and this species the upper portions of the mountain chains.

I am not aware that a good figure of this tree has ever been made, having been brought to the notice of botanists and the public first by Dr. Engelmann, in Wislizenus's report, in 1848.

PINUS EDULIS.—This is called *Piñon* by Mexicans, and the fruit *Piñones*; by Americans, *nut pine*. Everywhere that the cedars grow, from the bluffs of the Llano Estacado, some one hundred and fifty miles east of the Rio Grande, to the Cajon Pass of the Sierra Nevada, I find this tree closely associated with them. This tree seldom grows very large. A little west of the San Francisco mountain it grows some forty or sixty feet high. Its general height, however, is about thirty feet. The timber is seldom used for domestic purposes, and I am therefore unable to express an opinion on its fitness and adaptability for railroad purposes.

The wood is tough and elastic; but with regard to its durability, when exposed to the vicissitudes of the weather, I am unable to determine.

From its diffusion along the route, it would form an important item should it prove durable, as in other respects it would be well adapted to those purposes. On the other hand, should it be subject to early decay, I have no doubt but that the subjection of it to the process of kyanization, as resorted to in the English railroad system, would obviate that difficulty, and prove with us, as with them, more economical in the long run, although rather expensive at first. This might be the case even with our more durable species.

Its range of elevation above the sea level, as well as general diffusion, is considerably greater than any other pine. I have not seen it, however, on the western slopes of the Sierra Nevada above Los Angeles, or in the upper portion of California.

The nut is sweet and edible, about the size of a hazlenut. It is used as an article of trade by the New Mexicans of the upper Rio Grande with those below and about El Paso. The fruit has a slightly terebinthinate taste, but the New Mexicans are very fond of them. When it is considered how expensive it is to cultivate corn in those arid regions where irrigation is necessary, one would naturally infer that an oil nut as easily and abundantly produced as the piñon would become an item of the first importance, and I have no doubt such will

be the fact when the country comes to be occupied by an enterprising and intelligent race. In the fattening of swine this tree would receive a large share of public attention. Bears in large numbers in those regions exist upon this fruit.

This tree was first described by Dr. Engelmann, in Wislizenus's report, pages 25 and 26, from specimens collected by Dr. Wislizenus. Dr. Torrey has given a very good figure of the branch and fruit of this tree in Captain Sitgreaves's expedition, plate 20.

PINUS FLEXILES; common name, *Rocky mountain white pine*.—This tree I find at the Sandia mountains of New Mexico, at an elevation of about 12,000 feet above the level of the sea. Dr. Engelmann observes that Dr. Wislizenus overlooked this pine while at Santa Fe, but it was collected there by Mr. Fendler. In cones and habit it is closely assimilated to *pinus strobus*, the white or Weymouth pine of the North and East. On the authority of Dr. James, who first discovered and described this species, it is asserted that its seeds are large and edible. The piñones in use about Santa Fe, however, Dr. Engelmann observes is the produce of the *P. edulis*.

At an elevation nearly equal that of the Sandia mountains, I find it again at the San Francisco mountain, forming a large and beautiful tree, 100 to 130 feet in height. These are the only two localities where I saw this pine. I was not high enough on any of the points of the Sierra Nevada to know whether it grows there; but at the proper elevation I have no doubt of it.

With its wood, either for lumber or railroad ties, I am entirely unacquainted. From its close affinity with other most valuable kinds, as before intimated, I have no doubt it will form a valuable one in our list.

JUNIPERUS VIRGINIANA, *red cedar*.—In places along the Canadian river near Sans Bois creek this tree grows quite large and in abundance. I did not meet it, however, further west than old Fort Arbuckle. I am told it is too brash for railroad ties, although it would be as durable as almost any other timber that could be procured.

On the bluffs of the Llano Estacado, and from that point west as far as Cajon Pass, occur in many places, and sometimes in great abundance, three other species of cedar. Dr. Torrey, in the "Report of an Expedition down the Zuni and Colorado rivers by Captain Sitgreaves," observes that one may be *Juniperus occidentalis*, (Hook. ;) the second he suspects is *J. tetragona*, (Schlect. ;) while the third he suspects is probably new. If so celebrated a botanist as Dr. Torrey is in doubt in reference to the place these plants should occupy, it would be folly in me to attempt to determine them. Some of them, I have no doubt, are distinct from our common red cedar; but the third, I suspect, is a scrubby form of the extremely polymorphous species of *J. Virginiana*. The trunks of the western varieties are too short to render the timber of much value. The berries of most of them—especially the *J. occidentalis*, which has a large slightly tuberculate fruit—are quite sweet and nutritious; affording sustenance to bears, wolves, and a variety of other animals, if not to the Indian himself.

ALGAROBIA GLANDULA, *mezquite*.—I find trees of this species considerably east of the Picós and Rio Grande valley, but mostly in a shrub-

by state. In the valleys of Chiquito Colorado, Santa Maria, Colorado Grande, and Mojave, this tree grows to a considerable size. In lower and western Texas, the tree is considered invaluable from its extreme durable qualities. Fences in that region of Texas, made of this timber, have been known to stand in a perfect state of preservation over fifty years. From its hardness and durability, I have no doubt but it would make ties equal to the *lignumvitæ* of tropical climates; to which family it is indeed closely allied botanically, being of the section *mimosæ* of leguminous plants.

There are other trees of this order abounding along the valley of Rio Santa Maria attaining the size of the mezquite, but I have not had an opportunity to determine their names. One of them is described by Major Emory, in his report, as the "green-bark acacia." It is more nearly allied to *prosopis* than to acacia. It is interesting from the fact that it forms the nursery for the propagation of the wonderful *cereus giganteus* of that region. Every young tree will be accompanied and protected by this one; but as soon as the gigantic cactus becomes able to take care of itself, it indignantly turns upon its protector and destroys it—numerous instances of which we saw on our journey.

POPULUS MONILIFERA, called in Spanish *alamo*, and popularly *cotton-wood* or *poplar*.—This tree is somewhat different from the Mississippi cotton-wood, which I believe is *pangulata*. I find it east as far as the Canadian, and west until we cross the Sierra Nevada. In the Rio Grande valley, it is used by the Mexicans for building and farming utensils, the most unique of which is their cart or *carreta*, the wheels being made of a section of the tree some six or eight inches thick and manufactured with much rudeness. The timber is tough and hard, and, although probably not as durable when exposed to the weather, yet I have no doubt would serve the purpose very well for railroad ties, until a road is formed to regions where more desirable timbers abound. It does not grow near as tall as those on the Mississippi; but I have seen them quite large and spreading.

QUERCUS, oaks.—Besides the several species mentioned by Dr. Torrey in Captain Sitgreaves's report, I find at Cajon Pass of the Sierra Nevada a live oak with a cupule an inch or an inch and a half in diameter, forming a beautiful and valuable timber tree. It grows in various parts of California, but how widely it is diffused I am unable to determine. It attains the height of eighty to one hundred feet, and is two to four feet in diameter. The timber is no doubt valuable.

CHAPTER X.

Description of special forest trees in California—Wellingtonia, Redwood, Sugar Pine, Nutmeg tree, &c.: By J. M. Bigelow, M. D., Botanist.

PINUS LAMBERTIANA; common name, *sugar pine*.—This is one of the most magnificent pines of the Sierra Nevada. We first noticed its appearance at San Bernardino, not far from San Diego, and it probably follows the coast of the Sierra Nevada to Oregon. At Sonora, Moke-

lumne Hill, Nevada, and Downieville, and every place in those mountains, where you ascend to the height of 4,000 or 5,000 feet above the level of the sea, I find this noble tree in perfection. It ordinarily attains the height of two hundred feet, and is six to ten feet in diameter. It is very symmetrical and beautiful in shape, with a slender but graceful foliage, probably in this respect more handsome than any other pine tree of California.

It forms a lumber equalling that of any other in the world. Its grain and rive is so straight and even, that thousands of houses in California are weather-boarded with shingles merely riven, without any other expense or work. There are many mills in the vicinity of Grass valley, Nevada, Downieville, and Sonora, where lumber is manufactured and planed by means of machinery in quantities to supply vast regions in that country. Were it not that transportation is so expensive in that country, San Francisco, Sacramento, and all the coast region, could be supplied with this lumber of a quality far superior to that now brought from Oregon. Lindley, in his *Vegetable Kingdom*, page 228, speaking of this tree in connexion with *abies Douglassii*, says they are probably the most valuable fir timbers of the whole family. And it will be remembered this family stands at the head of the list.

WELLINGTONIA GIGANTEA.—It is popularly known in the district where it grows as the "*Mammoth Washington tree*." At this time, probably, this tree possesses more interest than any other American tree. It has been known to exist, by our backwoodsmen, since the beginning of the California gold excitement, being situated very near a rich auriferous region, about equidistant from Sonora and Mokelumne Hill, both rich districts, much resorted to by emigrants and gold-seekers. It is north of those places, near the headwaters of Calaveras and Mokelumne rivers. Dr. Randall, the worthy President of the California Academy of Natural Sciences, had his attention called to it several years ago, and was persuaded it possessed characters generically distinct from the redwood, (*sequoia sempervirem*,) and with many other interesting objects of natural history, sent, more than eighteen months ago, large and beautiful specimens of this tree to Drs. Torrey and Gray, the best and almost the only botanical bibliographers and writers we have in the United States. Most unfortunately, they were lost in the transit of the Isthmus; doubly unfortunate it has happened to us as *Americans*, because we have been anticipated in giving it a proud American name, WASHINGTONIA. Dr. Randall and his friends, being convinced of its possessing the type of a new genus, proposed to give it the name of our revered Washington, but not having books of reference at hand, sent it to Drs. Torrey and Gray for that purpose, and, as before stated, was lost. In the mean time, Mr. Lobb, a seed collector for some society in Scotland, sent home enough of it to characterize the plant, which was done by Lindley in the *London Gardener's Chronicle*. However, it must now content us to possess the tree, as England must be with the empty name. As some considerable discussion has been had already with regard to the age of this tree, I may state that, when I visited it in May last, at a section of it eighteen feet from the stump it was fourteen and a half feet in diameter. As the diminution of the size of the annual rings of growth from its heart or

centre to the surface, or sap-wood, appeared pretty regularly graduated, I placed my hand and measured six inches midway between, and carefully counted the rings on that space, which was one hundred and thirty; making the tree 1,885 years old. Since I came home, Dr. Torrey tells me he has actually counted every ring of a section of the tree, and it amounts to somewhat less than 1,000. This makes a great discrepancy with Lindley in the London Gardener's Chronicle, where it is estimated at more than 3,000 years. I believe they say it germinated when Moses was a little boy.

A verbal or written description of the size of this tree cannot give one a sensible idea of its dimensions. It required me thirty-one paces, three feet to the pace, to measure it thus rudely at its stump. The only way it could be felled was by boring it through and through with pump augers, requiring five men twenty-two days to perform the operation.

After they had succeeded in severing it at the stump, the shoulders were so broad, and the tree so perfectly equipoised, that it required the same five men two days in driving wedges with a battering-ram, one on each side of the cut, to throw it out of its equilibrium sufficiently to make it fall. The mere felling of the tree, at California prices for wages, cost the sum of \$550.

A short distance from this tree was another of larger dimensions, which, apparently, had been felled by accident some forty or fifty years ago. The tree was hollow some distance, and quite a rivulet was running through it at the time I was there. The trunk was three hundred feet in length. The top was broken off, and by some agency—probably fire—was destroyed. At this point, three hundred feet from the butt, its trunk was forty feet in circumference, or more than twelve feet in diameter. Fragments of this kind of a tree, apparently exposed to the vicissitudes of the weather the same length of time, and supposed to be from the same tree, are now to be found projected in a line with it one hundred and fifty feet from the top, evidencing, to a degree of moral certainty, that the tree, when standing alive, must have attained the height of four hundred and fifty or five hundred feet. At the butt it is one hundred and ten feet in circumference, or about thirty-six feet in diameter. I collected specimens of currants and gooseberries on its body from considerable-sized bushes, elevated twenty-two feet from the ground. The tree is situated in a dense forest of sugar and yellow pines, balsam fir, white cedar, (*tibocedrus decurrens*), in its foliage much resembling the American arbor vitae, and a little yew, supposed to be *Taxus Canadensis*. Although it does not greatly exceed them in height, yet its courteous and majestic bearing strikes the beholder with awe and wonder, while we involuntarily bow to it as the king of the forest. The bark is of a dull brown color, varying much in thickness, sometimes being fifteen inches or more. The whole number of trees, young and old, do not exceed five hundred, and are comprised within an area of about fifty acres, between eighty and ninety being of the gigantic size. The extremely limited locality, and numbers of trees in existence, forcibly struck me that the tree is rapidly becoming extinct, as evinced by its slow reproduction.

Indeed, when one considers them so marked in their rusty habit from their present associates, we can hardly view them, in their present relations, excepting as links connecting us with ages so long past that they seem but reminiscences of an eternal bygone. If Lindley's estimate of its age be correct, one tree is only reproduced in six years; or if Dr. Torrey be correct, one only in two years is reproduced. One thing I observed very peculiar with regard to their fruit cones was, they were in every state of development, from the germ to the ripe fruit. I was there about the middle of May. The ground was literally covered with fruit and seed. The leaves are triangular and scale-like, as in the cedars, but never dimorphous by being expanded into flat lamina, like many others of the same tribe of cupressinæ, as supposed might be the case by Dr. Gray. The wood is deep red, much resembling that of the celebrated redwood of the coast mountains. Indeed, this fact led to confounding the two for a long time, in popular opinion especially. The value of the wood for timber is a matter of speculation merely, as it is too limited in quantity and locality to excite much interest, except indeed it be possible to wrest it from the seal apparently set upon it by time and nature, and reproducing it by means of art, and cultivating it in plantations. Such an experiment, with so noble a tree, would surely be worthy an assiduous and laborious trial.

SEQUOIA SEMPERVIREM; common name, redwood.—This was long known as the *Taxodium sempervirem* of Don. This noble and splendid tree is only found along the coast of California, from near the region of Monterey to the mouth of Russian river, above the Bay of Bodega; but whether that is its extreme limit, I am unable to learn. It does not reach into the interior of the State, and is never found at any considerable distance from the coast range of mountains. In the neighborhood of San Francisco, amid the deep mountain gorges, I have measured fallen trees eleven feet in diameter, and paced their length two hundred feet; and I have seen others standing, in appearance very much taller, but I had not the time nor means at hand to measure them. I am told, however, by men of credibility, that they grow from one hundred and eighty to three hundred feet high. It has been but lately distinguished and separated from the genus *Taxodium*. The gifted but unfortunate Douglass was among the first to notice the peculiar gigantic forms of these trees of California, and from that fact many English botanists ascribe to him the credit of discovering the still more gigantic Washingtonia. Another reason advanced is, because he penetrated as far north as 38° 45' north latitude, and saw gigantic trees, it was inferred he must have seen them both. But I have been assured by Dr. Randall, who was well acquainted with Douglass's botanizing localities, that he never penetrated inland while in California, much less the mountains of the Sierra Nevada.

Little has been written of the valuable qualities of this tree for timber, it having come into general use but for a comparatively short period of time—since the settlement of California by Americans. The wood a good deal resembles cedar in lightness and susceptibility to polish, possessing a slightly darker shade of red.

In the rural districts along the coast farmers use it for making rails, for fencing fields, and it is almost certain to excite incredulity to state the number of rails that can be made from a single tree. They are counted by thousands as we count them by hundreds in the eastern States. For building purposes and cabinet work, it probably excels every tree in California. In the cities and towns in its vicinity, where the transportation can be afforded, it takes the place of every other kind. Oregon lumber is frequently brought into the San Francisco market at a cheaper rate than it can be brought from the surrounding hills, but a few miles distant. The foliage of this tree is dimorphous, like most cupressinæ, the younger branches having a two-ranked, dilated spruce-like lamina, while the older ones assume the scale-like foliage of the juniper. I collected the old cones of last year, but fear I failed in procuring the seeds, all having already been shed.

LIBOCEDRUS DECUNENS.—This tree in California is called "white cedar," but quite different from a tree of the same common name in the eastern States, and I presume it is so called from its having something of a resemblance in foliage and habit to the American arbor vitæ. The fruit cone, however, is quite different, and justifies the botanist in separating it from *Thuja*. The representation given of it by Dr. Torrey, in *Plantæ Fremontianæ* (Smithsonian Contributions to Knowledge, plate 3, letter-press description, pages 7 and 8) is correct, excepting the fruit cones are represented as being erect, whereas they are always pendulous. This results probably from the drawing having been made from the dried specimens in the herbarium, rather than from nature. It is only to be found, at an elevation of some five thousand feet above the level of the sea, in the Sierra Nevada mountains. I found it near Sonora, at the headwaters of the Stanislaus river, considerably south of 38° north latitude, and also at the headwaters of the Calaveras and Mokelumne rivers, in juxtaposition with the *Wellingtonia gigantea*. In some instances it appeared nearly as tall as that tree. It certainly attains a height of over two hundred feet. The timber is much sought for, by farmers in that region, for making rails and fencing timber, being considered superior to the other species of pines in the neighborhood. The wood is very light, of a dirty yellowish hue, and is thought to be more durable than redwood.

TORREYA CALIFORNICA; *common name, nutmeg tree.*—I found this interesting tree not very far from the coast, near Tomales bay, in a deep redwood ravine called the "Redwoods." I am told it grows also on the American fork of the Sacramento. I was anxious to obtain the one on the American river, to determine whether it might not be a different species from that near the coast, as the coast and the Sierra Nevada mountain plants seldom intermingle. It has the foliage of a two-ranked leaved spruce, but the fruit is very characteristic, and different in appearance from any of the family in America. It very much resembles the nutmeg; so much so, indeed, as at one time to deceive some pretty well informed persons, and make them believe it was *not a wooden nutmeg*, but a nutmeg indeed, in character as well as in appearance. It is a great pity that Dame Nature should amuse herself thus by playing such pranks, and endanger the monopoly of our good Yankee friends in the manufacture of this indispensable luxury.

The tree grows some forty or fifty feet high, with very slender and drooping branches, and a thin light foliage; bark smooth, somewhat resembling the common black mulberry; wood hard and firm. I am unable to say anything with regard to its durability or fitness for timber in railroad or domestic purposes. I do not know either whether it is widely diffused in California. I think not, however, from the fact that I saw it but in one locality, and could trace it definitely only in another.

It was not the season for collecting the fruit when I visited the tree, all having been long before destroyed by squirrels, rats, and other vermin, which are said to be exceedingly fond of them. I understood, verbally, from Dr. Randall, that the nut was too bitter and terebinthinate to be of any use in domestic economy. I have no doubt it will make an excellent remedial agent in many diseases.

The tree is closely related to the podocarpo, of the tropical regions, and yews, which are common to the temperate regions of Europe and America. Lindley has separated them entirely from true coniferæ. Most of the family are remarkable for the elasticity and durability of its timber. The true nutmeg, however, belongs to a widely-separated family in its botanical relations, ranging exclusively in the tropics of India and America.

TAXUS CANADENSIS—I much regretted being unable to find the fruit of this plant. It grows in the forest with the *Washingtonia*; and also at Downieville, some degree and a half further north. Mr. Lobb, while there, pronounced it, without seeing the fruit, however, *Taxus baccata*, which is the European species. The tree is small, but the wood is very tough and elastic, being much prized by the Indians for making their bows. On finding its fruit and seeds, it may be quite a different species from its eastern congener. It belongs to the same natural subdivision of the pines or coniferæ as the nutmeg tree of California.

PINUS SABINIANA.—This tree is so called by Dr. Randall and other California botanists who have paid special attention to this kind of botany. From not having books at hand for reference, I am unable to say by whom it was first noticed.

This tree grows at the base of the Sierra Nevada, at Sonora, Moke-lumne Hill, Grass valley, and Nevada. But as you ascend into the mountains its place is taken by Douglass's spruce, sugar pine, balsam fir, and the yellow pine of that region. It bears a very large ovate cone, the scales of which are armed with upturned hooked spurs. The nut is said to be large and edible. This tree has not the erect and rigid appearance of most other pines, but is flexuous and crooked like deciduous-leaved trees. The foliage is also thin and sparing, of a very light green, giving it a very peculiar aspect, so different from any other species of pine that I know. The wood of it is very tough and elastic; but with regard to its durability when exposed to the weather I had no means of determination, from the fact that it is seldom or never used in the districts where it grows. This results from the sugar and yellow pine being so abundant, which is so much superior. Many other kinds of valuable timber trees grow also in the same neighborhood.

PINUS INSIGNIS.—This is so named by our California botanists, and I have no book at hand that refers to its description. This pine is found growing along the mountains of the sea-coast in the neighborhood of San Francisco. I find it also growing on the Yuba river, in the vicinity of Nevada city. It, however, there, is not a large tree, and I presume is not very valuable as timber, although I know nothing about it, except it is not used or sought for in the neighborhood where it grows. This, however, is only a relative circumstance against it, as it is surrounded and associated with other trees so much more superior in size and beauty.

PINUS—species undetermined.—High up in the mountains above Sonora, and also at Cajon Pass, I met with a pine very nearly related to the yellow pine of this country, (*P. brachyptera*;) the cone is larger and more cylindrical; scales armed with a strong, recurved spine; seed larger and broader-winged; leaf longer, regular in threes, with a longer sheath. I had a very good figure of it made. It is a large tree, valuable for its timber, with a light-colored bark. I am not certain, in the absence of books of reference, that it is a new species.

CHAPTER XI.

Concluding remarks.

The concluding report will describe many new species both of plants and animals. We will also be enabled to present to the department a complete geological and mineralogical section from the Mississippi river through the Rocky mountains, the Sierra Madre, the chains east of Rio Colorado and the Sierra Nevada, to the Pacific ocean. This was a field new to science, and our geologist, with abundant experience both in Europe and America, was well fitted for this exploration. The various formations have been developed, the ages of mountain chains established, and the position of mineral regions determined.

Specimens of rock for building-material have been procured in order to test the qualities of hardness, durability, and general adaptation to the purposes of construction.

Sketches have been obtained of landscapes, as well as of animals, plants, Indian portraits, scenes, ancient paintings, hieroglyphics, and curiosities.

An extensive series of meteorological and magnetic observations have been obtained for climatological investigations, and for the determination of the elements of inclination, declination, and intensity, over the region traversed. They are necessarily deferred to the conclusion of our operations.

In relation to this subject I would, however, refer to the accompanying climatological map, with remarks prepared by L. Blodget, esq., from observations collected by the Smithsonian Institution in connexion with those made during the survey. It will be perceived that the par-

allel of 35° is particularly favored by rain. The valley of the Canadian, the Zuni region, the vicinity of the San Francisco mountains, and the Aquarius range, have evidently a large supply of precipitated moisture. The arid deserts between the Mississippi and the Pacific coast are here contracted to their narrowest limits; consequently, upon this route there are more springs, more streams, and more woodland, than can be found upon lines I have traversed further south.

The gradients found to be practicable are marked upon the profile.

Curves of less radius than half a mile occur only in the Cajon Pass, and on Cañon and Big Sandy creeks, where they break through low mountain chains of metamorphic rock. There are there a few sharp turns, and it would be necessary in one place to tunnel through a point perhaps four or five hundred feet in thickness to attain a radius of one thousand feet. The few other bad places would require cutting, as upon the Hudson River railroad, at the edge of the bluffs. But already it has been mentioned that the Cajon Pass is considered only as the last resort for an entrance to the Pacific coast; and the firm belief that, by ascending the main eastern branch of Rio Santa Maria, both Cañon creek and Big Sandy may be avoided.

The principal bridges would be required at Rio Pecos, Rio del Norte, Cañon creek, and Rio Colorado; all others are of minor importance. The first and second have already been mentioned. Cañon creek, I doubt not, may be avoided by following the main eastern branch of Rio Santa Maria. Should it prove otherwise, it would be necessary to throw arches across the stream at three several points where cañons occur. The best of stone for this purpose is abundant in the vicinity. Two excellent points for crossing the Colorado occur—one at the cañon immediately below the junction of Rio Santa Maria, the other where rocky spurs impinge upon the river below the Mojave villages. The width of the stream between natural abutments, at these points, does not exceed two hundred and fifty yards.

Our line could in many places be made straighter and shorter, should wells be dug at proper points; either common or artesian wells would undoubtedly be successful throughout the whole distance from Fort Smith to Rio Pecos. Between that stream and the del Norte the strata are too much broken to be depended upon. Westward there are points where they could probably be made available. Rio Puerco, which at some seasons, in places, sinks, could doubtless be reached by this means. If so, a very rich soil, now unoccupied, would become available to agriculture. The whole region from the Sierra Madre to the Colorado Chiquito could probably be fertilized by the same agency. With the desire to test this question, we carried a small boring apparatus; but not having time to devote to the undertaking, the instrument was sold to certain citizens of New Mexico, who proposed to make a trial of its virtues. Between the Colorado Chiquito and Rio Colorado, volcanic forces have too much tilted and broken the regular strata to allow any dependence to be placed on this means of increasing the supply of water. Fortunately, however, the southern slopes of the mountains abound in permanent springs and streams, which renders the resort to wells unnecessary. From Rio Colorado to the Mojave river, to avoid ascent to mountain springs, we must have recourse to artificial means of

procuring water. Should the Mojave have a channel to the Colorado, the water cannot pass below the level of the latter stream, and by perforations to the proper depth, must be obtained. In Soda lake, by turning the sod, we found an abundance of brackish water. Pure water would probably be found twenty or thirty feet below the surface. Rio Mojave now furnishes an abundant supply until we reach the eastern base of the Sierra Nevada, from which numerous rivulets are said to flow. After passing the Sierra Nevada, neither in the valley leading to San Pedro nor in those we would follow to San Francisco, is want of water apprehended. Wherever permanent streams do not occur, common wells or artesian borings would prove available.

Snows upon this route can never prove the slightest obstruction to a railway. From Memphis, on the Mississippi river, to Rio Pecos, snow-storms rarely occur in winter. At Fort Smith, as has been shown, only one such storm was noted in the winter of 1852; that covered the ground to the depth of two inches. From thence to the Pecos, snow may occasionally fall to the depth of three or four inches, but must rapidly be absorbed by the warm, porous soil. I doubt whether the surface would remain whitened for ten days during the year.

Passing the ranges of the Rocky mountains east and the Sierra Madre west of the Rio Grande, storms are said to be more frequent, covering the surface with snow sometimes to the depth of a foot. But here, too, the snow quickly melts, and forms no obstruction to travelers. We passed the latter range late in November, and not the slightest trace of snow was visible among the loftiest peaks. The first seen was in December, glistening upon the distant peaks of Sierra Mogoyon. During the latter part of December and the first of January we were at the base of the San Francisco mountains, the only place where snow was found upon our route. It never exceeded eight inches in depth upon the surface, was nowhere drifted into banks, and formed no obstruction to our march. We believed, nevertheless, that the season was unusually severe, and the amount of snow fallen was almost unprecedented. Soon after leaving these mountains, snow disappeared. But on the 18th of January, when on a reconnoissance in the Aztec mountains, another storm occurred; snow falling to the depth of four inches. Four days afterwards we were again at the same spot, and the snow had nearly disappeared; the southern slopes were entirely bare. Leaving this range, we saw no more indications of snow except upon a few distant mountain summits. Without doubt, between the Aztec Pass and California a few storms may occur in winter, covering the surface with snow to the depth of three or four inches; but so mild a climate soon melts it away.

Fuel is believed to be more abundant upon this route than upon any other known from the Mississippi to the Pacific. The State of Arkansas and the Choctaw territory, as far as Shawneetown, are covered with wood, excellent for fuel, and also furnish an abundance of coal. Westward of Shawneetown we have wood upon the streams, and live-oak and black-jack in the Cross Timbers to the head of the Washita; thence to the Pecos are occasional forests of cedars, which afford excellent fuel. From the Pecos to Albuquerque, and thence to Zuñi, is a constant succession of pines, firs, and cedars. Coal, also, is found

in this region. Beyond Zuñi, cedar wood covers a wide extent of country for about forty miles. Beyond, plenty of fuel could be floated down the Colorado Chiquito from the well-wooded region of the Mogoyon, from whence it issues. The San Francisco forests of pine unite with cedar thickets, extending through the Black forest and across the Aztec mountains to the Rio Santa Maria; thence to Rio Colorado, and even to the base of Sierra Nevada. Although there are occasional thickets and groves of mezquite cedar and alamo, a general scarcity of fuel characterizes other portions of this section. Upon the mountain slopes of California, the supply both of timber and fuel is supposed to be exhaustless.

COST OF CONSTRUCTION.

From so hasty a survey, little more could be expected than to furnish approximate materials for a rough estimate. The time allotted to the preparation of this part of the work scarcely admits a reference to that data. It will be furnished to the department for future examination.

A few remarks, however, expressing merely in general terms the ideas impressed by the field observations, may not be inapplicable to the conclusion of this subject. For this purpose I propose to divide the line into sections, and, by a comparison with roads already constructed, draw an inference of the probable expense of completing the Pacific railway.

SECTION I. *From Fort Smith to camp 33, near the head of Washita river, three hundred and sixty-five miles.*—The general surface is an inclination nearly uniform of four feet to the mile. Following the line of profile 1, there are hills and undulating prairies, intersected by frequent rivulets. The soil is fertile; timber and stone for construction abundant. The labor required for masonry and graduation will compare favorably with the average upon the railroads of the State of New York. The average total cost for construction and equipment of New York railroads, as reported by the State engineer, is \$45,091 84 per mile. As steamboat navigation exists to the mouth of the Canadian, ten per cent. added ought certainly to cover all the extraordinary expenses due to the locality described; making \$49,600 per mile, or \$18,104,000 for the total cost of construction and equipment of this section.

SECTION II. *From camp 33, head of Washita river, to Tucumcari creek, two hundred and eighty-one miles.*—Following the valley of the Canadian, the average grade is eight feet per mile. Although there is some good soil upon the streams, many sandy spots occur, and the general aspect of this section is that of sterility. Water can easily be obtained; but timber of good quality for railroad-ties is scarce. Cedars are abundant, it is true; but it is doubtful whether they would be available except for fuel. The main supply would, therefore, be of oak, obtained from the Cross Timbers at the eastern end of the section. For graduation and masonry, our standard of comparison may be the same as before. But increased expenses for transportation will make it proper to add twenty per cent. to the original, making the estimate about \$54,100 per mile, or for the section \$15,202,000.

SECTION III. *From Tucumcari creek to Albuquerque, two hundred and one miles.*—Leaving the Canadian river, the surface is undulating to Rio Pecos. Thence to Albuquerque much labor will be required—equal, probably, to that employed upon the Hudson River road. The total cost of construction and equipment of the latter is stated to be \$81,812 16 per mile. As good timber is abundant upon the latter part of the line, and we are among a civilized people of agricultural and pastoral pursuits, where wages of native labor are low, it is believed that thirty per cent. added to our standard may, with proper economy, accomplish the work. This estimate amounts to \$106,355 per mile, and for the section \$21,377,355.

SECTION IV. *From Albuquerque to Zuñi, one hundred and fifty-one miles.*—The labor required for graduation and masonry upon this section will be less than upon the last, and an abundance of good timber and stone is easy of access. The cost of construction and equipment on this portion of the route may be compared with the western railroad from Worcester to Albany, which is \$64,218 per mile. Adding forty per cent. for increased expenses of transportation, &c., and our estimate amounts to about \$90,000 per mile, equal to \$13,590,000 for the section.

SECTION V. *From Zuñi to San Francisco Springs, one hundred and ninety-eight miles.*—Throughout this portion of the route excellent timber may easily be obtained from the Zuñi mountain of Sierra Madre, from Sierra Mogoyon by rafts down the Colorado Chiquito, and, finally, in the vast forests in the midst of which this section terminates. Much of the distance along the Colorado Chiquito, and elsewhere, being nearly level, the labor required for graduation and masonry will be quite light—probably less than that expended upon the Providence and Worcester railroad, which cost, per mile, \$44,774. Fifty per cent. added for extraordinary expenses, gives about \$89,540 per mile, and for the section \$17,721,000.

SECTION VI. *From the San Francisco Springs to the Rio Colorado, two hundred and seventy-nine miles.*—It has been already stated that over this section more favorable ground is believed to exist south of the main portion of our route. If not, the labor of graduation and masonry through the cañoned creeks will far exceed that upon any previous portion of the road. It would be similar to what was required along the cliffs of the highlands on the Hudson River road. But in estimating the cost, sixty per cent. increase will probably cover the extraordinary expenses due to locality, provided the road be built continuously from the coast, so as to furnish railway transportation for supplies. Total cost of construction and equipment of Hudson River road, \$81,812 16 per mile. Add sixty per cent., and we have about \$131,000 per mile, and for the section \$36,549,000.

SECTION VII. *From Rio Colorado to the Pacific, three hundred and seventy-four miles.*—The line traversed is recommended only in case subsequent explorations should prove that the more direct routes suggested are less favorable than appearances would indicate. The expense, however, is estimated with due regard to the magnitude of the work. It is believed, however, that upon no portion of this route, except the tunnel through Cajon pass, can the difficulties exceed what

was encountered upon the Baltimore and Ohio railroad; and for the greater part of the distance, where wide valleys are followed, labor of graduation and masonry will be very small. In making the comparison referred to above, we find reported the sum of \$58,410 as the total cost per mile. To this we would add cent. per cent., giving about \$117,000 per mile, or for the section \$43,758,000. This is supposed to include about \$5,000,000 for the tunnel of the pass.

RECAPITULATION OF ESTIMATE.

Section.	Length in miles.	Average cost per mile.	Total amount for graduation and equipment complete.
I.....	365	\$49,600	\$18,104,000
II.....	281	54,100	15,202,000
III.....	201	106,000	21,306,000
IV.....	151	90,000	13,590,000
V.....	198	89,500	17,721,000
VI.....	279	131,000	36,549,000
VII.....	374	117,000	43,758,000
Total.....	1,849	89,903	166,230,000

I am aware that the above estimate far exceeds those made by eminent engineers, such as E. F. Johnson and Septimus Norris. But it is believed, that without having been eye-witnesses of the uninhabited regions through which it is proposed to execute a work of such magnitude, they have failed to appreciate the extent of the difficulties which such an unprecedented condition of things would produce.

It is true, that should a general route be agreed upon, and a portion of the cultivable valleys it would traverse thrown open to actual settlers, two years would produce an astonishing change in this region. Fields of grain and vegetables would spring up, as if by magic, from one end of the line to the other; and, upon each section, an adequate supply of subsistence would doubtless be afforded from local productions. But there are other difficulties attending the absence of facilities for transportation, and of the innumerable conveniences of a numerous population, which can be remedied only by the completion of the railway. The expense of the operation would also be modified to conform to the method of its commencement, and the manner in which it may be conducted.

To begin simultaneously from the eastern and western limits, and proceed to a mutual junction, would enable the road itself, in a great measure, to bear the burden of its own supplies. The grading, however, in order to hasten the completion of the work, would doubtless be carried on from New Mexico, and probably at the same time from various other points.

Its successful and speedy completion, however, can be effected

whenever the people of this country feel its importance to the union, dignity, and prosperity of the United States, and are willing—in consideration of the national advantages to be derived—to give efficient national aid.

I have the honor to be, sir, very respectfully, your obedient servant,
A. W. WHIPPLE,

Lieut. Top. Engineers, in charge of Exploration.

HON. JEFFERSON DAVIS,
Secretary of War.

APPENDIX A.

Determination of elements for the reduction of barometric observations for heights—Remarks upon the value of the observations—Curves of daily oscillation of barometric column in New Mexico—Report and chart of climatological investigations: By L. Blodget, esq., Smithsonian Institution.

The direction given to the barometric reductions of the survey, (made by Lt. Whipple, Topographical Engineers, for a railroad route near the 35th parallel,) differs somewhat from that usual to these observations, and the following notes and explanations of the processes may be necessary. The large number of barometric observations made, and the general accuracy and uniform comparison retained throughout the survey, by the instruments employed, render the observations of this extended line unusually important and valuable. Determinations made by them are almost the best possible by this mode of survey, and for this reason great care was required, and was given, to their reduction.

The first series of observations made with the barometers at Cincinnati, Little Rock, and Fort Smith, were employed to determine positive comparisons of the instruments among themselves, those given by the maker not being found correct after transportation. The best results that could then be determined for zero error were obtained from these, and from comparison with other barometers. The relative position of the instruments, as thus determined, was found to be the same at Albuquerque and at the termination of the survey; and the slight zero-error possibly remaining, in the absence of opportunity to compare anew with an absolute standard, would be unimportant.

The observations at Cincinnati, Napoleon, Little Rock, and Fort Smith, are given in full, to show the comparison of the instruments. The original comparisons of the maker, and the corrections as finally determined and applied, follow:

BAROMETER No. 781.

Date.	Time.	Upper vernier.	Lower vernier.	Cor. height.	Difference.
<i>Burnet House, Cincinnati.</i>					
June 13.....	10½ a. m.....	30.938	1.064	29.874	+ .057
13.....	12½ p. m.....	.931	.071	.860	
13.....	5½ p. m.....	.885	.118	.767	+ .049
13.....	9 p. m.....	.894	.125	.769	
14.....	10 a. m.....	.888	.100	.788	+ .030
14.....	12 m.....	.889	.116	.773	+ .042
<i>Arkansas Hotel, Napoleon, Arkansas.</i>					
June 23.....	8 p. m.....	31.092	0.913	30.179	
24.....	10 a. m.....	.150	.850	.300	
<i>Anthony House, Little Rock.</i>					
June 27.....	8¾ a. m.....	30.408	0.424	29.966	+ .038
27.....	12½ p. m.....	31.007	1.041	.966	+ .056
27.....	6 p. m.....	30.980	.074	.906	+ .059
27.....	9¾ p. m.....	.955	.076	.879	+ .049
28.....	7 a. m.....	.983	.052	.931	
28.....	10¾ a. m.....	.997	.044	.953	+ .040
28.....	6½ p. m.....	.965	.090	.875	+ .048
28.....	Midnight.....	.938	.079	.859	+ .034
29.....	7½ a. m.....	.966	.067	.899	+ .045
29.....	11½ a. m.....	.987	.068	.919	+ .037
<i>Fort Smith, Rodgers's Hotel.</i>					
July 4.....	1½ p. m.....	30.917	1.162	29.755	+ .047
4.....	4¾ p. m.....	.915	.167	.748	+ .057
5.....	8.35 a. m.....	.966	.143	.823	+ .054
5.....	12.19 p. m.....	.958	.150	.808	+ .048
5.....	10¼ p. m.....	.940	.157	.783	+ .050
6.....	8½ a. m.....	.976	.133	.843	+ .056
6.....	2 p. m.....	.955	.160	.790	+ .056
6.....	9 p. m.....	.951	.119	.832	+ .040
7.....	9½ a. m.....	.926	.119	.867	+ .055
7.....	12¼ p. m.....	.982	.145	.837	+ .051
7.....	3¼ p. m.....	.969	.150	.819	+ .064
7.....	6.10 p. m.....	.970	.157	.813	+ .043
8.....	3¼ p. m.....	.969	.186	.783	+ .047
8.....	6¼ p. m.....	.938	.160	.778	
9.....	9 a. m.....	.964	.134	.830	+ .063
9.....	12 m.....	31.390	.600	.790	+ .047
9.....	3 p. m.....	30.931	.170	.761	+ .058
9.....	5¾ p. m.....	.916	.171	.745	+ .046
11.....	9½ a. m.....	.932	.162	.770	+ .052
11.....	12 m.....	.928	.171	.757	+ .047
11.....	2½ p. m.....	.997	.188	.709	+ .059
11.....	6 p. m.....	.890	.188	.692	+ .054
12.....	8½ a. m.....	.953	.198	.755	+ .059

BAROMETER No. 783.

Date.	Time.	Upper vernier.	Lower vernier.	Cor. height.	Difference.
<i>Burnet House, Cincinnati.</i>					
June 13.....	10½ a. m.....	31.155	1.291	29.864	+ .047
13.....	12½ p. m.....	.154	.300	.854	+ .058
13.....	5½ p. m.....	.107	.342	.765	+ .047
13.....	9 p. m.....	.114	.336	.778	
14.....	10 a. m.....	.106	.323	.783	
14.....	12 m.....	.111	.333	.778	+ .047
<i>Arkansas Hotel, Napoleon.</i>					
June 24.....	11 a. m.....	31.375	1.092	30.283	+ .033
<i>Anthony House, Little Rock.</i>					
June 27.....	8¾ a. m.....	31.230	1.264	29.966	+ .038
27.....	12½ p. m.....	.236	.279	.957	+ .047
27.....	6 p. m.....	.200	.300	.900	+ .053
27.....	9¾ p. m.....	.174	.300	.874	+ .044
28.....	7 a. m.....	.177	.278	.899	
28.....	10¾ a. m.....	.212	.272	.950	+ .047
28.....	6½ p. m.....	.175	.299	.876	+ .039
28.....	Midnight.....	.150	.291	.859	+ .034
29.....	7.20 a. m.....	.161	.280	.881	
29.....	11½ a. m.....	.188	.271	.917	+ .035
<i>Rodgers's Hotel, Fort Smith.</i>					
July 4.....	1½ p. m.....	31.113	1.369	29.744	+ .036
4.....	4¾ p. m.....	.098	.367	.731	+ .040
5.....	8.35 a. m.....	.122	.313	.809	+ .032
8.....	9¼ a. m.....	.169	.286	.883	+ .048
8.....	3¼ p. m.....	.117	.338	.779	+ .043
8.....	6¼ p. m.....	.092	.330	.762	+ .046
9.....	9 a. m.....	.115	.310	.805	+ .038
9.....	12 m.....	.107	.316	.791	+ .038
9.....	3 p. m.....	.188	.442	.746	+ .043
9.....	5¾ p. m.....	.078	.335	.743	+ .044
10.....	9¼ a. m.....	.096	.328	.768	+ .060
10.....	12 m.....	.090	.335	.755	+ .045
11.....	2¼ p. m.....	.064	.368	.696	+ .046
11.....	6 p. m.....	.050	.369	.681	+ .043
12.....	9 a. m.....	.081	.333	.748	+ .052
12.....	12½ p. m.....	.081	.344	.737	+ .047

BAROMETER No. 734.

Date.	Time.	Upper vernier.	Lower vernier.	Cor. height.	Difference.
<i>Burnet House, Cincinnati.</i>					
June 13.....	10½ a. m.....	31.452	1.586	29.866	+0.43
13.....	12½ p. m.....	.449	.559	.890	
13.....	5½ p. m.....	.404	.644	.760	+0.42
13.....	9 p. m.....	.406	.638	.768	
14.....	10 a. m.....	.410	.626	.784	
14.....	12 m.....	.410	.636	.774	+0.41
<i>Arkansas Hotel, Napoleon.</i>					
June 24.....	11 a. m.....	31.519	1.228	30.291	+0.39
<i>Anthony House, Little Rock.</i>					
June 27.....	8¾ a. m.....	31.330	1.366	29.964	+0.36
27.....	12½ p. m.....	.333	.380	.953	+0.43
27.....	6 p. m.....	.304	.416	.888	+0.41
27.....	9¾ p. m.....	.280	.419	.861	+0.31
28.....	7 a. m.....	.307	.383	.924	
28.....	10¾ a. m.....	.331	.377	.954	+0.41
28.....	6½ p. m.....	.281	.421	.860	+0.33
28.....	Midnight.....	.263	.416	.847	
29.....	7.20 a. m.....	.280	.397	.883	
29.....	11½ a. m.....	.306	.391	.915	+0.32
<i>Rodgers's Hotel, Fort Smith.</i>					
July 4.....	1½ p. m.....	31.188	1.435	29.753	+0.45
4.....	4¾ p. m.....	.177	.436	.741	+0.50
5.....	8.35 a. m.....	.430	.614	.816	+0.47
5.....	12.19 p. m.....	.419	.617	.802	+0.42
5.....	10¼ p. m.....	.410	.628	.782	+0.39
6.....	8¼ a. m.....	.423	.595	.828	+0.41
6.....	2 p. m.....	.402	.628	.774	+0.40
6.....	9 p. m.....	.434	.588	.846	+0.54
7.....	9½ a. m.....	.432	.572	.860	+0.48
7.....	12¼ p. m.....	.428	.583	.845	+0.59
7.....	3¼ p. m.....	.418	.600	.818	+0.65
7.....	6.10 p. m.....	.409	.590	.819	+0.49
8.....	9½ a. m.....	.446	.554	.892	+0.57
8.....	3¼ p. m.....	.400	.614	.786	+0.50
8.....	6¼ p. m.....	.383	.608	.775	+0.59
9.....	9 a. m.....	.394	.579	.815	+0.48
9.....	12 m.....	30.950	.154	.896	
9.....	3 p. m.....	31.370	.611	.759	+0.56
9.....	5¾ p. m.....	.360	.623	.737	+0.38
11.....	9½ a. m.....	.359	.608	.751	+0.33
11.....	12 m.....	.339	.672	.667	
11.....	2½ p. m.....	.340	.660	.688	+0.38
11.....	6 p. m.....	.339	.661	.779	
12.....	9 a. m.....	.350	.630	.720	+0.24
12.....	12½ p. m.....	.360	.636	.724	+0.34

BAROMETER No. 785.

Date.	Time.	Upper vernier.	Lower vernier.	Cor. height.	Difference.
<i>Burnet House, Cincinnati.</i>					
June 13.....	10½ a. m.....	31.153	1.300	29.853	+0.36
13.....	12½ p. m.....	.150	.310	.840	+0.44
13.....	5½ p. m.....	.102	.350	.752	+0.34
13.....	9 p. m.....	.102	.336	.766	
14.....	10 a. m.....	.100	.328	.772	
14.....	12 m.....	.101	.336	.765	+0.33
<i>Arkansas Hotel, Napoleon.</i>					
June 24.....	11 a. m.....	31.340	1.112	30.278	+0.28
<i>Anthony House, Little Rock.</i>					
June 27.....	8¾ a. m.....	31.215	1.258	29.957	+0.29
27.....	12½ p. m.....	.219	.277	.942	+0.32
27.....	6 p. m.....	.188	.308	.880	+0.33
27.....	9¾ p. m.....	.165	.304	.859	+0.29
28.....	7 a. m.....	.188	.272	.916	
28.....	10¾ a. m.....	.206	.277	.929	
28.....	6½ p. m.....	.161	.301	.860	+0.33
28.....	Midnight.....	.142	.293	.849	+0.24
29.....	7½ a. m.....	.153	.279	.876	+0.21
29.....	11½ a. m.....	.169	.261	.908	+0.26
<i>Rodgers's Hotel, Fort Smith.</i>					
July 4.....	1½ p. m.....	31.112	1.378	29.734	+0.26
4.....	4¾ p. m.....	.104	.379	.725	+0.34
5.....	8.35 a. m.....	.129	.332	.797	+0.28
5.....	12.19 p. m.....	.123	.336	.787	+0.27
5.....	10.15 p. m.....	.100	.345	.755	+0.22
6.....	8½ a. m.....	.128	.314	.814	+0.27
6.....	2 p. m.....	.129	.368	.761	+0.27
6.....	9 p. m.....	.180	.357	.823	+0.31
7.....	9½ a. m.....	.138	.296	.842	+0.30
7.....	12¼ p. m.....	.130	.308	.822	+0.36
7.....	3¼ p. m.....	.118	.327	.791	+0.36
7.....	6.10 p. m.....	.116	.308	.808	+0.38
8.....	9½ a. m.....	.152	.281	.871	+0.36
8.....	3¼ p. m.....	.090	.320	.770	+0.34
8.....	6¼ p. m.....	.079	.330	.749	+0.33
9.....	9 a. m.....	.100	.304	.796	+0.29
9.....	12 m.....	.088	.314	.774	+0.31
9.....	3 p. m.....	.075	.335	.740	+0.37
9.....	5¾ p. m.....	.060	.331	.729	+0.30
11.....	9½ a. m.....	.080	.328	.752	+0.34
11.....	12 m.....	.072	.331	.741	+0.31
11.....	2½ p. m.....	.040	.361	.679	+0.29
11.....	6 p. m.....	.031	.367	.664	+0.26
12.....	9 a. m.....	.060	.334	.726	+0.30
12.....	12¼ p. m.....	.066	.340	.726	+0.36

BAROMETER No. 790—(CISTERN.)

Date.	Time.	Cor. height.	Date.	Time.	Cor. height.
<i>Burnet House, Cincinnati.</i>			<i>Rodgers's Hotel, Fort Smith.</i>		
June 13.....	10½ a. m....	29.817	July 4.....	1¼ p. m....	29.708
13.....	12½ p. m....	.796	4.....	4¾ p. m....	.691
13.....	5½ p. m....	.718	5.....	8.35 a. m....	.769
14.....	12 m. ....	.731	5.....	12.19 p. m..	.760
<i>Arkansas Hotel, Napoleon.</i>			5.....	10¼ p. m....	.733
June 24.....	11 a. m....	30.250	6.....	8¼ a. m....	.787
<i>Anthony House, Little Rock.</i>			6.....	2 p. m....	.734
June 27.....	8¾ a. m....	29.928	6.....	9 p. m....	.792
27.....	12½ p. m....	.910	7.....	9¼ a. m....	.812
27.....	6 p. m....	.847	7.....	12¼ p. m....	.786
27.....	9¾ p. m....	.830	7.....	3¼ p. m....	.755
28.....	10¾ a. m....	.913	7.....	6.10 p. m....	.770
29.....	7¾ a. m....	.855	8.....	9¼ a. m....	.835
29.....	11¼ a. m....	.882	8.....	3¼ p. m....	.736
			8.....	6¼ p. m....	.716
			9.....	9 a. m....	.769
			9.....	12 m. ....	.743
			9.....	3 p. m....	.703
			9.....	5¼ p. m....	.699
			11.....	9¼ a. m....	.718
			11.....	12 m. ....	.710
			11.....	2¼ p. m....	.650
			11.....	6 p. m....	.638
			12.....	9 a. m....	.696
			12.....	12¼ p. m....	.690

NOTE.—Some observations are rejected for obvious errors of reading. Such are detected by comparison of the several instruments at particular observations.

Comparisons by J. Green, maker.—Cistern barometer, No. 790, reads exactly with standard, (Smithsonian :) capillary action being corrected by final adjustment of scale, (diameter of tube, .23 inch,) no correction is wanted but in reducing temperature to 32° Fahrenheit.

Standard, 30.275. Syphon No. 780.—Upper vernier, 31.325
Lower vernier, 1.020

Syphon too high, 0.030. 30.305

Standard, 30.275. Syphon No. 785.—Upper vernier, 21.330
Lower vernier, 1.052

Syphon too high, 0.003. 30.278

Standard, 30.108. Syphon No. 781.—Upper vernier, 31.145
Lower vernier, 1.010

Syphon too high, 0.027. 30.135

Standard, 30.108. Syphon No. 783.—Upper vernier, 31.282
Lower vernier, 1.162

Syphon too high, 0.012. 30.120

Standard, 30.104.

Syphon No. 784.—Upper vernier,	31.574
Lower vernier,	1.449

Syphon too high, 0.021.

30.125

As the mean result of comparison of all the instruments at the commencement of the survey, the following measures were adopted :

Cistern barometer, No. 790,	—	.019
Syphon do	781,	+ .031
Do do	783,	+ .024
Do do	784,	+ .024
Do do	785,	+ .012

Comparison was made with the barometer of Dr. Ray, at Cincinnati, giving the following result :

Dr. Ray's cistern,	0.000
Cistern No. 790,	— .026
Syphon No. 781,	+ .024
Do 783,	+ .017
Do 784,	+ .017

This comparison confirms the corrections determined by mutual comparison of the instruments of the survey.

Next to this verification of instruments, it became necessary to determine the constants proper to be applied in prosecution of the detail of the work. For this purpose, the precedents in barometric determination of heights are scarcely adequate for application to lines of such extent, and for distances so great from the initial point. There is strong reason to suspect the accuracy of temperature corrections, particularly when applied for temperature of the air on a long line. It is certain that these corrections will not apply in case of considerable changes of surface-temperature at places having nearly the same elevation; and in the present case, the errors arising in this way were avoided by the use, as much as possible, of mean results from many observations in fixing the elevation of every camp or important point in the line from Fort Smith to Albuquerque.

The horary variations of pressure are another constant too important to be neglected. For these a scale was first applied, deduced from the determinations at Washington and Philadelphia, modified in the extremes of its range to conform to the less considerable changes shown by recent observations to exist in the daily curve of atmospheric pressure at the coast of the Gulf of Mexico. This low scale of horary correction was applied to all the observations from Napoleon, Arkansas, to camp No. 32, near the Washita river—thus bringing each observation to the mean pressure for the day. The signs, as given in the table, represent the relation of the several hours to the true daily mean of pressure, and are corrections with the opposite sign.

This degree of correction is not thought sufficient for the comparatively arid climates of the open plains, and is therefore carried only to camp No. 32.

Horary corrections used from Napoleon to Camp No. 32.

4 a. m.....	-0.008	3 p. m.....	-0.006
5 a. m.....	-0.006	4 p. m.....	-0.015
6 a. m.....	+0.002	5 p. m.....	-0.020
7 a. m.....	+0.006	6 p. m.....	-0.018
8 a. m.....	+0.014	7 p. m.....	-0.012
9 a. m.....	+0.018	8 p. m.....	-0.008
10 a. m.....	+0.020	9 p. m.....	-0.005
11 a. m.....	+0.018	10 p. m.....	+0.005
12 m.....	+0.010	11 p. m.....	+0.005
1 p. m.....	+0.006	12 p. m.....	+0.000
2 p. m.....	-0.003		

For the transition climate from camp No. 32 forward to near the boundary of New Mexico, a modified scale with a larger range was employed.

Horary corrections applied from Camp No. 32 to Camp No. 50, near the Laguna Colorado.

6 a. m.....	+0.007	2 p. m.....	-0.015
7 a. m.....	+0.020	3 p. m.....	-0.030
8 a. m.....	+0.030	4 p. m.....	-0.045
9 a. m.....	+0.040	5 p. m.....	-0.050
10 a. m.....	+0.050	6 p. m.....	-0.030
11 a. m.....	+0.055	7 p. m.....	-0.020
12 m.....	+0.025	8 p. m.....	-0.005
1 p. m.....	+0.005	9 p. m.....	-0.000

For New Mexico, and the arid climates of the remainder of the route, a still larger horary variation was found to exist. The quantities were determined from hourly observations, made by the survey at Albuquerque, from the 3d to the 10th of October, for sixteen hours of the day, and continued for six hours daily to November 8. Observations at Zuni every fifteen minutes on November 22, were also used to establish this curve.

The curves drawn from these observations will be seen to exhibit similar features in all cases, and the corrected curve from which the scale was taken to be so symmetrical as to leave no doubt of the accuracy of this unusually large measure of variation of pressure through the successive hours of the day.

Scale of horary corrections applicable to the arid climates of New Mexico and California.

6 a. m.....	+0.010
7 a. m.....	+0.030
8 a. m.....	+0.045
9 a. m.....	+0.050
10 a. m.....	+0.057
11 a. m.....	+0.070

12 m.....	+.032
1 p. m.....	-.009
2 p. m.....	-.030
3 p. m.....	-.040
4 p. m.....	-.050
5 p. m.....	-.045
6 p. m.....	-.035
7 p. m.....	-.025
8 p. m.....	-.010
9 p. m.....	-.005

This important correction for barometric readings used in the determination of heights has scarcely been referred to in previous surveys; and the large values it certainly has along the line of this survey should be verified more fully than they yet have been. The correction for horary variation is probably large, and important over all the interior, in which the barometer is the chief reliance for determining elevations.

ALBUQUERQUE, N. M.—BAROMETER No. 783.

Date.	6 A. M.	7 A. M.	8 A. M.	9 A. M.	10 A. M.	11 A. M.	12 M.	1 P. M.	2 P. M.	3 P. M.	4 P. M.	5 P. M.	6 P. M.	7 P. M.	8 P. M.	9 P. M.
1853. Oct. 3	-----															25.231
4	25.289	25.325	25.323	25.303	25.283	25.282	25.260	25.252	25.213	25.213	25.196	25.187	25.191	25.197	25.208	.203
5	.228	.278	.283	.285	.284	.270	.233	.206	.197	.194	.200	.187	.191	.192	.211	.208
6	.236	.254	.250	.246	.216	.202	.180	.167	.138	.124	.105	.098	.121	.141	.106	.140
7	.184	.206	.211	.213	.213	.204	.155	.129	.109	.103	.097	.113	.100	.106	.115	.123
8	.158	.165	.197	.203	.192	.163	.135	.103	.082	.088	.068	.078	.081	.089	.096	.085
9	.124	.116	.122	.121	.102	.080	-----	.041	.029	24.958	24.970	.000	.005	.017	.000	.015
10	.070	.076	.083	.092												
Means . .	25.184	25.203	25.210	25.209	25.215	25.236	25.191	25.149	25.128	25.113	25.106	25.110	25.115	25.124	25.139	25.144

ALBUQUERQUE, N. M.—BAROMETER No. 785.

Date.	6 A. M.	9 A. M.	12 M.	3 P. M.	6 P. M.	9 P. M.
1853.						
October 8.....		25.224	25.164	25.101	25.090	25.100
9.....	25.135	.130	-----	24.986	.023	.021
10.....	.163	.118	.072	25.021	.029	.049
11.....	.113	.203	.169	.135	.122	.132
12.....	.160	.178	.129	.063	.051	.082
13.....	.092	.099	.078	24.984	.022	.056
14.....	.131	.102	.196	-----	.167	.260
15.....	.236	.286	.122	25.184	.171	.200
16.....	.226	.235	.242	.220	.215	.235
17.....	.263	.331	.294	.241	.224	.253
18.....	-----	.279	.195	.190	-----	.222
19.....	-----	.203	.294	.155	-----	.147
20.....	-----	.194	.158	.070	-----	.051
21.....	.093	.141	.088	24.981	-----	.004
22.....	24.957	24.968	24.890	.886	-----	.058
23.....	-----	25.172	25.119	25.120	-----	.185
24.....	25.236	.239	.171	.030	24.988	24.948
25.....	24.946	24.808	-----	-----	-----	-----
26.....	25.009	25.061	.050	.017	25.006	25.036
27.....	.125	.121	.200	.074	.106	-----
28.....	.222	.227	.342	.342	.344	-----
29.....	.167	.454	.484	.422	.412	-----
30.....	-----	.419	.350	.381	-----	.436
31.....	-----	.051	.074	.010	24.965	24.966
Nov'ber 1.....	24.992	24.979	24.954	24.880	.886	.950
2.....	25.113	25.184	25.175	25.163	25.177	25.196
3.....	.343	.312	.250	.209	.202	.213
4.....	-----	.297	.258	.214	-----	.211
5.....	-----	.343	.252	.169	-----	-----
6.....	-----	-----	.127	.065	-----	.052
7.....	.063	.039	.030	-----	-----	-----
8.....	.271	.315	-----	-----	-----	.508
Means	25.139	25.184	25.167	28.118	25.116	25.137
Cor. for bar. 785—, 022.	.117	.162	.145	0.96	.094	.115

CAMP 71, NEAR PUEBLO OF ZUNI.—BAROMETER No. 790.

NOVEMBER 22.

<i>h. m.</i>	<i>Inches.</i>	<i>h. m.</i>	<i>Inches.</i>	<i>h. m.</i>	<i>Inches.</i>
2 15 p. m.	23.891	10 30 p. m.	23.916	6 45 a. m.	23.929
2 30 p. m.	.877	10 45 p. m.	.914	7 00 a. m.	.941
2 45 p. m.	.877	11 00 p. m.	.916	7 15 a. m.	.939
3 00 p. m.	.881	11 15 p. m.	.912	7 30 a. m.	
3 15 p. m.	.878	11 30 p. m.	.914	7 45 a. m.	.939
3 30 p. m.	.877	11 45 p. m.	.916	8 00 a. m.	.937
3 45 p. m.	.881	12 00 p. m.	.912	8 15 a. m.	.938
4 00 p. m.	.881	12 15 a. m.	.914	8 30 a. m.	.946
4 15 p. m.	.878	12 30 a. m.	.918	8 45 a. m.	.954
4 30 p. m.	.879	12 45 a. m.	.918	9 00 a. m.	.952
4 45 p. m.	.873	1 00 a. m.	.919	9 15 a. m.	.953
5 00 p. m.	.876	1 15 a. m.	.916	9 30 a. m.	.959
5 15 p. m.	.873	1 30 a. m.	.908	9 45 a. m.	.957
5 30 p. m.	.879	1 45 a. m.	.906	10 00 a. m.	.956
5 45 p. m.	.874	2 00 a. m.	.903	10 15 a. m.	.951
6 00 p. m.	.894	2 15 a. m.	.906	10 30 a. m.	.950
6 15 p. m.		2 30 a. m.	.909	10 45 a. m.	.969
6 30 p. m.	.905	2 45 a. m.	.912	11 00 a. m.	.949
6 45 p. m.	.905	3 00 a. m.	.908	11 15 a. m.	.932
7 00 p. m.	.911	3 15 a. m.	.906	11 30 a. m.	.911
7 15 p. m.	.925	3 30 a. m.	.904	11 45 a. m.	.891
7 30 p. m.	.931	3 45 a. m.	.904	12 00 m.	.895
7 45 p. m.	.923	4 00 a. m.	.906	12 15 p. m.	.900
8 00 p. m.	.915	4 15 a. m.	.908	12 30 p. m.	.904
8 15 p. m.	.921	4 30 a. m.	.902	12 45 p. m.	.904
8 30 p. m.	.927	4 45 a. m.	.896	1 00 p. m.	.904
8 45 p. m.	.927	5 00 a. m.	.888	1 15 p. m.	.904
9 00 p. m.	.930	5 15 a. m.	.887	1 30 p. m.	.904
9 15 p. m.	.930	5 30 a. m.	.896	1 45 p. m.	.865
9 30 p. m.	.922	5 45 a. m.	.898	2 00 p. m.	.874
9 45 p. m.	.928	6 00 a. m.	.904	2 15 p. m.	.793
10 00 p. m.	.930	6 15 a. m.	.915		
10 15 p. m.	.920	6 30 a. m.	.931		

Another element found very important at the outset of the reductions was the non-periodic variation of pressure. Fortunately, several good barometers were observed sufficiently near this part of the line to give an approximate correction for many days. The importance of attention to this source of error is very great in lines determined by successive differences, and every mode of correction and avoidance of it was employed throughout.

The mode, or whether indeed any mode was employed to obviate errors arising in this manner, is not given by Nicollet and others who have made determinations in the interior; but the results on this line show careful attention to it to be indispensable.

At Napoleon, for the 24th of June, a non-periodic correction of $-.117$ was applied to the mean of the barometric readings, obtained from comparison with full records at Lebanon, Glenwood, and Memphis, Tennessee, and at New Orleans.

A less correction was applied at Little Rock; at Fort Smith the correction $-.027$ was applied to the mean of all the readings, and beyond this the corrections given below:

July 28th.....	— .030
July 29th.....	— .050

July 30th.....	— .080
July 31st.....	— .070
August 1st.....	— .030
August 3d.....	+ .080
August 4th.....	+ .080
August 5th.....	+ .040
August 7th.....	+ .020
August 8th.....	+ .060
August 9th.....	+ .050

Further correction in this manner was impossible; but the more important points were determined from observations carried through two or more days, and such points were made bases for reference of minor camps and intermediate stations.

The line was carried forward by reference of camp No. 2 to the sea-level, assuming 30.050 inches as the mean pressure at the Gulf with the barometer corrected to 32° , and the air temperature at 64° , and by subsequent reference of the principal camps to each other, correcting the differences to the station having the greatest number of observations, and correcting intermediate lines determined by minor camps and single stations, proportionally, for the error of their terminus.

At Albuquerque, a reference of the mean of its numerous observations was again made to sea-level, and the elevations eastward to Laguna Colorado were determined by differences from this point. The error resulting from non-periodic variation is mainly avoided in this manner, and the lines from these different bases agree very nearly at their terminus.

Beyond Albuquerque, the elevations are determined by mutual and cross reference of principal camps to each other, to Leroux's spring, camp No. 91. At the mouth of Rio Santa Maria (Bill Williams fork) a new base was determined, with which the elevations eastward were compared as far as camp No. 91, correcting the principal camps by direct reference to the sea. The same elements were taken for sea-level as before, viz: 30.050 inches as barometric height at 32° , and the air temperature at 64° . This check, by direct reference to the sea, gives but slight corrections on the determinations by consecutive comparisons from the Colorado, and the lines agree very nearly at their terminus at camp No. 91. The differences for single stations and minor camps are, however, sometimes considerable. These are corrected by taking departures from each principal camp, and correcting the elevations proportionally from their point of meeting midway.

West of the Colorado, the line is carried forward by differences from the mean of the three first camps at the point of departure, otherwise as before, and its terminus at the Pacific is without important error.

Through the entire line it has been sought to harmonize the results, as a survey of consecutive differences, with those obtained by new points of reference to the sea-level, and by reference of distant camps to the initial point, and to one another. To reconcile these absolutely on a line of such extent, and nearly across the continent, could not be anticipated, as there are sources of great error in non-periodic variations of pressure, and in the variable value of observations at the several camps and stations. Every check possible to be applied to the results.

has been applied, and the principal points are believed to be very near to accuracy.

All the constants of correction have been fully applied. A variable error from variation of pressure among the months would give a slight reduction of the elevations at Albuquerque and eastward to the sources of the Canadian. West of Albuquerque it would slightly add to the elevations.

CLIMATOLOGY.

The accompanying chart is prepared to give a comparison of the distribution of rain over the portion of the continent traversed by this line of survey. It is copied from a general chart of mean annual fall of rain for all parts of the continent as determined from the entire amount of American observation of this character. Most of the amounts are from positive measurements. Those for the interior, in positions not occupied by military posts at which observations have been made, are estimated from the climatological descriptions of chiefs of surveys and reconnaissances, and from general climatological laws.

Thus a more abundant fall of rain in the tract bordering the Canadian than either north or south of it, is inferred from the less elevation of the mountains westward and southwestward. Rains are not wholly arrested by these mountains as by the greater elevations northward, and at the south the border of the region of summer rains is not far off. The Estacado of Texas, the Rio Grande valley, and the Plains of the Gila, are in *desert latitudes*, or between the tropical and temperate climates. Few measurements have been taken of amount of rain on the Canadian, but the comparative abundance of rain in this belt is fully shown in the narratives of the survey.

West of the Rio Grande, the Zuñi plateaux and the adjacent mountains and districts are known to be comparatively well watered. The still more elevated mountains at the sources of the Rio Grande arrest an immense precipitation, and the extension westward of this profusion of rains at certain seasons, at least, is farthest at the 35th parallel, and on the San Francisco mountains and the adjacent plateaux. The Sierra Madre and coast ranges of mountains have also an abundant precipitation, though mainly confined to certain seasons, and not equally distributed through the year.

Generally, the districts near the 35th parallel on the western part of this continent are at the southern border of the regions of equally distributed rains. Those bordering the 30th parallel are the most extremely arid—the normal desert climates, though locally relieved in many cases. Southward, or at the 25th parallel, the summer rainy season and the alternations of tropical climates are fully instituted.

The temperature distribution of this portion of the continent is unimportant, except that its elevation moderates its extreme heats and gives it a general resemblance to that of the 40th parallel in the Eastern United States. The valley of the Colorado of California is an exception, however, having very high temperatures, but a very dry, elastic atmosphere. The cool and invigorating climates of the immediate coast of the Pacific are also a striking and valuable feature of this general climatology.

APPENDIX B.

Table containing the distances, altitudes, and astronomical positions of each camp from Fort Smith to the Pacific ocean.

Camp.	Name of station.	Viameter distance from		Altitude above the sea.	Latitude.	Longitude west from Greenwich.		Remarks.
		Preceding station.	Fort Smith.			In time.	In arc.	
No.		Miles.	Miles.	Feet.	° ' "	h. m. s.	° ' "	
0	Fort Smith, (Camp Wilson)....	-----	-----	460.3	35 22 55.44	6 17 56.00	94 29 00.00	Junction of the Puerto with Arkansas river.
1	Ring's Prairie.....	10.00	10.00	564.7	35 16 23.82	6 18 19.01	94 34 45.15	Wells of water.
2	Choctaw Agency.....	5.00	15.00	558.5	35 15 01.43	6 18 34.11	94 38 31.65	Permanent springs.
3	.....	8.82	23.82	336.3	35 12 45.00	6 19 10.76	94 47 41.40	Water in pools.
4	.....	4.94	28.76	432.4	35 12 42.91	6 19 32.13	94 53 01.90	Do.
5	.....	8.60	37.36	677.9	-----	-----	-----	Do.
6	.....	2.74	40.14	595.9	35 09 41.80	6 20 19.97	95 04 59.50	Do.
7	Sans Bois Creek.....	9.83	49.97	595.9	35 07 23.12	6 20 59.44	95 14 51.60	Permanent running water.
8	do.....	7.50	57.47	643.8	35 05 25.70	6 21 23.32	95 22 04.80	Do.
9	do.....	8.75	66.22	698.2	35 06 50.30	6 21 59.77	95 29 56.50	Do.
10	.....	17.50	83.72	650.4	35 01 32.82	-----	-----	Permanent springs.
11	Near Gaines's Creek.....	2.75	86.47	688.9	35 01 19.20	6 23 13.47	95 48 22.50	Permanent running water.
12	Near mouth of Coal Creek.....	13.50	99.97	625.8	-----	-----	-----	Do.
13	Do.....do.....	5.25	105.25	614.3	35 00 00.00	6 24 18.91	96 04 43.60	Do.
14	Head of Coal Creek.....	10.25	115.50	720.1	34 55 50.20	6 24 49.91	96 12 28.60	Do.
15	Near Shawnee villages.....	10.00	125.50	752.5	34 56 10.64	6 25 23.18	96 22 02.70	Do.
16	Near Shawnee Town.....	8.50	134.00	771.3	34 55 48.40	6 26 02.90	96 30 43.50	Do.
17	Branch of Boggy Creek.....	11.60	144.60	765.5	34 50 02.92	6 26 29.88	96 37 28.20	Water in pools.
18	Boggy Creek.....	13.00	157.60	889.9	34 45 41.00	6 27 17.66	96 49 24.90	Permanent running water.
19	Branch of Topofki Creek.....	14.50	172.10	1072.2	34 44 27.80	6 27 50.48	96 57 37.20	Do.
20	Topofki Creek.....	12.25	184.35	1172.4	34 45 59.00	6 28 11.66	97 07 54.90	Do.
21	Beaver's Town.....	14.00	198.35	1211.2	34 53 20.20	6 29 09.21	97 17 18.15	Permanent water
22	Branch of Canadian river.....	18.00	216.35	1338.2	34 46 15.90	-----	-----	Do.
23	Road from Chouteau's.....	10.50	226.85	1294.7	35 00 12.30	6 30 48.63	97 42 09.45	Permanent running water.

APPENDIX B—Continued.

Camp.	Name of station.	Viameter distance from		Altitude above the sea.	Latitude.	Longitude west from Greenwich.		Remarks.
		Preceding station.	Fort Smith.			In time.	In arc.	
No.		Miles.	Miles.	Feet.	° ' "	h. m. s.	° ' "	
24	Walnut Creek.....	6.00	232.85	1130.6	-----	-----	-----	Permanent running water.
25	Branch of Walnut Creek.....	11.95	244.80	1431.5	35 05 51.50	6 31 33.83	97 53 27.45	Do.
26	Branch Creek.....	16.00	266.80	1436.5	-----	-----	-----	Do.
27	Near Deer Creek.....	15.00	275.80	1331.3	35 19 53.80	-----	-----	Do.
28	do.....	13.00	288.80	1668.0	35 26 10.10	6 33 46.80	98 26 42.00	Do.
29	do.....	19.50	308.30	1728.5	35 28 05.90	6 35 04.20	98 46 03.00	Water hole.
30	Gypsum Creek.....	15.50	323.80	1832.8	35 31 40.80	6 36 04.00	99 01 00.00	Permanent running water.
31	Washita river.....	11.50	335.30	1750.7	35 32 21.40	6 36 58.70	99 14 40.50	Do.
32	Comet Creek.....	15.25	350.55	1950.6	35 37 50.60	6 37 33.90	99 23 28.50	Do.
33	Washita river.....	14.50	365.05	1893.0	35 42 32.60	6 38 24.70	99 36 10.50	Do.
34	Near Canadian river.....	20.00	385.05	2343.2	35 48 14.00	6 39 16.70	99 49 10.50	Do.
35	First camp on Canadian river...	12.25	397.30	2392.5	35 53 14.10	6 39 58.70	99 59 40.50	Do.
36	On Canadian river.....	19.00	416.30	2302.7	35 50 47.50	6 41 11.54	100 17 53.10	Do.
37	do.....	15.50	431.80	2391.1	35 53 07.60	6 42 03.44	100 30 51.60	Do.
38	do.....	17.50	449.30	2500.6	35 58 10.50	6 43 13.32	100 48 19.80	Do.
39	do.....	11.75	461.05	2524.2	35 57 48.90	-----	-----	Do.
40	do.....	14.50	475.55	2676.6	35 54 32.40	-----	-----	Do.
41	Last camp on Canadian river...	19.25	494.80	2865.3	35 45 48.40	6 45 56.12	101 29 01.80	Do.
42	Antelope Creek.....	18.37	513.17	3396.5	35 37 12.70	6 46 46.32	101 41 34.80	Water in holes.
43	Arroyo Bonito.....	19.88	533.05	3528.8	35 25 43.80	6 47 30.02	101 52 30.30	Permanent running water.
44	Beautiful View Creek.....	20.75	553.80	3718.6	35 21 58.40	6 48 34.92	102 08 43.88	Water in holes.
45	Arroyo Amarillo.....	19.75	573.55	4128.0	35 19 50.90	6 49 45.32	102 26 19.80	Permanent spring.
	Llano Estacado.....							
46	Rocky Dell Creek.....	27.50	606.05	4207.0	35 17 18.70	6 51 33.62	102 53 24.30	Permanent running water
47	Near Halt Creek.....	23.50	624.55	3980.5	35 06 15.80	6 52 39.33	103 09 50.00	Water in holes.
48	Tecumcari Creek.....	22.25	646.80	4093.3	-----	-----	-----	Do.
49	Branch of Fossil Creek.....	20.00	666.80	4191.8	35 01 16.10	6 55 29.93	103 52 29.00	Permanent running water.

50	Laguna Colorado.....	19.00	685.80	4541.6	35 03 02.60	6 56 47.63	104 11 54.45	Permanent water hole.
51	Pajarito Creek.....	16.00	701.80	4701.8	35 01 41.30	6 58 05.73	104 31 26.00	Permanent running water.
52	Hurrah Creek.....	13.75	715.55	5034.3	35 05 23.70	6 58 53.82	104 43 27.30	Permanent springs.
53	Sheep Springs.....	23.00	738.55	5425.7				Do.
54	Anton Chico.....	6.25	744.80	5414.3	35 11 10.50	7 00 39.02	105 09 45.30	Permanent running water.
55	Cañon Blanco.....	22.75	767.55	6503.3	35 12 24.30			Water in holes.
56	Lagunas.....	16.75	784.30	6995.5				Permanent water in holes.
57	.....	17.25	801.55	6471.9	34 56 23.80			Water in holes.
58	San Antonio.....	22.50	824.05	6624.1				Permanent running water.
59	Albuquerque.....	18.75	842.80	5032.8	35 05 50.80	7 06 31.47	106 37 52.12	Do.
60	Atrisco.....	0.88	843.68					Do.
61	Isleta.....	12.16	855.84	4945.1	34 54 27.06			Do.
62	Rio Puerco.....	22.78	878.62	5372.0	34 55 33.83			Water in holes.
63	Rio Rita.....	18.30	896.92	5675.7	35 01 01.91			Permanent running water.
64	Covera.....	13.77	910.69	6280.4	35 05 22.10			Do.
65	Hay Camp.....	14.66	925.34	6440.4	35 04 59.69	7 10 03.15	107 30 47.25	Do.
66	Sierra Madre.....	17.71	943.05	7330.9	34 57 17.55	7 10 50.77	107 42 41.55	No water.
67	Agua Frio.....	8.06	951.11	7946.6	35 01 35.56	7 11 14.30	107 48 34.50	Permanent running water.
68	Inscription Rock (El Moro).....	17.49	968.60	7413.9	35 02 40.86	7 12 19.93	108 04 58.95	Permanent springs.
69	Ojo del Pescado.....	14.23	982.83	6774.5	35 07 04.49	7 13 16.44	108 19 06.60	Do.
70	Zuñi.....	11.74	994.57	6354.9	35 05 41.88	7 13 58.64	108 29 39.60	Permanent running water.
71	Arch Spring.....	8.83	1003.40	6485.4				Permanent spring.
72	.....	10.77	1014.17	6329.7	35 01 13.23	7 15 02.60	108 45 39.00	No water.
73	Jacob's Well.....	19.69	1033.86	6064.7	35 03 53.49	7 16 25.86	109 06 27.90	Permanent water hole.
74	Navajo Spring.....	7.04	1040.89	5665.7	35 06 19.44	7 16 52.80	109 13 12.00	Permanent springs.
75	Willow Creek (Rio de la Jara).....	12.13	1053.02	5557.6	35 06 32.35	7 17 43.80	109 25 57.00	Water in holes.
76	Rio Puerco of the West.....	10.87	1063.89	5537.6	35 02 07.83	7 18 21.80	109 35 27.00	Do.
77	Lithodendron Creek.....	11.59	1075.48	5212.5	34 57 56.58	7 19 09.80	109 47 27.00	Permanent running water.
78	First camp on Colorado Chiquito.....	11.99	1087.47	5014.1	34 53 01.95	7 19 59.80	109 59 57.00	Do.
79	On Colorado Chiquito.....	14.42	1101.89	4775.5	34 58 53.15	7 20 56.80	110 14 12.00	Do.
80	do.....	8.63	1110.52	4747.5	34 59 39.19	7 21 36.80	110 24 12.00	Do.
81	do.....	4.94	1115.46	4934.6	35 01 21.03	7 21 58.80	110 29 42.00	Do.
82	do.....	1.35	1116.81	5225.3	35 02 55.50	7 22 01.90	110 30 28.50	Do.
83	do.....	4.90	1121.71	4981.9	35 05 18.26	7 22 05.33	110 31 19.45	Do.
84	do.....	10.99	1132.70	4836.2	35 12 02.77	7 22 23.96	110 35 59.00	Do.
85	do.....	15.88	1148.58	4775.3	35 18 11.74	7 23 12.76	110 48 11.40	Do.
86	do.....	4.44	1153.02	4875.3				Do.
87	Last camp on Colorado Chiquito.....	1.51	1154.53	4928.6	35 18 43.78	7 23 19.77	110 49 56.55	Do.
88	.....	11.11	1165.64	5518.1				No water.

APPENDIX B—Continued.

Camp.	Name of station.	Viameter distance from		Altitude above the sea.	Latitude.	Longitude west from Greenwich.		Remarks.
		Preceding station.	Fort Smith.			In time.	In arc.	
No. 89	Cohnino Caves.....	<i>Miles.</i> 14.61	<i>Miles.</i> 1180.25	<i>Feet.</i> 6298.2	° ' "	<i>h. m. s.</i> 7 25 09.74	° ' "	Permanent water hole. No water; water 4 miles from camp.
90	Near San Francisco Spring.....	11.81	1192.06	6859.5	35 15 02.87	111 17 26.10		
91	Leroux's Spring.....	10.46	1202.52	7450.6	35 16 48.77	7 26 27.57	111 36 53.55	Permanent spring.
92	.....	8.23	1210.75	7336.7	.....	.....	.....	No water.
93	.....	6.17	1216.92	7216.9	35 26 20.50(?)	.....	.....	Do.
94	New Year's Spring.....	8.54	1225.47	6767.7	35 17 28.08	7 28 01.10	112 00 16.50	Permanent spring.
95	Lava Creek.....	9.77	1235.23	6246.0	.....	.....	.....	Water in hole.
96	Cedar Creek.....	9.89	1245.12	5753.6	.....	7 28 54.00	112 13 30.00	Do.
97	Partridge Creek.....	13.26	1258.38	5189.2	35 18 11.33	7 29 42.86	112 25 42.90	Do.
98	do.....	3.89	1262.27	5182.5	.....	7 29 59.24	112 29 48.60	Do.
99	do.....	13.52	1275.79	5056.6	35 09 13.62	7 30 56.14	112 44 02.10	Do.
100	Picacho Springs.....	0.87	1276.66	4867.8	35 08 46.96(?)	.....	.....	Do.
101	.....	7.45	1284.11	5241.3	.....	.....	.....	No water.
102	Turkey Creek.....	8.69	1292.79	5548.6	34 59 12.00	7 30 54.25	112 43 33.75	Permanent running water.
103	Pueblo Creek.....	5.71	1298.50	5107.7	34 56 31.00	7 31 00.52	112 45 07.80	Do.
104	do.....	6.67	1305.17	5661.2	34 55 41.70	7 31 16.54	112 49 08.10	Permanent water in holes.
105	do.....	5.98	1311.15	5750.1	34 59 25.55	.....	.....	Do.
106	Cañon Creek.....	5.80	1316.94	5293.4	35 02 19.66	7 32 07.99	113 01 59.85	Do.
107	do.....	12.16	1329.10	4640.9	35 05 58.90	.....	.....	Do.
108	do.....	0.30	1329.40	4680.1	35 06 34.30	.....	.....	Water in holes.
109	do.....	11.29	1340.69	4711.0	35 12 26.50	7 33 13.94	113 18 29.10	Do.
110	Cactus Pass.....	9.64	1350.33	5182.0	35 13 22.50	7 33 49.07	113 27 16.05	Permanent running water.
111	White Cliff Creek.....	7.97	1358.30	3511.6	35 08 07.70	7 34 01.40	113 30 21.00	Do.
112	Big Horn Springs.....	11.60	1369.90	2760.9	35 00 51.53	7 34 30.97	113 37 44.55	Permanent spring.
113	Mouth of Cañon Creek.....	12.83	1382.73	2116.3	34 43 45.42	7 34 25.69	113 36 25.35	Permanent running water.
114	Big Sandy Creek.....	9.21	1391.94	1845.4	.....	.....	.....	Do.

115	do.....	4.35	1396.29	1722.6		7 34 15.20	113 33 48.00
116	do.....	6.21	1402.49	1563.3	34 38 19.39	7 34 14.04	113 33 36.00
117	do.....	4.08	1406.56	1501.6	34 32 29.60	7 34 01.11	113 30 16.65
118	do.....	6.10	1412.66	1433.1			
119	do.....	5.56	1418.22	1343.4			
120	Mouth of Big Sandy Creek.....	6.44	1424.66	1218.2			
121	First Camp on Rio Santa Maria.....	6.52	1431.18	948.0	34 16 51.10	7 34 09.99	113 32 29.85
122	On Rio Santa Maria.....	8.97	1440.15	851.0	34 12 32.40	7 34 43.69	113 40 55.35
123	do.....	6.83	1446.98	881.0			
124	do.....	7.22	1454.20	674.2			
125	do.....	3.90	1458.10	414.1	34 15 11.50	7 35 42.88	113 55 35.70
126	Last camp on Rio Santa Maria.....	8.69	1466.79	325.2	34 17 19.05	7 36 06.12	114 01 31.80
	Mouth of.....do.....do.....	4.33	1471.12		34 17 46.58	7 36 21.99	114 05 29.85
127	First camp on Colorado river.....	4.74	1475.86	272.0	34 21 43.10	7 36 29.75	114 07 26.25
128	On Colorado river.....	5.02	1480.88	224.7	34 23 10.10	7 36 48.50	114 12 07.50
129	do.....	9.06	1484.94	270.0			
130	do.....	11.39	1501.32	370.0	34 36 19.20	7 37 25.70	114 21 25.50
131	do.....	29.87	1531.19	250.2	34 44 30.00	7 37 37.75	114 24 26.25
132	Mojave villages.....	1.02	1532.21	326.1	34 45 53.60	7 37 33.49	114 23 26.35
133	Crossing of Colorado river.....	9.46	1541.66	368.5	34 50 23.20	7 38 00.34	114 30 05.10
134	On Colorado river.....	0.33	1541.99	415.7			
135	Last camp on Colorado river.....	2.78	1544.77	350.4	34 52 15.60		
136	.....	20.71	1565.48	2109.3	35 01 21.30	7 39 07.61	114 46 54.15
137	Pai-ute Creek.....	9.06	1574.55	2745.8	35 06 26.10	7 39 37.72	114 54 25.80
138	.....	13.38	1587.93	4377.4			
139	Rock Spring.....	6.66	1594.59	4938.8			
140	Near Marl Spring.....	17.65	1613.23	3959.9	35 11 08.00	7 42 09.58	115 32 23.70
141	.....	16.41	1628.64	2220.1			
142	Soda Lake.....	13.34	1641.98	1116.8	35 03 13.20	7 43 58.00	115 59 30.00
143	On Mojave river.....	12.31	1654.29	1239.3	35 00 34.05	7 44 46.30	116 11 34.50
144	do.....	12.94	1667.22	1700.9			
145	do.....	11.18	1678.40	1980.6	34 55 32.10	7 46 20.17	116 35 02.55
146	do.....	19.48	1797.38	2225.7	34 53 15.50	7 47 37.52	116 54 22.80
147	.....	22.37	1720.25	2555.4	34 45 55.40	7 48 58.63	117 14 39.45
148	Cajon Pass.....	24.47	1744.72	3539.7	34 27 15.30	7 49 25.45	117 27 21.75
149	.....	19.43	1764.15	2623.4			

Permanent running water; permanent spring 10 miles from camp 135.

No water.

Permanent running water.

No water.

Permanent springs.

No water; water 1 mile from camp 140.

No water.

Water obtained by digging.

Permanent running water.

Do.

Do.

Do.

No water.

Permanent running water.

Do.

APPENDIX B—Continued,

Camp.	Name of station.	Viameter distance from		Altitude above the sea.	Latitude.	Longitude west from Greenwich.		Remarks.
		Preceding station.	Fort Smith.			In time.	In arc.	
		<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	° ' "	<i>h. m. s.</i>	° ' "	
No. 150	Coco Mongo Creek.....	19.72	1783.87	1307.9	34 06 27.40	7 50 20.07	117 35 01.05	Permanent running water.
151	San Gabriel Creek	24.16	1808.03	354.5	-----	-----	-----	Do.
152	Los Angeles.....	14.26	1822.27	457.1	34 03 14.70	7 52 48.20	118 12 03.00	Do.
153	San Pedro	23.00	1845.27	-----	33 43 19.59	7 53 04.20	118 16 03.00	Do.

J. C. IVES, *Brevet Second Lieut. Topographical Engineers.*

APPENDIX C.

Table of heights and distances from Fort Smith to San Pedro, California.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	Miles.	Miles.	Feet.	Feet.
Memphis				96.00
Napoleon			-4.40	81.60
Little Rock			+228.80	310.40
Fort Smith			+149.90	460.30
Camp Wilson	0.25	0.25	+3.80	474.10
Camp 1	10.00	10.25	+90.60	564.70
Camp 2	5.00	15.25	-6.20	558.50
Camp 3	8.10	23.35	-222.20	336.30
Camp 4	4.94	28.29	+96.10	432.40
Station 6	2.74	31.03	+102.10	534.50
Four miles from Camp 4	1.26	32.29	+89.70	624.20
Camp 5	4.00	36.29	+53.70	677.90
Station 8	Not used.	Not used.	-3.50	674.40
Station 17	Not used.	Not used.	-33.60	640.80
Camp 6	2.70	38.99	-44.90	595.90
Station 6	1.00	39.99	-26.10	569.80
Station 34	4.33	44.32	+2.20	572.00
Camp 7	4.50	48.82	+23.90	595.90
Station 5	0.25	49.07	+27.30	623.20
Station 49	3.00	52.07	+104.30	727.50
Station 67	2.50	54.57	-91.70	635.80
Camp 8	1.75	56.32	+13.00	648.8
Station 6	0.50	56.82	+2.00	650.8
Station 42	6.50	63.32	+26.20	677.0
Camp 9	1.75	65.07	+21.20	698.2
Station 45	3.00	68.07	+20.40	718.6
Station 77	4.25	72.32	+39.10	757.7
Station 85	6.50	78.82	+55.80	813.5
Camp 10	3.75	82.57	-163.10	650.4
Station 31	2.75	85.32	+14.60	664.0
Camp 11	0.00	85.32	+24.90	688.9
Station 4	0.15	85.47	-22.60	666.40
Station 14	3.00	88.47	+49.80	716.20
Station 67	5.50	93.97	+68.40	784.60
Camp 12	5.00	98.97	-158.80	625.80
Station 10	0.50	99.47	+58.10	683.90
Station 25	3.75	103.22	+25.10	709.00
Camp 13	1.00	104.22	-84.70	614.30
Station 37	2.12	106.34	+71.20	685.50
Station 78	6.50	112.84	+22.30	707.80
Camp 14	1.53	114.37	+12.30	720.10
Station 89	7.75	122.12	+120.60	840.70
Camp 15	2.25	124.37	-88.20	752.50
Station 20	5.25	129.62	+16.50	769.00
Station 37	2.25	131.87	-1.00	768.00
Station 50	0.50	132.37	+92.70	860.70
Camp 16	0.50	132.87	-89.40	771.30
Station 5	2.00	134.87	+62.80	834.10
Station 31	5.10	139.97	-95.30	738.80
Station 59	4.50	144.47	+88.40	827.20
Camp 17	(Same.)	144.47	-61.70	765.50
Station 14	2.25	147.72	+55.30	820.80

APPENDIX C—Continued.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Station 34.....	7.00	154.72	+74.10	894.90
Station 43.....	3.75	158.47	+14.30	909.20
Camp 18.....	0.00	158.47	-20.30	889.90
Station 0.....	10.00	168.47	-9.80	899.70
Station 11.....	3.00	171.47	+319.00	1218.70
Camp 19.....	1. $\frac{1}{2}$	172.97	-146.50	1072.20
Station 10.....	3.75	176.72	+3.10	1075.30
Station 33.....	3.25	179.97	+43.00	1118.30
Station 49.....	2.25	182.22	+48.30	1166.60
Camp 20.....	3.00	185.22	+5.80	1172.40
Station 4.....	4.00	189.22	+81.60	1253.00
Station 17.....	6.00	195.22	+26.50	1279.50
Camp 21.....	4.00	199.22	-68.30	1211.20
Station 10.....	5.00	204.22	+89.20	1300.40
Station 23.....	6.50	210.72	-24.30	1276.10
Camp 22.....	6.50	217.22	+62.10	1338.20
Camp 23.....	10.50	227.72	-43.50	1294.70
Station 7.....	0.50	228.22	-78.50	1216.20
Station 10.....	1.00	229.22	+72.20	1288.40
Station 19.....	4.00	233.22	-90.80	1197.60
Camp 24.....	0.50	233.72	-67.00	1130.60
Station 2 + 500 feet.....	1.25	234.97	+96.40	1227.00
Station 13.....	3.20	238.17	+39.30	1266.30
Station 30.....	5.00	243.17	+199.60	1465.90
Camp 25.....	2.50	245.67	-34.40	1431.50
Between 17 and 18.....	4.00	249.67	+87.70	1529.20
Station 22.....	2.00	251.67	+03.10	1532.30
Station 35.....	7.50	259.17	+95.10	1627.40
Camp 26.....	2.50	261.67	-190.90	1436.50
Station 4.....	3.00	264.67	+4.50	1441.00
Station 18.....	6.50	271.17	+97.60	1538.60
Station 22.....	2.50	273.67	+31.10	1569.70
Camp 27.....	3.00	276.67	-238.40	1331.30
Station 9.....	5.50	282.17	+71.00	1402.30
Station 15.....	2.50	284.67	+181.10	1583.40
Camp 28.....	5.00	289.67	+74.60	1668.00
Station 7.....	4.00	293.67	+119.20	1787.20
Station 10.....	5.50	299.17	+093.00	1880.20
Between 18 and 19.....	6.00	305.17	-14.90	1865.30
Camp 29.....	4.00	309.17	-136.80	1728.50
Station 2.....	0.50	309.67	+59.94	1788.40
Between stations 7 and 8.....	7.50	317.17	+65.70	1854.10
Station 15.....	6.50	323.67	+10.00	1864.10
Camp 30.....	1.00	324.67	-31.30	1832.80
Between 4 and 3.....	0.50	325.17	+38.20	1871.00
Station 11.....	7.00	332.17	-27.70	1843.30
Camp 31.....	2.50	334.67	-93.60	1750.70
Station 3.....	1.50	336.17	+84.80	1835.50
Station 9.....	5.75	341.92	+92.20	1927.70
Station 15.....	6.50	348.42	+90.40	2028.10
Camp 32.....	1.50	349.92	-77.50	1950.60
Station 8.....	4.50	354.42	+39.80	1990.40
Station 16.....	6.50	360.92	-37.10	1953.30
Station 19.....	3.00	363.92	-12.00	1941.30

APPENDIX C—Continued.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Camp 33.....	0.50	364.42	-48.70	1893.00
Station 3 + 1 mile.....	2.25	366.67	+217.30	2110.30
Station 14.....	5.75	372.42	+0.20	2110.50
Station 23.....	7.00	379.42	+246.20	2356.70
Camp 34.....	5.00	384.42	-13.50	2343.20
Station 5.....	2.50	386.92	+91.50	2251.70
Station 11 + 1 mile.....	5.00	391.92	-3.00	2248.70
Camp 35.....	4.75	396.67	+143.80	2392.50
Station 1.....	0.75	397.42	-134.80	2257.70
Station 5 + 1 mile.....	5.00	402.42	+273.90	2531.60
Station 21.....	7.25	409.67	-189.60	2342.00
Camp 36.....	3.50	413.17	-39.30	2302.70
Between 3 and 4.....	3.50	416.67	-30.60	2271.90
Station 11.....	4.50	421.17	+161.20	2433.10
Station 23.....	5.25	426.42	+31.70	2464.80
Camp 37.....	2.25	428.67	-73.70	2391.10
Station 4.....	1.75	430.42	+88.70	2479.80
Station 16.....	7.00	437.42	-28.80	2451.00
Station 30.....	6.25	443.67	-12.90	2438.10
Camp 38.....	2.50	446.17	+62.50	2500.60
Station 4.....	1.75	447.92	-15.90	2484.70
Station 6 + $\frac{1}{2}$ mile.....	1.50	449.42	+25.90	2510.60
Camp 39.....	8.50	457.92	+13.70	2524.20
Between 3 and 4.....	0.25	458.17	-14.20	2510.00
Station 13.....	4.50	462.67	+158.60	2668.60
Station 28.....	7.00	469.67	-50.60	2618.00
Camp 40.....	2.75	472.42	+58.60	2676.60
Station 3.....	2.75	475.17	-68.50	2608.10
Station 12.....	6.33	481.50	+122.00	2730.10
Station 28.....	6.50	488.00	+44.80	2774.90
Camp 41.....	3.83	491.83	+90.40	2865.30
		Not used.	-32.00	*2833.30
Station 10.....	7.50	499.33	+46.80	2880.10
Station 19 + $\frac{1}{4}$ mile.....	4.87	504.20	-93.00	2787.10
Camp 42.....	6.00	510.20	+609.40	3396.50
Between 10 and 11.....	12.50	522.70	-28.40	3368.10
Station 18.....	7.25	529.95	+30.00	3398.10
Camp 43.....	0.12	530.07	+130.70	3528.80
Station between 3 and 4.....	3.50	533.57	+147.80	3676.60
Station 13.....	6.75	540.32	+138.10	3814.70
Station 22.....	7.25	547.57	+20.10	3834.80
Camp 44.....	3.25	551.82	-116.20	3718.60
Between 7 and 8.....	5.50	557.32	+193.40	3911.00
Between 14 and 15.....	7.00	564.32	+109.40	4020.40
Station 20.....	5.75	570.07	+120.00	4140.40
Camp 45.....	1.50	571.57	-18.40	4128.00
Station 12.....	8.75	580.32	+35.90	4163.90
Station 15.....	1.50	581.82	+148.10	4312.00
Station 25.....	14.00	595.82	+97.60	4409.60
Camp 46.....	3.25	599.07	-202.60	4207.00
Station 5.....	6.50	605.57	-73.50	4133.50
Station 14.....	6.50	612.07	+560.40	4693.90

*Not used

APPENDIX C—Continued.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	Miles.	Miles.	Feet.	Feet.
Station 21.....	8.50	620.57	-671.80	4022.10
Camp 47.....	1.50	622.07	-41.60	3980.50
Station 5.....	7.50	629.57	+24.60	4005.10
Station 9.....	7.00	636.57	+52.50	4057.60
Station 16.....	6.50	643.07	+13.30	4070.90
Camp 48.....	1.25	644.32	+22.20	4093.30
Station 2.....	3.00	647.32	+133.90	4226.20
Station 10.....	8.25	655.57	+28.30	4254.50
Station 18.....	8.00	663.57	+21.30	4275.80
Camp 49.....	0.75	664.32	-84.00	4191.80
Station 3 + $\frac{1}{4}$ mile.....	3.25	667.57	+176.80	4367.60
Station 7.....	7.50	675.07	+18.00	4485.60
Station 16.....	8.25	683.32	+31.20	4516.80
Camp 50.....	0.25	683.57	+24.80	4541.60
Station 6.....	4.00	687.57	+255.40	4797.00
Station 16.....	7.00	694.57	+5.80	4802.80
Station 18.....	4.00	698.57	+103.60	4926.40
Camp 51.....	0.75	699.32	-224.60	4701.80
Station 5.....	4.00	703.32	+395.80	5097.60
Station 14.....	8.50	711.82	+34.60	5132.20
Camp 52.....	1.25	713.07	-97.90	5034.30
Station 2.....	1.00	714.07	+98.10	5112.40
Station 8.....	7.00	721.07	+431.40	5543.70
Station 17.....	7.00	728.07	-121.30	5422.40
Camp 53.....	8.00	736.07	+3.30	5425.70
Station 5.....	3.50	739.57	+11.20	5514.50
Camp 54.....	2.75	742.32	-100.20	5414.30
Station 2.....	0.75	743.07	-0.20	5414.10
Station 12.....	6.50	749.57	+604.40	6018.50
Station 24.....	11.00	760.57	+455.00	6473.50
Camp 55.....	4.50	765.07	+29.80	6503.30
Station 4.....	3.50	768.57	+113.80	6617.10
Station 11.....	7.75	776.32	-11.80	6605.30
Camp 56.....	5.50	781.82	+390.20	6995.50
Station 2 + $\frac{1}{2}$ mile.....	8.50	790.32	-356.00	6639.50
Station 4.....	8.25	798.57	-116.30	6523.20
Camp 57.....	0.50	799.07	-51.30	6471.90
Station 0 + $2\frac{1}{2}$ miles.....	2.50	801.57	+151.60	6623.50
Station 7.....	9.75	811.32	+274.10	6897.60
Station 15.....	7.50	818.82	-31.00	6866.60
Camp 58.....	2.75	821.57	-242.50	6624.10
Station 3.....	2.50	824.07	-366.00	6258.10
Station 11.....	7.50	831.57	-522.30	5735.80
Station 17.....	7.50	839.07	-351.80	5184.00
Camp 59*.....	1.25	840.32	-151.20	5032.80
Camp 61.....	11.09	854.41	-87.7	4945.10
Station X + 100 yds.....	3.50	857.91	+172.9	5118.00
Station H.....	5.00	862.91	+452.3	5570.30
Station 3 + $\frac{1}{2}$ mile.....	2.50	865.41	+93.0	5663.30
Camp 62.....	12.00	877.41	-291.3	5372.00
Station 6.....	4.75	882.16	+424.65	5796.65
Between 16 and 17.....	7.25	889.41	-80.95	5715.70

* Camp 59 is at Albuquerque.

APPENDIX C—Continued.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Between 18 and 19.....	4. 75	894. 16	+42. 75	5758. 45
Camp 63.....	2. 33	896. 49	-82. 75	5675. 70
Station between 10 and 11.....	2. 80	899. 29	+279. 20	5954. 90
Station E.....	8. 80	908. 09	+174. 80	6129. 70
Camp 64.....	2. 90	910. 99	+150. 70	6280. 40
Station 3.....	0. 40	911. 39	+69. 50	6349. 90
Between 13 and 14.....	10. 19	921. 58	+79. 10	6429. 00
Camp 65.....	4. 25	925. 83	+11. 40	6440. 40
Station 6.....	3. 50	929. 33	+178. 40	6618. 80
Station H.....	4. 90	934. 23	+64. 90	6683. 70
Station I.....	2. 48	936. 71	+139. 60	6823. 30
Station K.....	1. 50	938. 21	+186. 70	7010. 00
Station L.....	0. 80	939. 01	+30. 20	7040. 20
Station 16.....	3. 00	942. 01	+225. 20	7265. 40
Camp 66.....	0. 60	942. 61	+65. 50	7330. 90
Station 3.....	1. 06	943. 67	+166. 50	7497. 40
Station I.....	6. 60	950. 27	Not used.	Not used.
Station K.....	Not used.	Not used.	Not used.	Not used.
Between 14 and 15.....	Not used.	Not used.	Not used.	Not used.
Camp 67.....	0. 50	950. 77	+449. 20	7946. 60
Station 3.....	1. 60	952. 37	+126. 90	8073. 50
Station K.....	0. 09	952. 46	+93. 50	8167. 00
Station 4.....	0. 20	952. 66	+106. 70	8273. 70
Station 7.....	0. 40	953. 06	-40. 20	8233. 50
Station 16 = M.....	2. 85	955. 91	-248. 20	7985. 30
Station 27.....	8. 01	963. 92	-406. 20	7579. 10
Station P.....	1. 66	965. 58	-190. 00	7389. 10
Camp 68.....	0. 60	966. 18	+975. 20	7413. 90
Station P.....	2. 66	968. 84	-42. 00	7371. 90
Station 6.....	6. 42	975. 26	-70. 50	7301. 40
Camp 69.....	5. 50	980. 76	-726. 90	6774. 50
Station 4.....	7. 50	988. 26	-277. 60	6499. 90
Station C.....	Not used.	Not used.	+105. 80	6605. 70
Camp 70.....	4. 40	992. 66	-250. 80	6354. 90
Station 1.....	0. 40	993. 06	+168. 10	6522. 00
Station N.....	6. 01	999. 07	-110. 30	6411. 70
Camp 71.....	2. 40	1001. 47	+73. 7	6485. 4
			-150. 8	6334. 6
Station M.....	9. 75	1011. 22	0. 0	6334. 6
Camp 72.....	1. 02	1012. 24	-4. 9	6329. 7
Station 2.....	1. 86	1014. 10	+64. 24	6393. 94
Station 8.....	6. 32	1020	+11. 24	6403. 18
Station 12.....	4. 75	1025. 20	+46. 84	6452. 02
Between 16 and 17.....	5. 00	1030. 20	-417. 26	6034. 76
Camp 73.....	1. 21	1031. 41	+29. 94	6064. 70
Station C.....	5. 00	1036. 41	-31. 40	6033. 30
Camp 74.....	2. 50	1038. 91	-367. 60	5665. 70
Station C.....	5. 10	1044. 01	-112. 00	5553. 70
Station 7.....	2. 20	1046. 21	+30. 50	5584. 20
Station K.....	0. 46	1046. 67	+76. 90	5661. 10
Station L.....	2. 10	1048. 77	+10. 30	5671. 40
Station P.....	0. 40	1049. 17	+70. 20	5741. 60
Camp 75.....	1. 60	1050. 77	-184. 00	5557. 60
Station B.....	2. 60	1053. 37	+189. 90	5747. 50

APPENDIX C—Continued.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Station 4.....	1. 10	1054. 47	-97. 90	5649. 60
Station K.....	4. 80	1059. 27	+00. 00	5649. 69
Camp 76.....	2. 30	1061. 57	-112. 00	5537. 60
Station P.....	3. 00	1064. 57	-234. 70	5302. 90
Station 7.....	2. 81	1067. 38	+36. 70	5339. 60
Station Z.....	4. 81	1072. 19	-114. 10	5225. 50
Camp 77.....	1. 25	1073. 44	-13. 00	5212. 50
Station E.....	6. 60	1080. 04	+4. 75	5217. 25
Camp 78.....	5. 30	1085. 34	-203. 10	5014. 10
Station 8.....	8. 40	1093. 74	-98. 70	4915. 40
Station E.....	4. 00	1097. 74	-53. 40	4862. 40
Camp 79.....	2. 30	1100. 04	-86. 50	4775. 50
Station B.....	4. 90	1104. 94	+33. 30	4808. 80
Camp 80.....	4. 03	1108. 97	-61. 3	4747. 50
Station 6.....	4. 40	1113. 37	+25. 3	4772. 80
Camp 81.....	0. 56	1113. 93	+161. 8	4934. 60
Camp 82.....	1. 52	1115. 45	+290. 70	5225. 30
Station 4.....	2. 90	1118. 35	Not used.	Not used.
Camp 83.....	1. 70	1120. 05	-243. 40	4981. 90
Station 2.....	4. 35	1124. 35	-162. 70	4819. 20
Camp 84.....	6. 90	1131. 25	+17. 00	4836. 20
Station C.....	7. 10	1138. 35	+83. 90	4920. 10
Station 7.....	5. 01	1143. 36	-127. 1	4793. 00
Camp 85.....	4. 00	1147. 36	-17. 7	4775. 30
Station A.....	0. 35	1147. 71	Not used.	Not used.
Camp 86.....	4. 10	1151. 81	+100. 00	4875. 30
Camp 87.....	1. 52	1153. 33	+53. 30	4928. 60
Station 2.....	1. 20	1154. 53	+92. 60	5021. 20
Station 4.....	1. 16	1155. 69	+155. 70	5176. 90
Station A.....	0. 75	1156. 44	+41. 60	5218. 5
Station 10.....	3. 90	1160. 34	+181. 6	5400. 10
Station 17.....	1. 96	1162. 30	+104. 6	5504. 70
Camp 88.....	1. 45	1163. 75	+13. 4	5518. 10
Station 7.....	6. 37	1170. 12	+429. 0	5947. 10
Station 9.....	1. 40	1171. 52	-105. 00	5842. 00
Station B.....	1. 75	1173. 27	-50. 90	5791. 20
Station 12.....	1. 50	1174. 77	+315. 20	6106. 40
Camp 89.....	6. 65	1181. 42	+191. 80	6298. 20
Station 1.....	1. 10	1182. 52	+149. 60	6447. 80
Station B.....	1. 16	1183. 68	-79. 9	6367. 90
Station C.....	2. 00	1185. 68	+82. 7	6450. 60
Station D.....	4. 15	1189. 83	+320. 80	6771. 40
Station F.....	1. 30	1191. 13	+181. 70	6953. 10
Camp 90.....	2. 50	1193. 63	-93. 60	6859. 50
Station 9.....	3. 76	1197. 39	+214. 10	7073. 60
Station 13.....	0. 98	1198. 37	+229. 70	7303. 30
Station 18.....	2. 00	1200. 37	-98. 60	7204. 70
Station 22.....	1. 86	1202. 23	-103. 50	7101. 20
Station D.....	1. 10	1203. 33	+212. 70	7313. 90
Camp 91.....	1. 00	1204. 33	+136. 70	7450. 60
Camp 7.....	3. 10	1207. 43	+22. 00	7472. 60
Camp 92.....	5. 20	1212. 63	-135. 9	7336. 70
Station C.....	1. 91	1214. 54	-57. 85	7278. 85
Camp 93.....	4. 40	1218. 94	-61. 95	7216. 90

APPENDIX C—Continued.

Station.	Distance from pre- ceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Station 12.....	4. 90	1223. 84	-26. 75	7190. 15
Camp 94.....	3. 90	1227. 74	-422. 45	6767. 70
Station C.....	2. 90	1230. 64	-96. 00	6671. 70
Camp 95.....	7. 00	1237. 64	-425. 70	6246. 00
Station 6.....	3. 37	1241. 01	+35. 50	6261. 50
Station B.....	3. 10	1244. 11	+135. 00	6396. 50
Station 13.....	2. 16	1246. 27	-482. 20	5914. 30
Camp 96.....	1. 30	1247. 57	-160. 70	5753. 60
Station 14.....	8. 06	1255. 63	-287. 00	5466. 60
Camp 97.....	5. 50	1261. 13	-277. 40	5189. 20
Camp 98.....	3. 90	1265. 03	-6. 70	5182. 50
Station A.....	6. 30	1271. 33	-76. 60	5105. 90
Station 15.....	6. 80	1278. 13	-113. 60	4992. 20
Camp 99.....	0. 72	1278. 85	+64. 30	5056. 60
Camp 100.....	0. 92	1279. 77	-188. 80	4867. 80
Camp 101.....	7. 60	1287. 37	+373. 50	5241. 30
Station 5.....	5. 50	1292. 87	+172. 30	5413. 60
Station 10.....	3. 30	1296. 17	-152. 70	5260. 90
Camp 102.....	1. 00	1297. 17	+287. 70	5548. 60
Station 5.....	1. 20	1298. 37	+32. 30	5580. 90
Camp 103.....	4. 60	1302. 97	-473. 20	5107. 70
Station C.....	2. 50	1305. 47	+182. 95	5290. 65
Station 14.....	3. 30	1308. 77	+343. 75	5634. 40
Station 17.....	0. 70	1309. 47	+37. 25	5671. 65
Camp 104.....	0. 40	1309. 87	-10. 45	5661. 20
Station 6.....	1. 70	1311. 57	+660. 00	6321. 20
Camp 105.....	4. 25	1315. 82	-571. 10	5750. 10
Station D.....	4. 10	1319. 92	-345. 40	5404. 70
Camp 106.....	1. 80	1321. 72	-111. 30	5293. 40
Station 17.....	12. 42	1334. 14	-652. 50	4640. 90
Camp 107.....	0. 00	1334. 14	0. 00	4640. 90
Station 15.....	Not used.	Not used.	Not used.	Not used.
Camp 108.....	0. 56	1334. 70	+39. 20	4680. 10
Station B.....	2. 40	1337. 10	+144. 10	4824. 20
Station F.....	6. 09	1343. 19	-111. 30	4712. 90
Camp 109.....	3. 30	1346. 49	-1. 90	4711. 00
Station 10.....	3. 00	1349. 49	+37. 00	4748. 00
Camp 110.....	6. 87	1356. 36	+434. 00	5182. 00
Station 1.....	0. 51	1356. 87	+114. 60	5296. 60
Station 6.....	3. 70	1360. 57	-397. 60	3899. 00
Camp 111.....	3. 80	1364. 37	-387. 40	3511. 60
Station 1.....	0. 61	1364. 98	-154. 50	3357. 10
Camp 112.....	11. 00	1375. 98	-596. 20	2760. 90
Station A.....	1. 30	1377. 28	+5. 65	2776. 55
Station 5.....	6. 32	1383. 60	-489. 35	2287. 20
Station 11.....	4. 87	1388. 47	-170. 00	2117. 20
Camp 113.....	0. 60	1389. 07	-0. 90	2116. 39
Station A.....	3. 32	1392. 39	-26. 30	2090. 00
Station B.....	2. 65	1395. 04	-135. 90	1954. 10
Camp 114.....	3. 40	1398. 44	-108. 70	1845. 40
Station A.....	0. 75	1399. 19	-48. 80	1796. 60
Camp 115.....	3. 76	1402. 95	-74. 00	1722. 60
Station 1.....	0. 62	1403. 57	0. 00	1722. 60
Station 8.....	4. 90	1408. 47	-57. 60	1664. 00

APPENDIX C—Continued.

Station.	Distance from pre- ceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Fect.</i>	<i>Fect.</i>
Camp 116.....	5. 30	1413. 77	—100. 70	1563. 30
Station A.....	0. 91	1414. 68	—17. 10	1546. 20
Camp 117.....	3. 29	1417. 97	—44. 60	1501. 60
Station A.....	3. 70	1421. 67	+3. 80	1505. 40
Camp 118.....	2. 10	1423. 77	—72. 30	1433. 10
Station A.....	3. 70	1427. 47	—48. 60	1384. 50
Camp 119.....	2. 00	1429. 47	—41. 10	1343. 40
Station A.....	3. 22	1432. 69	—30. 70	1312. 70
Camp 120.....	3. 20	1435. 89	—94. 50	1218. 20
Station A.....	4. 25	1440. 14	—158. 32	1059. 98
Camp 121.....	2. 28	1442. 42	—111. 92	948. 06
Station A.....	4. 61	1447. 03	—79. 72	868. 34
Station 7.....	3. 00	1450. 03	—14. 82	853. 52
Camp 122.....	1. 40	1451. 43	—2. 50	851. 02
Station 2.....	3. 20	1454. 63	+115. 28	966. 39
Camp 123.....	3. 65	1458. 28	—85. 21	881. 09
Station B.....	4. 80	1463. 08	—111. 92	769. 17
Camp 124.....	2. 46	1465. 54	—84. 92	674. 25
Station A.....	2. 90	1468. 44	—201. 02	473. 23
Camp 125.....	1. 10	1469. 54	—59. 12	414. 11
Station A.....	6. 45	1475. 99	—78. 42	335. 69
Camp 126.....	2. 40	1478. 39	—10. 42	325. 27
Station A 1.....	3. 76	1482. 15	—82. 80	242. 47
Station 6.....	2. 53	1484. 68	—14. 80	227. 67
Station A 2.....	1. 52	1486. 20	—19. 50	208. 17
Camp 127.....	2. 46	1488. 66	+63. 83	272. 00
Station 9.....	4. 04	1492. 70	Not used.	Not used.
Camp 128.....	1. 00	1493. 70	—47. 30	224. 70
Station 5.....	3. 66	1497. 36	Not used.	Not used.
Camp 129.....	0. 52	1497. 88	+45. 30	270. 00
Station 7.....	7. 30	1504. 66	Not used.	Not used.
Station 12.....	3. 12	1507. 78	Not used.	Not used.
Camp 130.....	1. 30	1509. 08	+100. 00	370 00
Station 3.....	6. 84	1515. 92	Not used.	Not used.
Station 5.....	6. 30	1522. 22	Not used.	Not used.
Station 8.....	6. 63	1528. 85	—119. 80	250. 20
Camp 131.....	3. 60	1532. 45	+65. 90	326. 10
Camp 132.....	1. 00	1533. 45	0. 00	326. 10
Station A.....	5. 50	1538. 95	Not used.	Not used.
Camp 133.....	4. 27	1543. 22	+42. 40	368. 50
Camp 134.....	0. 33	1543. 55	+47. 20	415. 70
Camp 135.....	2. 70	1546. 25	—65. 30	350. 40
Station B.....	3. 41	1549. 66	+235. 50	585. 00
Station C.....	2. 50	1551. 16	+111. 70	897. 60
Station 4.....	4. 90	1556. 06	+255. 30	1152. 90
Station D.....	5. 98	1562. 04	+400. 00	1552. 90
Camp 136.....	5. 36	1567. 40	+556. 40	2109. 30
Station 2.....	3. 70	1571. 10	+34. 10	2143. 40
Camp 137.....	6. 31	1577. 41	+602. 40	2745. 80
Station B.....	1. 60	1579. 01	+712. 60	3458. 40
Station F.....	4. 80	1583. 81	+237. 90	3696. 30
Station P.....	5. 98	1589. 79	+508. 20	4204. 50
Camp 138.....	1. 00	1590. 79	+172. 90	4377. 40
Station D.....	1. 47	1592. 26	+418. 10	4795. 50
Camp 139.....	2. 28	1594. 54	+143. 30	4938. 80

APPENDIX C—Continued.

Station.	Distance from preceding camp or station.	Distance from Ft. Smith.	Elevation above preceding camp or station.	Elevation above the sea.
	<i>Miles.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>
Station 5.....	3.00	1597.54	+334.00	5272.80
Station 6.....	2.00	1599.54	+19.90	5292.70
Station A.....	7.51	1607.05	-506.80	4785.90
Camp 140.....	5.41	1612.45	-826.00	3959.90
Station D.....	2.60	1614.05	-297.40	3662.50
Station P.....	3.70	1617.75	+310.10	3972.60
Station 9.....	2.60	1619.55	-110.30	3862.30
Station H.....	2.60	1622.15	+44.70	3907.00
Station B.....	4.30	1626.45	-652.10	3244.90
Camp 141.....	1.00	1627.45	-1024.80	2220.10
Station D.....	Not used.	Not used.	-800.80	1419.30
Station A.....	4.40	1631.85	+442.70	1862.00
Camp 142.....	9.10	1640.95	-745.20	1116.80
Station D.....	4.52	1645.47	+000.10	1106.90
Camp 143.....	8.00	1653.47	+132.40	1239.30
Station 0.....	Not used.	Not used.	+189.00	1428.30
Station 6.....	10.00	1663.47	+214.50	1642.80
Station O.....	1.50	1664.97	+6.90	1649.70
Camp 144.....	1.42	1666.39	+51.20	1709.90
Camp 145.....	11.21	1677.60	+279.70	1980.60
Station 1.....	5.10	1682.70	+70.10	2050.70
Station 4.....	6.50	1688.20	+208.40	2259.10
Camp 146.....	7.70	1695.90	-33.40	2225.70
Station 5.....	5.42	1701.32	+64.30	2290.00
Station 8.....	9.30	1710.62	+256.00	2546.00
Camp 147.....	7.80	1718.42	+9.40	2555.40
Station 4.....	6.20	1724.62	+130.80	2686.20
Station 5.....	4.12	1728.74	+47.40	2733.60
Camp 148.....	15.20	1743.94	+806.10	3539.70
Station 2.....	4.38	1748.32	+354.50	3894.20
Station 4.....	4.42	1752.74	+795.00	4689.20
Station D.....	1.01	1753.75	+820.10	3879.10
Station 5.....	2.00	1755.75	-249.40	3529.70
Station 6.....	3.36	1759.11	-507.70	3022.00
Camp 149.....	4.20	1763.31	-398.60	2623.40
Station 1.....	5.30	1768.61	-446.40	2177.00
Station 2.....	3.12	1771.73	-46.40	2130.60
Station F.....	7.22	1778.95	-633.20	1497.40
Camp 150.....	4.04	1782.99	-188.50	1307.90
Station D.....	7.51	1790.50	-139.80	1168.10
Station 9.....	6.22	1796.72	-218.10	950.00
Station P.....	2.14	1798.86	-260.00	690.00
Station H.....	6.20	1805.06	-277.40	412.69
Camp 151.....	2.50	1807.56	-58.10	354.50
Station D.....	6.61	1813.17	+52.30	406.80
Station H.....	6.10	1819.27	+24.50	431.30
Camp 152.....	3.00	1822.27	25.80	457.10
San Pedro.....	23.00	1845.27	-457.10	0.00

By N. HENRY HUTTON,
Assist. Eng. and Surveyor P. R. Survey, near 35th parallel.

APPENDIX D.

Meteorological Observations—Topographical Division.

NOTE TO THE BAROMETRIC OBSERVATIONS.

All barometric observations employed in determining elevations, and in construction of the profile, are given in the following table, as originally read and as finally corrected. The corrections applied are, first, that to reduce the reading of the column to the height at 32°; that for horary variation of pressure; the constant correction, or zero error, of the instrument; and a correction, for a part of the route, for non-periodic variation of pressure.

The first correction is from the usual table constructed for barometers with brass scales. That for horary variation of pressure is given in connexion with the hourly observations from which it is deduced, in another part of the report; where also the zero errors of the instruments are given, and the non-periodic variations applied.

By reference to the several corrections, and to the temperature observations given in connexion with the barometric readings, a re-examination of any part of the work may be made.

METEOROLOGICAL OBSERVATIONS.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.*	
Napoleon, Arkansas...	June 24	11 a. m...	781	30.296	77	Attached thermometer employed for determining air temperatures.	30.000		
			785	.278	76.6		.003		
			790	.250	77		.004		
			783	.283	77.1		29.994		
			784	.289	78		.997		
Little Rock, Arkansas.	June 27	8 $\frac{1}{2}$ a. m...	781	29.984	79.2		.804		29.735
			783	.966	78.8		.793		29.733
			785	.957	79		.796		29.735
			784	.964	79.3		.791		29.738
			790	.923	79.3		.798		29.743
		12 $\frac{1}{2}$ p. m...	781	.966	86.9		.768		
			783	.957	86.9		.766		
			785	.942	87		.763		
			784	.953	87		.762		
			790	.910	87.1		.762		
		6 p. m....	781	.906	90.1	.725			
			783	.900	90	.726			
			785	.880	89.5	.719			
			784	.888	90.2	.714			
	790		.847	90	.716				
	9 $\frac{1}{2}$ p. m...	781	.879	84.8	.699				
		783	.874	83	.706				
		785	.859	84	.700				
		784	.864	84.7	.788				
		790	.830	83.5	.704				
	June 28	7 a. m....	781	.931	79.5	.758	29.732		
			783	.899	79.5	.733	29.729		
			785	.916	79.5	.763	29.733		
			784	.924	79.5	.756	29.729		
			790	.907	79.1	.785	29.750		
		10 $\frac{1}{2}$ a. m...	781	.953	85.6	.752			
			783	.950	85.8	.754			
			785	.929	85.3	.748			
784			.954	85.8	.758				
790			.913	85.8	.780				
6 $\frac{1}{2}$ p. m...		781	.875	89.5	.693				
		783	.876	89.8	.701				
		785	.860	91.3	.694				
		784	.860	89.6	.684 $\frac{1}{2}$				
	790	.827	89.7	.696					
12 p. m...	781	.859	79.9	.684					
	783	.859	79.8	.691					
	785	.849	79.9	.690					
	784	.847	79.9	.679					
	790	.825	80	.700					
June 29	7.20 a. m.	781	.899	79	.725	29.748			
		783	.881	78.5	.715	29.746			
		785	.876	79.4	.720	29.751			
		784	.883	79.2	.716	29.745			
		790	.855	78.8	.731	29.758			

* Mean reading of each barometer at each station. The first entry opposite the number of barometer is the mean of all the readings of that barometer at the station; the subsequent entries are the mean for the day against which they are placed. The non-periodic corrections are applied to the daily means of each barometer.

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Little Rock, Arkansas.	June 29	11.30 a. m.	781	29.919	88	29.710		
			783	.917	87.6716		
			785	.909	87.1721		
			784	.915	88.1713		
			790	.882	87.9723		
Fort Smith.....	July 4	1.50 p. m.	781	.755	85.3568	29.610	
			783	.744	85.6566	29.568	
			785	.734	85.3668	29.593	
			784	.753	85.9574	29.589	
			790	.708	85.8574	29.579	
		4.45 p. m.	781	.748	86.5577		
	783		.731	85.6	.....	.571	
	785		.725	85.8	.....	.678	
	784		.741	86	.....	.580	
	790		.691	86.3	.....	.572	
		July 5	8.35 a. m.	781	.823	78.5645	29.600
	783			.809	78.6635	29.609	
	785			.816	78.7655	29.600	
	784			.816	78.9643	29.601	
	790			.769	78.5642	29.601	
		12.19 p. m.	781	.808	84618		
	785		.787	84.8	.....	.618	
	784		.802	84.3	.....	.620	
	790		.760	84.2	.....	.625	
	781		.783	78.9	.....	.618	
	10.15 p. m.	785	.755	79.6	.....	.610	
784		.782	79.3	.....	.622		
790		.733	78.4	.....	.618		
781		.843	78.2	.....	.664	29.655	
785		.814	78.3	.....	.655	29.621	
July 6	8.15 a. m.	784	.828	78.4	.....	.656	29.625
		790	.787	77.9	.....	.660	29.621
		781	.790	86.2	.....	.604	
		785	.761	81	.....	.606	
		784	.774	81	.....	.608	
		2 p. m. . . .	790	.734	86.3600		
	781		.832	78.2	.....	.774	
	785		.823	78.1	.....	.685	
	784		.846	77.9	.....	.694	
	790		.792	78	.....	.684	
		9 p. m. . . .	781	.867	81.6676	29.622	
	785		.842	81.3	.....	.670	29.625
	784		.860	81.4	.....	.676	29.633
	790		.812	81.6	.....	.672	29.621
	781		.837	85.5	.....	.646	
July 7	9½ a. m. . . .	785	.842	84.9	.....	.652	
		784	.845	84.9	.....	.663	
		790	.786	85.2	.....	.646	
		781	.819	88	.....	.633	
		785	.791	87.1	.....	.628	
		12¼ p. m. . . .	784	.818	87.1644		
	790		.755	87.6	.....	.623	
	781		.813	85.1	.....	.644	
	785		.808	85	.....	.659	
	784		.819	85.3	.....	.658	
		3¼ p. m. . . .	790	.770	85.2651		
	781		.813	85.1	.....	.644	
	785		.808	85	.....	.659	
	784		.819	85.3	.....	.658	
	790		.770	85.2	.....	.651	
	6.10 p. m.	781	.813	85.1	.....	.644	
785		.808	85	.....	.659		
784		.819	85.3	.....	.658		
790		.770	85.2	.....	.651		
781		.813	85.1	.....	.644		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Fert Smith.....	July 8	9½ a. m...	781	29.889	83.8	.....	29.690	29.608
			783	.883	84	.....	.694	29.609
			785	.871	83	.....	.695	29.611
			784	.892	88.3	.....	.735	29.632
			790	.835	83.4	.....	.690	29.607
		3.15 p. m.	781	.783	87.9	.....	.595	
			783	.779	87.3	.....	.604	
			785	.770	87.4	.....	.606	
			784	.786	87.3	.....	.617	
			790	.736	88.1	.....	.601	
		6¼ p. m...	781	.778	80.6	.....	.621	
			783	.762	80.6	.....	.611	
	785		.749	80.4	.....	.613		
	784		.775	80.5	.....	.626		
	790		.716	80.2	.....	.611		
	July 9	9 a. m....	781	.830	79.8	.....	.644	29.655
			783	.805	79	.....	.629	29.582
			785	.796	79.3	.....	.631	29.582
			784	.815	79.6	.....	.638	29.638
			790	.767	79.1	.....	.634	29.582
		12 m....	781	.790	78.6	.....	.616	
			783	.791	78.5	.....	.625	
			785	.774	78.9	.....	.618	
			784	.896	78.6	.....	.729	
			790	.742	77.8	.....	.619	
		3 p. m....	781	.761	82.4	.....	.589	
			783	.746	81.8	.....	.582	
	785		.740	82	.....	.588		
	784		.759	82	.....	.596		
	790		.703	81.8	.....	.584		
	5½ p. m...	781	.745	77.2	.....	.598		
		783	.743	77.1	.....	.603		
		785	.729	77.8	.....	.602		
		784	.737	77.3	.....	.697		
		790	.699	78	.....	.600		
	July 11	9½ a. m...	781	.770	80.6	.....	.582	29.585
			783	.768	80.3	.....	.588	29.527
			785	.752	80.5	.....	.584	29.523
			784	.751	80.6	.....	.575	29.521
			790	.718	80.6	.....	.581	29.523
		12 m....	781	.757	83.2	.....	.591	
			783	.755	82.5	.....	.578	
			785	.741	82.8	.....	.577	
			784	.667	82.8	.....	.491	
			790	.710	82.5	.....	.577	
		2¼ p. m...	781	.709	85.2	.....	.526	
			783	.696	85	.....	.526	
	785		.679	85	.....	.520		
	784		.688	85.4	.....	.508		
	790		.650	85.1	.....	.521		
6 p. m....	781	.692	84.8	.....	.525			
	783	.681	84.2	.....	.524			
	785	.664	84.6	.....	.520			
	784	.779	84	.....	.621			
	790	.638	84.6	.....	.522			
July 12	9 a. m....	781						
		783	.748	79	.....	.572	29.539	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Fort Smith.....	July 12	9 a. m....	785	29.726	79	.....	29.568	29.539
			784	.720	78.9	.....	.544	29.516
			790	.696	79	.....	.563	29.531
		12½ p. m....	781						
			783	.737	83.7	.....	.560	
			785	.726	83	.....	.564	
			784	.724	83.9	.....	.542	
			790	.690	83.5	.....	.554	
			781	.800	84.1	.....	.601	29.578
Camp Wilson.....	July 14	11 a. m....	781	.799	87.2	.....	.595	
		12 m....	781	.810	90.5	.....	.606	
		1 p. m....	781	.796	91.2	.....	.593	
		2 p. m....	781	.792	91.6	.....	.592	
		3 p. m....	781	.781	90.2	.....	.589	
		4 p. m....	781	.781	93.6	.....	.589	
		5 p. m....	781	.752	87.9	.....	.579	
		6 p. m....	781	.741	86.9	.....	.570	
		7 p. m....	781	.731	83	.....	.567	
		8 p. m....	781	.717	79.5	.....	.560	
		9 p. m....	781	.714	77.5	.....	.559	
		10 p. m....	781	.710	77.2	.....	.549	
		11 p. m....	781	.708	75.4	.....	.548	
		Sunrise....	790	.598	71	.....	.501	29.485
		7 a. m....	790	.615	76.7	.....	.502	
		8 a. m....	790	.640	78.4	.....	.513	
		9 a. m....	790	.650	81.9	.....	.509	
		10 a. m....	790	.642	86.1	.....	.490	
		11 a. m....	790	.639	86.8	.....	.486	
12 m....	790	.627	87.6	.....	.481			
1 p. m....	790	.627	87.6	.....	.485			
2 p. m....	790	.617	90.5	.....	.470			
3 p. m....	790	.615	92	.....	.469			
4 p. m....	790	.601	91.8	.....	.464			
5 p. m....	790	.587	88.6	.....	.463			
6 p. m....	790	.582	85	86	.....	.465		
7 p. m....	790	.576	82	.....	.465			
8 p. m....	790	.590	80	.....	.481			
9 a. m....	781	.696	82	.....	.506	29.491		
10 a. m....	781	.694	85.6	.....	.493			
11 a. m....	781	.683	86.1	.....	.483			
12 m....	781	.676	87	.....	.481			
1 p. m....	781	.676	87	.....	.485			
2 p. m....	781	.668	90	.....	.472			
3 p. m....	781	.662	92	.....	.466			
4 p. m....	781	.654	90.3	.....	.471			
5 p. m....	781	.644	88	.....	.471			
6 p. m....	781	.642	84.6	.....	.477			
7 p. m....	781	.638	82	.....	.477			
8 p. m....	781	.648	79.8	.....	.490			
Camp No. 1.....	July 18	3 p. m....	790	.628	89	90490	29.500
		4 p. m....	790	.630	89.5	91498	
		5 p. m....	790	.614	87	88494	
		6 p. m....	790	.612	84	85498	
		7 p. m....	790	.606	82.5	83.8494	
		8 p. m....	790	.640	81	83529	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.		
Camp No. 2.....	July 19	1½ p. m....	783	29.700	91.5	92	29.506	*29.468		
		3 p. m....	783	.699	92.4	93	.509	*29.493		
		4 p. m....	783	.682	89.3	91.2	.508			
			5 p. m....	783	.652	86.6	88	.491		
			6 p. m....	783	.632	84.5	86	.474		
			7 p. m....	783	.636	81.3	83	.484		
			8 p. m....	783	.642	82	84	.484		
		July 20	6 a. m....	783	.666	76.2	78	.514	29.516	
			7 a. m....	783	.673	80.2	81.1	.506		
			8 a. m....	783	.696	84	85.1	.512		
			9 a. m....	783	.700	87.2	89.5	.503		
			10½ a. m..	783	.717	91	93.5	.508		
			11 a. m....	783	.721	89	92.2	.520		
			12 m....	783	.722	92.6	94	.520		
			1 p. m....	783	.727	91.5	93.1	.531		
			2 p. m....	783	.710	91.6	93.4	.517		
			3 p. m....	783	.708	90.1	92	.524		
			4 p. m....	783	.694	89	90	.521		
			5 p. m....	783	.689	85.8	86.9	.509		
			6 p. m....	783	.660	83	84.6	.506		
			7 p. m....	783	.667	78.5	80.1	.522		
			8 p. m....	783	.672	76	79	.529		
		July 23	8½ a. m....	783	.600	78.2	79.5	.421	29.380	
			10 a. m....	783	.597	82.6	83	.411		
			11 a. m....	783	.586	85.5	87.2	.394		
			12 m....	783	.592	87.5	90	.403		
			1 p. m....	783	.582	93.6	95	.381		
			2 p. m....	783	.577	95.5	97.6	.374		
			3 p. m....	783	.566	97	98.1	.361		
			4 p. m....	783	.544	92.8	96	.362		
			5 p. m....	783	.513	88.1	90	.347		
			6 p. m....	783	.517	85	87	.357		
			7 p. m....	783	.520	79.5	83	.372		
			8 p. m....	783	.528	80	83.6	.376		
		July 24	5½ a. m....	783	.517	74.9	77	.375	29.353	
			7 a. m....	783	.533	78.6	80.3	.371		
			8 a. m....	783	.534	79.3	81.1	.362		
			9 a. m....	783	.537	85.5	87.5	.345		
			12 m....	783	.535	92	93.2	.334		
			1½ p. m....	783	.521	85	86.1	.344		
			2½ p. m....	783	.520	82.6	84	.351		
			4 p. m....	783	.474	73.6	76	.353		
			5½ p. m....	783	.484	74.9	77	.353		
				8 a. m....	783	.630	76	74		.466
				11½ a. m..	783	.670	82	83.6		.496
				12 m....	783	.664	85	87		.480
		July 25	1 p. m....	783	.666	87.5	90	.481	29.482	
			2 p. m....	783	.652	86	88	.475		
	3 p. m....		783	.616	85.5	86.5	.446			
	4 p. m....		783	.648	80.8	82	.497			
	5 p. m....		783	.642	78	80	.502			
	6 p. m....		783	.634	75	77	.500			
	7 p. m....		783	.648	71	74	.522			
	8 p. m....		783	.640	70	73	.514			

* Mean of all the readings of this barometer. The second number is the mean for the day.

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp No. 2	July 25	9 p. m....	783	29.658	69	72	29.531		
	July 26	Sunrise ..	783	.698	61	63.5	.594	29.583	
		6½ a. m....	783	.736	64	66	.614		
		7 a. m....	783	.734	66.5	68.5	.604		
		8 a. m....	783	.716	77.8	79.8	.549		
		9½ a. m....	783	.776	77	78	.604		
		10 a. m....	783	.780	77	80.5	.607		
		11 a. m....	783	.718	78.2	81.7	.545		
		12 m....	783	.752	79.5	83	.584		
		1 p. m....	783	.744	80	82	.577		
		2 p. m....	783	.750	82	83.9	.560		
	Camp No. 3	July 27	Sunrise ..	783	.760	56.6	59.5	.669	29.607
			6 a. m....	783	.802	70	66.7	.667	
			7 a. m....	783	.811	72	69.9	.666	
Camp No. 4	July 27	3 p. m....	783	.746	79.6	84	.590	29.465	
		6 p. m....	783	.646	74.5	77	.511		
		9 p. m....	783	.604	69	66	.475		
	July 28	Sunrise ..	783	.670	56.5	59	.579	29.507	
		9 a. m....	783	.754	87	-----	.557		
		12 m....	783	.704	82.8	-----	.528		
		3 p. m....	783	.674	85.5	-----	.502		
		Sunset ..	783	.650	75.8	-----	.513		
		9 p. m....	783	.667	68	73	.543		
		July 29	Sunrise ..	783	.653	56.6	59	.556	29.506
Station 6	July 29	9 a. m....	783	.693	78.4	79.8	.521		
	Camp 4 and 4 miles..	July 29	12 m....	783	.558	82.5	86	.383	
Camp No. 5	July 29	3 p. m....	783	.581	82.8	84	.417	29.344	
		6 p. m....	783	.520	74.6	77.5	.388		
	9 p. m....	783	.498	70	74	.379			
	July 30	Sunrise ..	783	.688	62	64.8	.580?		
Station 8	July 30	9 a. m....	783	.628	80.5	84	.449		
Station 17	July 30	12 m....	783	.642	84.2	85	.462		
Camp No. 6	July 30	3 p. m....	783	.667	88.5	88.6	.489	29.427	
		6 p. m....	783	.649	79.9	81.2	.504		
		9 p. m....	783	.664	72.6	75	.529		
	July 31	Sunrise ..	783	.648	72.5	77	.514		
Station 6	July 31	9 a. m....	783	.700	80.1	85.5	.520		
Station 34	July 31	12 m....	783	.698	82	83.8	.522		
Camp No. 7	July 31	3 p. m....	783	.676	86	87.9	.502	29.429	
		6 p. m....	783	.640	79.9	80.5	.495		
	9 p. m....	783	.633	71.8	73	.501			
	Aug. 1	Sunrise ..	783	.654	62.5	65	.547?		
Station 5	Aug. 1	9 a. m....	783	.698	90	82	.493		
Station 49	Aug. 1	12 m....	783	.558	87.8	90.7	.367		
Station 67	Aug. 1	3 p. m....	783	.614	89.5	94.5	.438		
Camp 8	Aug. 1	6 p. m....	783	.580	84.4	84	.409	29.380	
		9 p. m....	783	.552	72	78	.412		
	Aug. 2	Sunrise ..	783	.630	68.5	69	.501?		
Station 6	Aug. 2	9 a. m....	783	.498	78.4	79.5	.328		
Station 42	Aug. 2	12 m....	783	.485	89	89	.292		
Camp No. 9	Aug. 2	3 p. m....	783	.454	93.4	91.5	.261	29.261	
		6 p. m....	783	.416	82	84.4	.264		
		9 p. m....	783	.399	75	76	.258		
	Aug. 3	Sunrise ..	783	.446	76.9	78.3	.302	29.34	
		9 a. m....	783	.500	94.2	92	.286		
		12 m....	783	.470	94.2	94	.264		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp No. 9	Aug. 3	3 p. m.	783	29.448	94	94.7	29.254	
		6 p. m.	783	.410	90.5	90	.236	
		9 p. m.	783	.439	83	86	.277	
Station 45	Aug. 4	Sunrise ..	783	.430	77	78	.284	29.364
		9 a. m.	783	.460	90.6	91	.258	
Station 77	Aug. 4	12 m.	783	.420	95.1	96.3	.211	
Station 85	Aug. 4	3 p. m.	783	.352	96.7	97	.150	
Camp No. 10	Aug. 4	6 p. m.	783	.476	90.5	91.5	.304	29.387
		9 p. m.	783	.460	79	82	.309	
Station 31	Aug. 5	5½ a. m. ...	783	.472	75.9	76	.319	29.373
		9 a. m.	783	.464	81	82	.284	
Camp 11	Aug. 5	12 m.	783	.528	84	86	.348	29.362
		3 p. m.	783	.465	94	92	.271	
		6 p. m.	783	.420	77	78	.281	
Station 4	Aug. 6	9 p. m.	782	.527	73.5	76.5	.390	29.334
		Sunrise ..	783	.442	72	73.1	.307	
		9 a. m.	783	.503	86	86	.310	
Station 14	Aug. 6	12 m.	783	.471	92.5	92.5	.267	
Station 67	Aug. 6	3 p. m.	783	.400	94	93.9	.206	
At crossing of river...	Aug. 6	6 p. m.	783	.500	88	88	.332	
Camp 12	Aug. 6	9 p. m.	783	.522	76	76.5	.378	
		Sunrise ..	783	.489	72.5	73.9	.373	
Two miles from camp								
12	Aug. 7	9 a. m.	783	.508	81.6	81.5	.325	
Station 18 (?)	Aug. 7	12 m.	783	.576	87.5	90	.367	
Station 25 (?)	Aug. 7	3 p. m.	783	.436	89.5	91	.253	
Camp 13	Aug. 7	6 p. m.	783	.486	83.5	83	.331	29.360
		9 p. m.	783	.490	75	75.5	.349	
		Sunrise ..	783	.480	69.2	71	.353	
Station 39	Aug. 8	9 a. m.	783	.440	83.8	84		29.386
Station 78	Aug. 8	12 m.	783	.400	88.6	92		
Camp 14	Aug. 8	3 p. m.	783	.366	94	96	.174	29.275
		7 p. m.	783	.422	77.8	82	.278	
		9 p. m.	783	.338	76.5	77.5	.994	
Station 40	Aug. 9	Sunrise ..	783	.353	67.6	.....	.232	
		9 a. m.	783	.165	85.4	.....	28.974	
		12 m.	783	.371	90.4	.....	29.175	
Station 69	Aug. 9	3 p. m.	783	.286	90.2	.....	.105	
Station 89	Aug. 9	6 p. m.	783	.358	85.5	.....	.200	29.256
Camp 15	Aug. 9	9 p. m.	783	.354	79.2	.....	.213	
		Sunrise ..	783	.363	70.5	.....	.234	
Station 20	Aug. 10	9 a. m.	783	.376	76.4	.....	.211	
Station 37	Aug. 10	12 m.	783	.396	88.8	94	.206	
Station 50	Aug. 10	3 p. m.	783	.306	92.3	90.5	.120	
Camp 16	Aug. 10	6 p. m.	783	.352	86	84	.191	29.271
		9 p. m.	783	.362	76.9	79	.219	
		Sunrise ..	783	.382	71.5	73.5	.250	
Station 50	Aug. 11	9 a. m.	783	.358	78.4	77.6	.188	
Station 37	Aug. 11	12 m.	783	.466	84.2	89	.286	
Station 59	Aug. 11	3 p. m.	783	.368	85.4	88.4	.200	
Camp 17	Aug. 11	6 p. m.	783	.416	78.2	79.5	.276	29.273
		9 p. m.	783	.398	70.7	75.1	.270	
		Sunrise ..	783	.310	64.9	68.9	.197	
Station 50	Aug. 12	9 a. m.	783	.498	97	95	.278	29.243
		12 m.	783	.451	92.9	93.6	.248	
		3 p. m.	783	.412	96.9	98.8	.212	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 17.....	Aug. 12	6 p. m....	783	29.462	83.5	85.2	29.308	29.197	
		9 p. m....	783	.342	70.6	73.6	.215		
	Aug. 13	Sunrise...	783	.240	63.5	66.9	.130		
		9 a. m....	783	.440	95.5	93.7	.225		
		10 a. m....	783	.441	91.3	.....	.234
		11 a. m....	783	.447	93.6	.....	.237
		12 m....	783	.429	93.5	94.6	.227		
		1 p. m....	783	.416	94.6	.....	.215
		2 p. m....	783	.364	77.9	.....	.207
		3 p. m....	783	.364	90.3	93.9	.182		
	Aug. 14	4 p. m....	783	.356	90.2	95.6	.182		
		5 p. m....	783	.338	85.6	.....	.181
		6 p. m....	783	.292	73.7	78	.165		
		7 p. m....	783	.292	70.6	.....	.171
		8 p. m....	783	.314	68.2	.....	.195
		9 p. m....	783	.318	66.4	69.3	.209		
Sunrise...		783	.321	60.6	62.6	.218			
9 a. m....		783	.350	84.1	86.5	.164			
Station 14.....	Aug. 14	12 m....	783	.282	88.5	91.5	.093	29.086	
Station 34.....	Aug. 14	3 p. m....	783	.246	92.9	92.5	.081		
Station 43.....	Aug. 14	6 p. m....	783	.256	82.9	82.9	.103		
Camp 18.....	Aug. 14	9 p. m....	783	.222	72.6	73.5	.089		
		Sunrise...	783	.232	64.6	66.6	.119		
Station 0.....	Aug. 15	9 a. m....	783	.286	87.5	89.9	.092		29.908
Station 11.....	Aug. 15	12 m....	783	28.958	90.6	94	28.764		
Camp 19.....	Aug. 15	3 p. m....	783	29.074	90.8	93.7	.890		
		6 p. m....	783	.081	85	83.2	.924		
		9 p. m....	783	.051	74.9	76.6	.912		
Aug. 16	Sunrise...	783	.060	69	70.6	.935	28.859		
	9 a. m....	783	.142	93.5	96	.932			
Station 10.....	Aug. 16	12 m....	783	.074	97.8	100.6	.885.	28.861	
Station 33.....	Aug. 16	3 p. m....	783	.025	94.2	95.1	.834		
Station 49.....	Aug. 16	6 p. m....	783	28.978	84.3	84.3	.824		
Camp 20.....	Aug. 17	Sunrise...	783	.926	62.5	64.5	.820		
		9 a. m....	783	.968	91.5	92.4	.764		
Station 4.....	Aug. 17	12 m....	783	.978	99.4	100.4	.762		28.849
Station 17.....	Aug. 17	6 p. m....	783	29.008	83.9	85.4	.853		
Camp 21.....	Aug. 17	9 p. m....	783	28.984	67	67.4	.865		
		Sunrise...	783	.964	57	59.5	.874		
		9 a. m....	783	29.100	93	93.6	.891		
Aug. 18	12 m....	783	.070	97.9	103	.854	28.792		
	3 p. m....	783	.062	10.7	114	.842			
	6 p. m....	783	.058	100.5	96	.863			
	9 p. m....	783	28.974	70	72.8	.847			
	Sunrise...	783	.988	63.6	65	.879			
	9 a. m....	783	29.074	89.7	91.3	.875			
	12 m....	783	.064	96.5	98	.855			
	3 p. m....	783	.038	98	99	.837			
Aug. 19	6 p. m....	783	28.982	87.3	90.3	.821	28.849		
	9 p. m....	783	.962	73.4	74	.828			
	Sunrise...	783	.980	75.8	73.9	.838			
	6 a. m....	783	.991	79	.....	.835	
	7 a. m....	783	.996	86	.....	.817	
	8 a. m....	783	29.001	87.3	.....	.811	
	9 a. m....	783	.012	92.1	93.1	.806			
	10 a. m....	783	28.016	95.1	.....	.830	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 21.....	Aug. 20	11 a. m.	783	28.012	96.5	28.794		
		12 m.	783	.998	98.9	.....	.786
		1 p. m.	783	.980	100.2	.....	.766
		2 p. m.	783	.964	99.6	.....	.755
		3 p. m.	783	.955	99.5	100.8751
		4 p. m.	783	.946	96.3	.....	.758
		5 p. m.	783	.940	93.2	.....	.764
		6 p. m.	783	.910	81.2	83.9763
	Aug. 21	7 p. m.	783	.910	80.2	.....	.764
		8 p. m.	783	.912	78.1	.....	.767
		9 p. m.	783	29.007	77.6	79860
		Sunrise	783	28.940	70.6	72.8812
		7 a. m.	783	.996	83	.....	.825
		8 a. m.	783	29.004	87.9	.....	.815
		9 a. m.	783	.015	90	.....	.814
		10 a. m.	783	.034	93.5	.....	.822
		11 a. m.	783	.016	95.6	.....	.801
		12 m.	783	29.000	98.5	101.4786
		1 p. m.	783	28.996	100.5	.....	.782
		2 p. m.	783	.976	100.5	.....	.765
	Aug. 20	3 p. m.	783	.966	100.1	101.6760
		4 p. m.	783	.962	96.6	.....	.774
		5 p. m.	783	.950	95	.....	.763
		6 p. m.	783	.932	88.2	89.9763
		7 p. m.	783	.978	83.9	.....	.824
		8 p. m.	783	.942	80.5	.....	.793
		9 p. m.	783	.936	76.8	79.2793
		Sunrise	790	.956	73.8	.....	.862
		Aug. 21	6 a. m.	790	.963	77.1854
			7 a. m.	790	.996	86861
			8 a. m.	790	.996	87.7851
			9 a. m.	790	29.006	93843
	10 a. m.		790	.002	96	.....	.827
	11 a. m.		790	28.992	97.1	.....	.816
	12 m.		790	.976	101.5	.....	.800
	1 p. m.		790	.958	103	.....	.782
	2 p. m.		790	.954	103	.....	.781
	3 p. m.		790	.942	104.2	.....	.772
	4 p. m.		790	.923	99.9	.....	.769
	5 p. m.		790	.898	92.3	.....	.768
	Aug. 21	6 p. m.	790	.894	81.6	.....	.786
		7 p. m.	790	.896	80	.....	.793
		8 p. m.	790	.896	78	.....	.795
		9 p. m.	790	.892	76.9	.....	.789
		Sunrise	790	.930	70.6	.....	.844
		6 a. m.	790	.960	76.9	.....	.852
		7 a. m.	790	.988	82.7	.....	.861
		8 a. m.	790	.992	87.5	.....	.845
9 a. m.		790	29.008	90	.....	.850	
10 a. m.		790	.008	93.8	.....	.839	
11 a. m.		790	28.998	98.6	.....	.819	
12 m.		790	.986	101.8	.....	.815	
1 p. m.	790	.976	103	.....	.800		
2 p. m.	790	.966	103	.....	.783		
3 p. m.	790	.950	104	.....	.781		

28.793

28.813
28.808

28.818

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 21.....	Aug. 21	4 p. m....	790	28.950	100.4	.....	28.795	
		5 p. m....	790	.928	96	.....	.788	
		6 p. m....	790	.915	89.9	.....	.789	
		7 p. m....	790	.912	84	.....	.798	
		8 p. m....	790	.934	80.6	.....	.826	
		9 p. m....	790	.938	78.1	.....	.834	
Station 10.....	Aug. 22	Sunrise...	783	.976	70.8	73.8	.846	
		9 a. m....	783	.944	91	93	.740	
Station 23.....	Aug. 22	12 m....	783	.957	96.7	99.3	.746	
Camp 22.....	Aug. 22	3.45 p. m.	783	.862	97.2	98.6	.669	28.703
		6 p. m....	783	.854	86.7	88	.693	
		9 p. m....	783	.852	79.3	80.5	.701	
Camp 23.....	Aug. 23	Sunrise...	783	.883	69.6	71.4	.751	
		12 m....	783	.946	99.6	96.3	.729	28.746
		3 p. m....	783	.918	96.8	97.4	.721	
		6 p. m....	783	.854	83.8	85.6	.702	
Station 7.....	Aug. 24	9 p. m....	783	.896	74.9	76.4	.760	
		Sunrise...	783	.946	71.6	75	.819	
Station 10.....	Aug. 24	9 a. m....	783	29.038	74.	75.6	.878	
Station 10.....	Aug. 24	12 m....	783	28.964	83.9	.....	.786	
Station 19.....	Aug. 24	3 p. m....	783	29.024	84.8	84.8	.856	
Camp 24.....	Aug. 24	6 p. m....	783	.040	77.8	78.4	.903	28.910
		9 p. m....	783	.030	71.5	74.2	.900	
Station 2.....	Aug. 25	Sunrise...	783	.054	66.6	68.8	.929	
		9 a. m....	783	28.984	73.2	74.2	.827	
Station 13 + 1600 feet.	Aug. 25	12 m....	783	.974	88.9	85.9	.784	
Station 30.....	Aug. 25	3 p. m....	783	.761	87.8	87.9	.585	
Camp 25.....	Aug. 25	6 p. m....	783	.756	79	79	.615	28.607
		9 p. m....	783	.740	72.3	73.5	.609	
Half way between stations 7 and 8.....	Aug. 26	Sunrise...	783	.727	68.6	69.9	.599	
		9 a. m....	783	.688	85.8	86.8	.497	
Station 22.....	Aug. 26	12 m....	783	.688	92.4	93	.489	
Station 35.....	Aug. 26	3 p. m....	783	.584	94	94.8	.393	
Camp 26.....	Aug. 26	6 p. m....	783	.716	80	80.9	.573	28.603
		9 p. m....	783	.766	73.6	75.6	.633	
Station 4.....	Aug. 27	9 a. m....	783	.876	55.8	56.8	.763	
Station 18.....	Aug. 27	12 m....	783	.855	67.6	70	.621	
Station 22.....	Aug. 27	3 p. m....	783	.802	75	78.2	.660	
Camp 27.....	Aug. 27	6 p. m....	783	.884	69.2	68.3	.769	28.762
		9 p. m....	783	.886	64	64.5	.776	
Station 9.....	Aug. 28	Sunrise...	783	.846	59.5	60.7	.741	
		9 a. m....	783	.806	71.5	74	.653	
Station 15.....	Aug. 28	12 m....	783	.633	82.7	81.5	.458	
Camp 28.....	Aug. 28	4 p. m....	783	.520	85.6	82.1	.360	28.422
		6 p. m....	783	.572	76	77	.439	
		9 p. m....	783	.576	72.2	72.6	.445	
Station 7.....	Aug. 29	Sunrise...	783	.572	66.9	68.3	.446	
		9 a. m....	783	.510	81.3	81.5	.334	
Station 10.....	Aug. 29	12 m....	783	.458	96.8	87.5	.250	
Station bet. 18 and 19.	Aug. 29	3 p. m....	783	.430	86.5	86.5	.261	
Camp 29.....	Aug. 29	6 p. m....	783	.557	81.8	82.3	.410	28.362
		9 p. m....	783	.474	72.6	75	.342	
Station 2.....	Aug. 30	Sunrise...	783	.464	68.9	70.7	.336	
		9 a. m....	783	.480	89.2	87	.284	
Station between 7 & 8.	Aug. 30	12 m....	783	.426	91.9	91.1	.231	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Station 15.....	Aug. 30	3 p. m....	783	28.410	91.6	93.7	28.228	
Camp 30.....	Aug. 30	6 p. m....	783	.412	81.5	82.3	.265	28.259
		9 p. m....	783	.411	74	76	.275	
	Aug. 31	Sunrise ...	783	.362	66.4	68.1	.239	
Station between 4 & 5.	Aug. 31	9 a. m....	783	.400	89	88.5	.204	
		12 m....	783	.578	92.3	96.4	-----	
Station 11.....	Aug. 31	4 p. m....	783	.414	94.6	94.5	.233	
Camp 31.....	Aug. 31	6 p. m....	783	.485	88.4	87	.323	28.340
		9 p. m....	783	.468	74	75	.347	
	Sept. 1	Sunrise ...	783	.467	64.9	67.9	.352	
Station 3.....	Sept. 1	9 a. m....	783	.460	89.6	92.5	.263	
Station 9.....	Sept. 1	12 m....	783	.376	96.5	99.5	.170	
Station 15.....	Sept. 1	3 p. m....	783	.276	101.5	96.5	.070	
Camp 32.....	Sept. 1	6 p. m....	783	.303	90	85.1	.138	28.143
		9 p. m....	783	.261	74.5	73	.127	
	Sept. 2	Sunrise ...	783	.286	66.8	68.5	.165	
Station 8.....	Sept. 2	9 a. m....	783	.349	92.7	92.9	.121	
Station 16.....	Sept. 2	12 m....	783	.366	94.6	96	.150	
Station 19.....	Sept. 2	3 p. m....	783	.328	98.7	97	.156	
Camp 33.....	Sept. 2	9 p. m....	783	.338	75	74	.197	28.200
	Sept. 3	Sunrise ...	783	.302	55.5	65.5	.204	
Station 3.....	Sept. 3	9 a. m....	783	.206	90	89.5	27.989	
Station 14.....	Sept. 3	12 m....	783	.201	95	95	.986	
Station 23.....	Sept. 3	3 p. m....	783	27.920	98	95.5	.753	
Camp 34.....	Sept. 3	6 p. m....	783	.904	86.5	85.7	.763	27.758
		9 p. m....	783	.912	77.5	77	.765	
	Sept. 4	Sunrise ...	783	.866	64.7	65.5	.747	
Station 5.....	Sept. 4	9 a. m....	783	28.004	89.9	90.5	.787	
Station 11.....	Sept. 4	12 m....	783	27.960	96.	95.5	.743	
Camp 35.....	Sept. 4	3 p. m....	783	.774	92.4	94	.563	27.691
		6 p. m....	783	.770	78.5	79	.598	
		9 p. m....	783	.788	72	72.9	.656	
	Sept. 5	Sunrise ...	783	.770	58.2	59	.665	
		9 a. m....	783	.872	85.8	89.3	.662	
		12 m....	783	.896	101.8	99.5	.670	
		3 p. m....	783	.876	98.8	94.6	.709	
		6 p. m....	783	.848	81.8	83.4	.718	
		9 p. m....	783	.908	72.5	73.5	.775	
	Sept. 6	Sunrise ...	783	28.012	63	65	.895	
Station 1 + 1/4 mile....	Sept. 6	9 a. m....	783	.109	67.4	69	.948	
Station 5 + 1 mile....	Sept. 6	12 m....	783	27.804	73.6	74.6	.643	
Station 21.....	Sept. 6	3 p. m....	783	.884	77.6	80	.768	
Camp 36.....	Sept. 6	6 p. m....	783	.866	76.2	78.2	.748	27.779
		9 p. m....	783	.898	64	64.5	.786	
	Sept. 7	Sunrise ...	783	.896	53.4	54.3	.803	
Station between 3 & 4.	Sept. 7	9 a. m....	783	.998	70	70.5	.830	
Station 11.....	Sept. 7	12 m....	783	.846	79.5	79.2	.670	
Station 23.....	Sept. 7	3 p. m....	783	.766	83.2	81.8	.636	
Camp 37.....	Sept. 7	6 p. m....	783	.816	74.5	72.8	.703	27.692
		9 p. m....	783	.780	61	61	.676	
	Sept. 8	Sunrise ...	783	.796	55.9	57	.697	
Station 4.....	Sept. 8	9 a. m....	783	.752	70.8	73.1	.552	
Station 16.....	Sept. 8	12 m....	783	.791	83.4	82.6	.605	
Station 30.....	Sept. 8	3 p. m....	783	.746	84	81.5	.613	
Camp 38.....	Sept. 8	6 p. m....	783	.662	75.2	75.6	.548	27.584
		9 p. m....	783	.672	64	65.7	.560	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 38.....	Sept. 9	Sunrise...	783	27.746	56.5	57	27.646	
Station 4.....	Sept. 9	9 a. m....	783	.822	76	75.5	.639	
Station 16.....	Sept. 9	12 m.....	783	.770	80	79.3	.592	
Camp 39.....	Sept. 9	3 p. m....	783	.688	84.2	.....	.557	27.560
		6 p. m....	783	.671	78.9	75.7	.548	
		9 p. m....	783	.690	66.8	68	.572	
	Sept. 10	Sunrise...	783	.666	56.9	58.2	.564	
Station between 3 & 4.	Sept. 10	10 a. m....	783	.766	79	76	.566	
Station 13.....	Sept. 10	12 m.....	783	.690	83.5	87.2	.404	
Station 27.....	Sept. 10	3 p. m....	783	.577	86.8	89	.440	
Camp 40.....	Sept. 10	6 p. m....	783	.540	81.2	80.6	.411	27.411
		9 p. m....	783	.552	73.8	75	.415	
	Sept. 11	Sunrise...	783	.506	56.4	58.1	.407	
Station 3.....	Sept. 11	9 a. m....	783	.540	78.2	81.5	.354	
Station 12.....	Sept. 11	12 m.....	783	.469	91.2	91.2	.267	
Station 28.....	Sept. 11	3 p. m....	783	.396	92.5	92.9	.246	
Camp 41.....	Sept. 11	6.40 p. m.	783	.340	82.5	82.5	.....
		9 p. m....	783	.362	76.5	76.7	.222	27.231
	Sept. 12	Sunrise...	783	.348	60.3	61.2	.240	
Station 2.....	Sept. 12	9 a. m....	783	.412	77	77	.229	
Station 10.....	Sept. 12	12 m.....	783	.346	90.8	90.9	.145	
Station 19.....	Sept. 12	3 p. m....	783	26.968	88.5	88.7	26.830	
		6 p. m....	783	27.012	85.8	84	.875	
Camp 42.....	Sept. 12	9 p. m....	783	26.960	72.6	73	.831	26.745
	Sept. 13	Sunrise...	783	.894	63.1	64	.780	
		9 a. m....	783	.939	80.8	81	.750	
		12 m.....	783	.910	89	89.3	.716	
		3 p. m....	783	.844	86.5	88.7	.711	
		6 p. m....	783	.843	83.5	84.6	.711	
		9 p. m....	783	.850	70.5	71.8	.727	
	Sept. 14	Sunrise...	783	.838	53.7	54.9	.739	
Station bet. 10 and 11.	Sept. 14	12 m.....	783	.562	89	91.7	.....
Station near camp 43.	Sept. 14	3 p. m....	783	.748	92.7	93.7	.601	
Camp 43.....	Sept. 14	6 p. m....	783	.727	84.5	84.3	.594	26.622
		9 p. m....	783	.722	78.3	80	.580	
	Sept. 15	Sunrise...	783	.784	54.5	56.9	.692	
Station between 3 & 4.	Sept. 15	9 a. m....	783	.715	91.6	92.5	.537	
Station 13.....	Sept. 15	12 m.....	783	.596	76	82.9	.398	
Station 22.....	Sept. 15	3 p. m....	783	.516	94.7	96.7	.365	
Camp 44.....	Sept. 15	6 p. m....	783	.585	86.4	86.1	.449	26.445
		9 p. m....	783	.578	72.5	74	.450	
	Sept. 16	Sunrise...	783	.558	66.2	67.9	.438	
Station between 8 & 9.	Sept. 16	9 a. m....	783	.448	84	87.7	.253	
Station bet. 14 and 15.	Sept. 16	12 m.....	783	.338	90	89	.146	
Station 20.....	Sept. 16	3 p. m....	783	.178	94.7	92.5	.030	
Camp 45.....	Sept. 16	6 p. m....	783	.151	80.5	80.2	.032	26.067
		9 p. m....	783	.176	73.5	74.5	.048	
	Sept. 17	Sunrise...	783	.230	61.5	61.5	.123	
Station 12.....	Sept. 17	9 a. m....	783	.202	75.9	76.4	.028	
Station 15.....	Sept. 17	12 m.....	783	.010	82.8	83.9	25.835	
		3 p. m....	783	25.896	87.7	89	.....
Station 25.....	Sept. 17	6 p. m....	783	.812	82	81.2	.689	
Camp 46.....	Sept. 17	9.30 p. m.	783	.944	75	75.5	.812	25.995
	Sept. 18	Sunrise...	783	.958	56.5	56.8	.863	
		9 a. m....	783	26.140	67.7	69.5	.988	
		12 m.....	783	.168	75.2	76.4	26.011	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 46.....	Sept. 18	3 p. m....	783	26.151	77.9	80.6	26.042	
		6 p. m....	783	.119	68.5	69.5	.039	
		9 p. m....	783	.150	59.5	60.7	.055	
Station 5.....	Sept. 19	Sunrise...	783	.241	54.6	55.6	.150	
		9 a. m....	783	.298	67.5	68.7	.144	
Station 14.....	Sept. 19	12 m....	783	.898	75.6	75.7	.738	
Station 21.....	Sept. 19	3 p. m....	783	.308	79.5	82.1	.194	
Camp 47.....	Sept. 19	6 p. m....	783	.268	75	73.5	.160	26.204
		9 p. m....	783	.280	65.5	68	.170	
		Sunrise...	783	.380	56	57.5	.284	
Station 5.....	Sept. 20	12 m....	783	.378	68.5	70.5	.236	
		3 p. m....	783	.250	68.5	69.5	.163	
Station 9.....	Sept. 20	6 p. m....	783	.206	62.7	62.3	.126	
Station 16.....	Sept. 20	9 p. m....	783	.180	61.1	62	.080	26.098
Camp 48.....	Sept. 21	Sunrise...	783	.198	50	51.4	.117	
		9 a. m....	783	.319	65.9	65.9	.167	
Station 2.....	Sept. 21	12 m....	783	.169	73.5	74	.016	
Station 10.....	Sept. 21	4 p. m....	783	.157	74.7	75.5	.070	
Camp 49.....	Sept. 21	6 p. m....	783	.119	70.1	65.7	.023	26.005
		9 p. m....	783	.086	55	56.5		
		Sunrise...	783	.080	53.5	54.3	25.992	
Station 3+1195 rev...	Sept. 22	9 a. m....	783	25.993	70.1	73	.833	
Station 7.....	Sept. 22	12 m....	783	.899	80.3	81.8	.731	
Station 16.....	Sept. 22	3 p. m....	783	.825	82.3	83.1	.707	
Camp 50.....	Sept. 22	6 p. m....	783	.780	73	74.3	.689	
		9 p. m....	783	.796	69.5	70.8	.681	
		Sunrise...	783	.766	53.6	52	.675	
Station 6.....	Sept. 23	9 a. m....	783	.614	72.2	72.5	.441	
		12 m....	783	.616	83	82.2	.436	
Station 16.....	Sept. 23	3.30 p. m.	783	.429	80.3	80.9	.328	
Camp 51.....	Sept. 23	6 p. m....	783	.435	70.7	69.3	.350	25.351
		9 p. m....	783	.422	57.1	57.2	.336	
		Sunrise...	783	.442	46.3	47	.368	
Station 5.....	Sept. 24	9 a. m....	783	.370	69.1	70	.205	
		12 m....	783	.415	76	76.6	.251	
Camp 52.....	Sept. 24	3 p. m....	783	.394	80.5	79.5	.293	25.245
		6 p. m....	783	.360	70.8	71.9	.276	
		9 p. m....	783	.352	55.9	56.2	.262	
Station 5.....	Sept. 25	Sunrise...	783	.345	41.2	42.1	.282	
		9 a. m....	783	.391	70.3	66.8	.222	
		12 m....	783	.364	74.7	76.1	.205	
		3 p. m....	783	.316	77.7	79	.223	
		6 p. m....	783	.296	68.8	69.5	.218	
		9 p. m....	783	.324	57.5	58.2	.240	
Station 2.....	Sept. 26	Sunrise...	783	.268	46.3	47.5	.195	
		9 a. m....	783	24.963	72	65	24.792	
Station 8.....	Sept. 26	12 m....	783	25.048	75.5	73.9	.887	
Camp 53.....	Sept. 26	3.30 p. m.	783	24.957	77.7	79	.871	24.894
		6 p. m....	783	.978	71.2	69	.895	
		9 p. m....	783	25.014	64.3	64.5	.906	
Station 5.....	Sept. 27	Sunrise...	783	.006	59	59	.904	
		9 a. m....	783	24.981	65	66	.825	
Camp 54.....	Sept. 27	12 m....	783	25.070	76.5	76.3	.907	24.904
		3 p. m....	783	.036	75.5	77.6	.947	
		6 p. m....	783	.032	64.3	63.3	.965	
		9 p. m....	783	.050	63.5	61.9	.953	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 54.....	Sept. 28	Sunrise ..	783	25.030	55.7	57	24.937	
		9 a. m....	783	.047	63.2	66.1	.896	
		12 m.....	783	24.984	61	63	.855	
		3 p. m....	783	.953	65	65.3	.887	
		6 p. m....	783	.958	59.5	62	.909	
		9 p. m....	783	.916	56.5	58.5	.836	
Station 2.....	Sept. 29	Sunrise ..	783	.932	49.5	50.5	.852	
		9 a. m....	783	.912	65.7	64.7	.754	
Station 12.....	Sept. 29	12 m.....	783	.476	72	71.3	.329	
Station 24.....	Sept. 29	3 p. m....	783	.020	70.5	71.9	23.946	
Camp 55.....	Sept. 29	9 p. m....	783	.006	58	57.5	.924	23.943
		Sunrise ..	783	.044	50.6	51.5	.963	
Station 4.....	Sept. 30	9 a. m....	783	23.978	54.7	51.8	.847	
		12 m.....	783	.958	56.9	56.5	.841	
Station 11.....	Sept. 30	3 p. m....	783	.526	53.5	54.5	.489	23.513
		6 p. m....	783	.542	49.5	49.5	.509	
Camp 56.....	Sept. 30	8 p. m....	783	.552	45	47.3	.503	
		Sunrise ..	783	.614	41.5	42	.552	
Station 2 + 299 rev..	Oct. 1	9 a. m....	783	.697	45.7	47		
		12 m.....	783	.964	53.7	56.5	.853	
Station 4.....	Oct. 1	3 p. m....	783	.987	55.5	57.8	.945	
Camp 57.....	Oct. 1	9 p. m....	783	24.017	50.5	51	.982	23.977
		9 p. m....	783	.022	42.1	42	.973	
Camp 57 + 890 rev..	Oct. 2	Sunrise ..	783	.018	32.5	29.5	.976	
		9 a. m....	783	23.975	53.4	57.5	.848	
Station 7.....	Oct. 2	12 m.....	783	.749	62.3	64	.621	
Station 15.....	Oct. 2	3 p. m....	783	.716	65.5	69	.654	
Camp 58.....	Oct. 2	9 p. m....	783	.918	58.5	59.7	.866	23.842
		9 p. m....	783	.888	44.7	46.3	.834	
Station 3.....	Oct. 3	Sunrise ..	783	.872	32.3	32	.828	
		9 a. m....	783	24.296	55.3	58.5	24.214	
Station 11.....	Oct. 3	12 m.....	783	.868	66	71	.728	
Station 17.....	Oct. 3	3 p. m....	783	25.354	73.7	78.7	25.268	
Camp 59.....	Oct. 3	6 p. m....	783	.320	73.5	71.5		
		9 p. m....	783	.288	53.7	54.8	.207	25.129
Albuquerque	Oct. 4	Sunrise ..	783	.313	39.3	39.7	.255	25.224
		7 a. m....	783	.364	46	-----	.261	
		8 a. m....	783	.376	52	-----	.254	
		9 a. m....	783	.392	67.7	72.3	.229	
		10 a. m....	783	.376	70	75.5	.202	
		11 a. m....	783	.398	80.1	76.9	.188	
		12 m.....	783	.399	89.5	84.7	.204	
		1 p. m....	783	.384	86.9	84.3	.239	
		2 p. m....	783	.335	78.1	84.5	.219	
		3 p. m....	783	.335	82.5	87.5	.229	
		4 p. m....	783	.314	81	84	.222	
		5 p. m....	783	.294	76.5	82	.208	
		6 p. m....	783	.282	69.5	72	.202	
		7 p. m....	783	.272	62.3	63	.198	
		8 p. m....	783	.270	56.5	57.1	.194	
		9 p. m....	783	.260	53.7	54.4	.184	
	Oct. 5	Sunrise ..	783	.254	40.3	41	.194	25.200
7 a. m....		783	.348	58.7	57.1	.214		
8 a. m....		783	.364	64.3	-----	.214		
9 a. m....		783	.364	63.1	64.8	.211		
10 a. m....		783	.381	70.8	74.5	.203		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Albuquerque	Oct. 5	11 a. m....	783	25.369	72.3	74	25.176	
		12 m.....	783	.364	86	83.4	.177	
		1 p. m....	783	.350	92	93.2	.191	
		2 p. m....	783	.334	89	92.5	.203	
		3 p. m....	783	.332	85	.....	.210	
		4 p. m....	783	.322	82.5	87	.226	
		5 p. m....	783	.286	72.3	73.5	.208	
		6 p. m....	783	.274	65.6	67.5	.202	
	Oct. 6	7 p. m....	783	.266	61	62	.193	
		8 p. m....	783	.274	56.5	59.5	.197	
		9 p. m....	783	.286	63	64.1	.189	
		6 a. m....	783	.262	40	40	.202	25.143
		7 a. m....	783	.294	46.5	47.3	.190	
		8 a. m....	783	.308	54.3	56	.181	
		9 a. m....	783	.334	67.5	73.1	.172	
		10 a. m....	783	.308	69.5	77.8	.135	
		11 a. m....	783	.302	72.7	82.3	.108	
		12 m.....	783	.299	81.5	81.5	.124	
		1 p. m....	783	.274	76	78.1	.152	
		2 p. m....	783	.250	77.9	82.8	.144	
		3 p. m....	783	.238	79.3	84	.140	
		4 p. m....	783	.210	75	80	.131	
	5 p. m....	783	.192	70.8	75	.119		
	Oct. 7	6 p. m....	783	.201	64	65.6	.132	
		7 p. m....	783	.210	59.9	61.1	.142	
		8 p. m....	783	.172	58.5	52.8	.092	
		9 p. m....	783	.184	48.1	50	.111	
		6 a. m....	783	.208	39.5	37.5	.159	25.122
		7 a. m....	783	.275	58.7	61	.142	
		8 a. m....	783	.286	61.5	66	.142	
		9 a. m....	783	.300	67	72	.139	
		10 a. m....	783	.304	68.7	70.7	.132	
		11 a. m....	783	.302	72	80	.110	
		12 m.....	783	.294	90	86	.099	
		1 p. m....	783	.248	81.7	87	.114	
		2 p. m....	783	.242	87.5	82.5	.115	
		3 p. m....	783	.250	94	100.6	.119	
		4 p. m....	783	.234	89.5	92.3	.123	
		5 p. m....	783	.216	74	79.5	.134	
	Oct. 8	5½ p. m....	783	.182	64.9	67	.116	
		7 p. m....	783	.172	57.8	58.3	.107	
		8 p. m....	783	.180?	.....	.....	.101	
		9 p. m....	783	.180	54	54.5	.104	
		6 a. m....	783	.170	34	34.5	.124	25.096
		7 a. m....	783	.230	62	52.7	.101	
		8 a. m....	783	.266	59	63	.128	
		9 a. m....	783	.280	62.5	70.5	.129	
		9 a. m....	785	.332	76.5	.....	.162	25.126
		10 a. m....	783	.290	72	72	.111	
	11 a. m....	783	.260	70.6	74.5	.060		
	12 m.....	783	.242	76	79	.079		
	12 m.....	785	.276	77.9	79	.120		
1 p. m....	783	.227	87.5	80	.088			
2 p. m....	783	.220	90	83.4	.088			
3 p. m....	783	.196	80.7	83.5	.104			
3 p. m....	785	.209	80.2	.....	.129			

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Albuquerque.....	Oct. 8	4 p. m....	783	25.177	80.5	81	25.094		
		5 p. m....	783	.186	80.8	80.8	.095		
		6 p. m....	783	.054	74.3	72	.092		
		6 p. m....	785	.166	71	-----	.113		
		7 p. m....	783	.140	58.3	57.5	.090		
		8 p. m....	783	.142	58	-----	.082		
		9 p. m....	783	.138	51.8	51.7	.066		
		9 p. m....	785	.150	51	51.7	.093		
	Oct. 9	6 a. m....	785	.156	34.8	35	.113		25.051
		6 a. m....	783	.138	34.6	35	.090		25.021
		7 a. m....	783	.166	51.2	-----	.052		
		8 a. m....	783	.192	59.5	-----	.053		
		9 a. m....	785	.236	76.5	68.9	.068		
		10 a. m....	783	.198	70.9	-----	.021		
		11 a. m....	783	.180	73.5	74	24.986		
		1 p. m....	783	.157	80.5	80.5	25.026		
		2 p. m....	783	.144	80.5	80.2	.035		
		3 p. m....	783	.679	83	79.5	24.974		
		3 p. m....	785	.102	80.5	-----	25.014		
		4 p. m....	783	(?)	-----	-----	24.996		
		5 p. m....	783	(?)	-----	-----	25.021		
		6 p. m....	783	.102	72.4	72.9	.016		
		6 p. m....	785	.118	70.7	-----	.046		
		7 p. m....	783	.078	56.5	56.5	.018		
	8 p. m....	783	.054	53.6	54	24.986			
	9 p. m....	783	.070	51.8	51.7	.996			
	9 p. m....	785	.074	51.8	-----	25.014			
	Oct. 10	6 a. m....	785	.198	44	44	.140		25.062
		6 a. m....	783	.098	41.5	-----	.036		
		7 a. m....	783	.182	76.5	62.9	.012		
		9 a. m....	783	.178	66.8	71.2	.018		
		9 a. m....	785	.230	68.3	71.2	.140		
		12 m....	785	.199	85.2	86.6	.032		
		3 p. m....	785	.149	86.1	86.6	.049		
		6 p. m....	785	.115	66.9	69.3	.052		
	Oct. 11	9 p. m....	785	.115	58	48	.042		
		6 a. m....	785	.148	44	43	.091		25.131
		9 a. m....	785	.288	66.3	69.2	.141		
		12 m....	785	.275	75.3	78.5	.125		
		3 p. m....	785	.244	76.8	80	.163		
		6 p. m....	785	.204	64.9	65	.145		
	Oct. 12	9 p. m....	785	.186	52.3	53	.125		
		6 a. m....	785	.192	43	43.1	.138		25.098
		9 a. m....	785	.254	62.2	65	.116		
		12 m....	785	.248	81.5	84	.085		
		3 p. m....	785	.194	87	88.1	.091		
		6 p. m....	785	.144	70	71.8	.084		
		9 p. m....	785	.160	63.7	66.7	.075		
		6 a. m....	785	.149	54	54.5	.070		25.041
	Oct. 13	9 a. m....	785	.207	76.8	83.5	.037		
		12 m....	785	.204	84.5	88.9	.034		
		3 p. m....	785	.090	76.2	79.1	.012		
6 p. m....		785	.110	67.7	69	.045			
9 p. m....		785	.133	62.7	62.9	.049			
6 a. m....		785	.179	50	50	.109	25.144		
Oct. 14	9 a. m....	785	.192	68.8	70.9	.040			

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Albuquerque.....	Oct. 14	12 m.....	785	25.280	65.8	66.5	25.152		
		6 p. m.....	785	.237	59.5	59.9	.190		
		9 p. m.....	785	.325	56.7	57	.253		
	Oct. 15	6 a. m.....	785	.290	52	52.8	.214		25.186
		9 a. m.....	785	.358	60	59.3	.224		
		12 m.....	785	.236	79.2	83	.078		
	Oct. 16	3 p. m.....	785	.269	66	68.5	.212		25.215
		6 p. m.....	785	.238	58.5	59.5	.194		
		9 p. m.....	785	.274	61.2	62.5	.193		
		6 a. m.....	785	.282	52.9	53.7	.204		
		9 a. m.....	785	.300	57	57.5	.173		
		12 m.....	785	.314	60.2	61.5	.198		
	Oct. 17	3 p. m.....	785	.291	60.1	63	.248		25.252
		6 p. m.....	785	.280	57	58	.238		
		9 p. m.....	785	.282	48.7	51.5	.228		
		6 a. m.....	785	.308	48.5	49.3	.241		
		9 a. m.....	785	.396	57	58.7	.269		
		12 m.....	785	.404	77.1	78.6	.250		
	Oct. 18	3 p. m.....	785	.336	70	75.2	.269		25.210
		6 p. m.....	785	.307	65	68	.247		
		9 p. m.....	785	.318	57.5	58.3	.246		
		9 a. m.....	785	.362	65.5	65.6	.257		
		12 m.....	785	.298	73.9	79.2	.151		
		3 p. m.....	785	.299	77	81.5	.218		
	Oct. 19	9 p. m.....	785	.232	65	69.5	.215		25.166
		9 a. m.....	785	.310	76	75.2	.181		
		12 m.....	785	.314	77.1	79.9	.160		
		3 p. m.....	785	.277	82.8	86.5	.183		
		9 p. m.....	785	.198	51.6	52.9	.140		
		9 a. m.....	785	.290	70.7	71.5	.172		
	Oct. 20	12 m.....	785	.268	77.5	80.5	.114		25.107
		3 p. m.....	785	.180	77.6	78	.098		
		9 p. m.....	785	.124	61	60.5	.044		
		6 a. m.....	785	.130	45	45.5	.071		
		9 a. m.....	785	.222	64.5	65.5	.079		
		12 m.....	735	.200	78.5	82	.044		
	Oct. 21	3 p. m.....	785	.096	80	83.5	.009		25.040
		9 p. m.....	785	.054	51	47.1	24.997		
		6 a. m.....	785	24.978	38	37.3	.993		
		9 a. m.....	785	25.032	57.2	60.5	.906		
		12 m.....	785	24.980	69.5	71.4	.846		
		3 p. m.....	785	.961	62.5	66	.914		
	Oct. 22	9 p. m.....	785	25.075	36.1	38.2	25.051		25.137
		9 a. m.....	785	.204	43	44	.150		
		12 m.....	785	.214	70.5	61	.075		
		3 p. m.....	785	.216	71	72	.148		
		9 p. m.....	785	.198	34.5	34	.178		
		6 a. m.....	785	.244	25	25	.214		
	Oct. 24	9 a. m.....	785	.311	60.5	63.3	.177		25.089
		12 m.....	785	.247	62.5	62	.137		
		3 p. m.....	785	.122	69.5	70.8	.058		
		6 p. m.....	785	.036	50	50	.011		
		9 p. m.....	785	24.974	40	44	24.941		
		9 a. m.....	785	.978	43	42	.924		
Oct. 25	9 a. m.....	785	.874	57.7	57.8	.746	24.835		
	6 a. m.....	785	.978	43	42	.924			
Oct. 26	6 a. m.....	785	25.016	31.5	29.5	.987	25.106		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Albuquerque.....	Oct. 26	9 a. m....	785	25.121	55.5	53.5	24.999	
		12 m....	785	.142	69.5	70.5	25.006	
		3 p. m....	785	.105	67.7	68	.045	
	Oct. 27	6 p. m....	785	.052	49	49	.030	
		9 p. m....	785	.044	32	34.5	.029	
		6 a. m....	785	.123	27.5	27	.103	25.109
	Oct. 28	9 a. m....	785	.196	62.3	63.5	.059	
		12 m....	785	.216	80	79.1	.156	
		3 p. m....	785	.168	70	70.3	.102	
	Oct. 29	6 p. m....	785	.156	50.6	51.6	.129	
		6 a. m....	785	.233	33.5	33.5	.200	25.280
		9 a. m....	785	.328	73.5	74.5	.165	
	Oct. 30	12 m....	785	.442	72.5	75.4	.298	
		3 p. m....	785	.446	73.8	74	.370	
		6 p. m....	785	.410	57.5	58.2	.367	
	Oct. 31	6 a. m....	785	.179	34	33	.145	25.350
		9 a. m....	785	.628	61	58	.392	
		12 m....	785	.584	72.3	78.2	.430	
	Nov. 1	3 p. m....	785	.546	82.9	81.5	.452	
		6 p. m....	785	.488	62	62	.435	
		9 a. m....	785	.496	62.5	59.5	.357	25.374
	Nov. 2	12 m....	785	.478	85	84.5	.303	
		3 p. m....	785	.481	72.7	74.5	.409	
		9 p. m....	785	.452	35.5	35.5	.429	
	Nov. 3	9 a. m....	785	.126	61.7	61.2	24.989	25.000
		12 m....	785	.174	73.1	75.4	25.030	
		3 p. m....	785	.106	71.5	79.5	.038	
	Nov. 4	6 p. m....	785	.039	61.5	63.5	24.988	
		9 p. m....	785	24.994	40.8	42	.959	
		6 a. m....	785	25.020	41.2	42.5	.970	24.926
	Nov. 5	9 a. m....	785	.053	61.5	61.7	.917	
		12 m....	785	.068	79.5	82.4	.910	
		3 p. m....	785	24.994	79.5	80.3	.908	
	Nov. 6	6 p. m....	785	.970	66	66.2	.909	
		9 p. m....	785	.978	41	43	.943	
		6 a. m....	785	25.112	28	27.5	25.091	25.152
	Nov. 7	9 a. m....	785	.250	58	58.9	.122	
		12 m....	785	.278	73.6	75.5	.131	
		3 p. m....	785	.258	70.5	71.2	.191	
	Nov. 8	6 p. m....	785	.236	55	55.2	.200	
		9 p. m....	785	.216	37.5	29.5	.179	
		6 a. m....	785	.342	29	28	.321	25.240
	Nov. 9	9 a. m....	785	.361	50	49.7	.250	
		12 m....	785	.364	78.5	81.5	.206	
		3 p. m....	785	.308	72.5	70.2	.237	
	Nov. 10	6 p. m....	785	.282	64	63.5	.225	
		9 p. m....	785	.232	37	39	.206	
		9 a. m....	785	.378	64.5	64.5	.235	25.223
	Nov. 11	12 m....	785	.359	73.2	75	.214	
		3 p. m....	785	.310	70.6	77.2	.242	
		9 p. m....	785	.226	35	36.5	.204	
	Nov. 12	9 a. m....	785	.404	55.6	58	.282	25.229
		12 m....	785	.338	66.5	70.5	.208	
		3 p. m....	785	.279	77.5	80	.197	
Nov. 13	12 m....	785	.210	65.7	68.2	.083	25.073	
	3 p. m....	785	.154	68.3	70.2	.093		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Albuquerque.....	Nov. 6	9 p. m....	785	25.100	50	51	25.045	25.001	
	Nov. 7	6 a. m....	785	.082	37	37	.041		
Camp 61.....	Nov. 8	9 a. m....	785	.094	53	54.5	24.977	25.251	
		12 m....	785	.094	57	.....	.986
	6 a. m....	785	.288	36	38	25.249			
	9 a. m....	785	.364	50	51.4	.253			
Camp 61.....	Nov. 9	9 p. m....	785	.348	39.9	37.5	.315	25.208	
	Nov. 10	Sunrise...	785	.202	24	25	.175		
Station —.....	Nov. 10	9 a. m....	785	.255	54	72	.136	24.992	
		12 m....	785	.109	60.7	64.5	24.992		
Station H.....	Nov. 10	3 p. m....	785	24.665	69	65.5	.604	24.807	
Station 3 + 1/4 mile ..	Nov. 10	Sunset...	785	.574	61.5	58.5	.524		
Camp 62.....	Nov. 11	Sunrise...	785	.824	22.5	23	.802	24.807	
		9 a. m....	785	.924	51	50	.812		
Station 6.....	Nov. 11	1 p. m....	785	.479	63.5	64.5	.399	24.552	
Station between 16 & 17.....	Nov. 11	4 p. m....	785	.500	66.3	67.5	.456		
Station between 18 & 19.....	Nov. 11	Sunset...	785	.457	62.5	61.5	.406	24.552	
Camp 63.....	Nov. 11	9 p. m....	785	.512	46.8	46.9	.467		
	Nov. 12	Sunrise...	785	.657	34.5	33	.608		
Camp 63.....	Nov. 12	9 a. m....	785	.734	46.5634	24.552	
		12 m....	785	.746	68.7	75	.616		
		3 p. m....	785	.708	73.7	80.2	.633		
		6 p. m....	785	.670	58.5	58.5	.628		
		9 p. m....	785	.614	34.5	34.6	.595		
		Sunrise...	785	.586	28.7	28.5	.550		
	Nov. 13	9 a. m....	785	.660	49.2	52	.553		24.552
		12 m....	785	.650	73	84	.509		
		3 p. m....	785	.588	73.8	.....	.519
	Nov. 14	5 p. m....	785	.543	63	63.7	.500		24.552
		9 p. m....	785	.522	41.8	42.7	.488		
		Sunrise ..	785	.476	29	29	.438		
Station between 10 & 11.....	Nov. 14	9 a. m....	785	.330	50	51	.221	24.016	
Station E.....	Nov. 14	12 m....	785	.228	65.3	65	.106		
Camp 64.....	Nov. 14	3 p. m....	785	.068	67.5	67.1	.013	24.016	
		Sunset...	785	.056	62.7	61.8	.040		
Camp 64.....	Nov. 14	9 p. m....	785	.051	49.3	49	.028	24.016	
		Sunrise ..	785	.030	26	27	23.983		
Station 3.....	Nov. 15	9 a. m....	785	.052	51	50.5	.942	23.874	
Station between 13 & 14.....	Nov. 15	1 p. m....	785	.030	64.5	64.5	.953		
Camp 65.....	Nov. 15	3 p. m....	785	23.956	65.5	64	.906	23.874	
		9 p. m....	785	.900	35.7	37.8	.879		
Camp 65.....	Nov. 16	Sunrise...	785	.882	25	25	.838	23.098	
		9 p. m....	785	.799	44.5	49.7	.704		
Station 6.....	Nov. 16	9 a. m....	785	.799	44.5	49.7	.704	23.098	
Station I, bet. 13 & 14	Nov. 16	12 m....	785	.688	59.5	61.3	.579		
Camp 66.....	Nov. 16	3 p. m....	785	.208	62.7	60.7	.165	23.098	
		6 p. m....	785	.180	51.3	51.5	.162		
		9 p. m....	785	.170	27.6	28	22.968		
Station 3.....	Nov. 17	Sunrise...	785	22.988	35	29	.953	22.573	
Station bet. 14 and 15	Nov. 17	9.30 a. m.	785	.719	49	51	.612		
Camp 67.....	Nov. 17	12 m....	785	.660	51.3	51	.571	22.573	
		3 p. m....	785	.582	51.6	52.3	.565		
Camp 67.....	Nov. 17	Sunset....	785	.591	46.7	47.1	.589		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 67.....	Nov. 17	9 p. m....	785	22.594	29.5	31	22.592	
	Nov. 18	Sunrise...	785	.580	17.5	.....	.551	
Station 3.....	Nov. 18	9 a. m....	785	.512	29	29.8	.449	
Station 16.....	Nov. 18	12 m.....	785	.632	48	47.3	.549	
Station 27.....	Nov. 18	3 p. m....	785	.914	49.8	49.5	.899	
Station bet. 31 and 32	Nov. 18	6 p. m....	785	23.082	47.5	45	23.066	
Camp 68.....	Nov. 18	9 p. m....	785	.075	36.2	36	.052	23.033
	Nov. 19	Sunrise...	785	.057	24	24	.014	
Station P.....	Nov. 19	9.30 a. m..	785	.170	40.2	40	.081	
Station 6.....	Nov. 19	12 m.....	785	.253	47.5	48.5	.171	
Camp 69.....	Nov. 19	3 p. m....	785	.534	58.3	54.6	.500	23.562
		Sunset....	785	.526	48.7	47.7	.518	
	Nov. 20	9 p. m....	785	.556	28	25.5	.550	
		Sunrise...	785	.601	9.7	.....	.590	
Station 4.....	Nov. 20	9 a. m....	785	.693	35.5	37.2	.617	
		12 m.....	785	.908	49.8	57.5	.818	
Camp 70, near Zuñi...	Nov. 20	3 p. m....	785	24.032	59.5	61.5	.995	23.995
		5 p. m....	785	.005	53.5	52.7	.985	
	Nov. 21	9 p. m....	785	.014	29.3	28	24.006	
		7 a. m....	785	.024	20.5	.....	23.990	23.979
	Nov. 22	9 a. m....	785	.100	36.5	38	24.022	
		12 m.....	785	.110	64.5	68	23.990	
	Nov. 23	3.30 p. m.	785	.074	65.5	66.5	.938	
		5 p. m....	785	.058	57.7	56.3	.938	
	Nov. 22	9 p. m....	785	.018	32.6	32.7	24.001	
		7 a. m....	785	.020	22	.....	23.982	23.961
	Nov. 24	9 a. m....	785	.028	35.5	36	.961	
		12 m.....	785	.044	65.5	64.8	.921	
	Nov. 23	3 p. m....	785	23.994	68.7	66.9	.935	
		5 p. m....	785	.970	58.5	58.9	.939	
	Nov. 23	9 p. m....	785	24.034	29.8	28.8	24.030	
		7 a. m....	785	23.914	16.5	.....	23.888	23.900
	Nov. 24	9 a. m....	785	.956	34.5	34.7	.881	
		12 m.....	785	.988	64.3	64	.868	
	Nov. 24	3 p. m....	785	.976	68.7	69.5	.917	
		5 p. m....	785	.962	60.3	60.5	.927	
	Nov. 24	9 p. m....	785	.936	32.3	32.5	.921	
		7 a. m....	785	.978	27	25.5	.929	23.931
	Nov. 25	9 a. m....	785	24.020	43.2	44.5	.927	
		12 m.....	785	.037	70.5	70.5	.903	
	Nov. 25	3 p. m....	785	.004	66.8	67.5	.949	
		6 p. m....	785	23.980	58.8	58.5	.938	
	Nov. 25	9 p. m....	785	.964	36.2	36	.941	
		7 a. m....	785	.936	24.5	23.5	.893	23.924
	Nov. 26	9 a. m....	785	.984	36.5	36.9	.906	
		12 m.....	785	24.022	59.3	60.8	.913	
	Nov. 26	3 p. m....	785	23.966	62.8	62.7	24.006	
		6 p. m....	785	.944	55.3	54.5	23.915	
	Nov. 26	9 p. m....	785	.928	31	31	.916	
		7 a. m....	785	.912	26.7	.....	.885	23.892
	Nov. 26	9 a. m....	785	.964	43.8	43.8	.892	*23.931
		3 p. m....	790	24.012	59.5	61.5	24.005	24.030
	Nov. 26	5 p. m....	790	.020	53.5	52.7	.030	
		9 p. m....	790	.028	29.3	28	.055	

* Mean of all the readings of barometer 785.

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 70, near Zuñi...	Nov. 21	7 a. m....	790	24.050	20.5	24.037	24.033	
		9 a. m....	790	.086	36.5	38	.038		
		12 m....	790	.096	64.5	68	.013		
		3 p. m....	790	.066	65.5	66.5	.046		
		5 p. m....	790	.042	57.7	56.3	.045		
	Nov. 22	9 p. m....	790	.006	32.6	32.7	.019		
		7 a. m....	790	23.995	22	23.988		23.972
	Nov. 23	9 a. m....	790	24.028	35.5	36	.984		
		12 m....	790	.034	65.5	64.8	.946		
		3 p. m....	790	23.960	68.7	66.9	.927		23.934
	Nov. 24	5 p. m....	790	.934	60.3	60.5	.930		
		9 p. m....	790	.930	32.3	32.5	.946		
Nov. 25	9 a. m....	790	24.010	43.2	44.5	.950	23.955		
	12 m....	790	.038	70.5	70.5	.937			
	3 p. m....	790	23.985	66.8	67.5	.951			
	6 p. m....	790	.963	58.8	58.5	.953			
	9 p. m....	790	.978	36.2	36.0	.984			
Nov. 26	7 a. m....	790	.934	24.5	23.5	.922	23.922		
	9 a. m....	790	.962	36.5	36.9	.914			
	12 m....	790	24.010	59.3	60.8	.932			
	3 p. m....	790	23.932	62.8	62.7	.919			
	6 p. m....	790	.916	55.3	54.5	.914			
	9 p. m....	790	.904	31	31	.923			
Nov. 26	7 a. m....	790	.898	27.2	26.5	*23.966		
	9 a. m....	790	.931	41.8	43.8	.....		
Station 1.....	Nov. 26	12 m....	785	.937	57.8	58.4	.842	23.832	
Camp 71.....	Nov. 26	3 p. m....	785	.946	60.4	59	.906		
		Sunset...	785	.934	54.2	54	.912		
		9 p. m....	785	.962	48.5	48.5	.912		
Nov. 27	Sunrise...	785	.846	44.5	44.5	.761			
	9 a. m....	785	.854	38.5	38.8	.772			
	12 m....	785	.845	41.2	42	.774			
	3 p. m....	785	.820	48	49	.806			
	5 p. m....	785	.816	42.3	42	.820			
Nov. 28	9 p. m....	785	.798	35.2	35.5	.777			
	Sunrise...	785	.900	23.5	32.5	.859			
	9 a. m....	785	.928	33.8	33.3	.855			
Station bet. 4 and 5...	Nov. 28	12 m....	785	24.052	44.5	46.2	.973	23.971	
Station M.....	Nov. 28	3 p. m....	785	46.5	.973		
Camp 72.....	Nov. 28	Sunset...	785	23.989	57.5	58.5	.960		
		9 p. m....	785	24.004	31.7	36	.989		
Nov. 29	Sunrise...	785	.040	35	35	.974			
	9 a. m....	785	.046	37.8	44.8	.964			
	12 m....	785	.029	51.7	52	.935			
Station 8.....	Nov. 29	3 p. m....	785	23.950	59.3	59	.913		24.272
Station 12.....	Nov. 29	Sunset...	785	24.928	54.6	50	24.299		
Station bet. 16 and 17	Nov. 29	9 p. m....	785	.322	39	37.5	.292		
		Camp 73.....	Nov. 30	Sunrise...	785	.322	37.5			30	.251
Nov. 30	9 a. m....	785	.391	53.8	53.8	.273			
	Station C.....	Nov. 30	12 m....	785	.490	49.7	50	.299	
	Camp 74.....	Nov. 30	3 p. m....	785	.660	56.8	56	.626	
Sunset...			785	.648	53.2	53	.626		
9 p. m....			785	.615	36	36.3	.592		
Dec. 1	Sunrise...	785	.610	21	20.5	.575			

* Mean of all the readings of barometer 790.

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 74.....	Dec. 1	9 a. m....	785	24.670	47.3	41.5	24.566	
Station C.....	Dec. 1	12 m.....	785	.771	52.5	56.3	.674	
Station L.....	Dec. 1	3 p. m.....	785	.624	57.8	59.5	.587	
Camp 75.....	Dec. 1	Sunset....	785	.733	57.8	59.3	.701	24.677
		9 p. m.....	785	.682	31.7	34.7	.667	
		Sunrise....	785	.722	25.5	24.5	.678	
	Dec. 2	9 a. m.....	785	.762	45.2	42.5	.663	
Station B.....	Dec. 2	12 m.....	785	.608	55.7	53.7	.504	
Station K.....	Dec. 2	3 p. m.....	785	.657	64.8	60.9	.605	
Camp 76.....	Dec. 2	Sunset....	785	.775	65.4	59.5	.726	24.696
		9 p. m.....	785	.736	38.3	38.3	.708	
	Dec. 3	Sunrise....	785	.698	26.5	26.3	.651	
		9 a. m.....	785	.797	43.7	44	.701	
Station P.....	Dec. 3	12 m.....	785	25.035	56	59.5	.930	
Station 7.....	Dec. 3	3 p. m.....	785	24.959	66.2	64	.903	
Station Z.....	Dec. 3	Sunset....	785	25.076	62.3	54	25.021	
Camp 77.....	Dec. 3	9 p. m.....	785	.068	33.8	32.3	.049	24.992
	Dec. 4	Sunrise....	785	.032	25.3	25	24.987	
		9 a. m.....	785	.100	47.8	44.3	.994	
		12 m.....	785	.073	57.7	.....	.963	
		3 p. m.....	785	.038	61.5	.....	.992	
		5 p. m.....	785	.054	66.7	73.3	25.001	
		9 p. m.....	785	24.996	30	31.3	24.986	
Station E.....	Dec. 5	7 a. m.....	785	25.000	19.5	19.5	.968	
Camp 78.....	Dec. 5	12 m.....	785	.072	64.6	.....	.948	
	Dec. 5	3 p. m.....	785	.180	67.5	65.2	25.120	25.179
		Sunset....	785	.182	57.7	58.2	.149	
		9 p. m.....	785	.202	35.5	37	.182	
	Dec. 6	Sunrise....	785	.248	19.5	20.2	.218	
		9 a. m.....	785	.315	38.6	39	.229	
Station 8.....	Dec. 6	3 p. m.....	785	.353	60.3	59.3	.310	
Station E.....	Dec. 6	Sunset....	785	.378	53.8	51.3	.348	
Camp 79.....	Dec. 6	9 p. m.....	785	.432	30.8	27.9	.419	25.407
	Dec. 7	Sunrise....	785	.416	12	.....	.402	
		9 a. m.....	785	.474	32.8	36.7	.402	
Station B.....	Dec. 7	12 m.....	785	.504	51.8	56.5	.406	
Camp 80.....	Dec. 7	3 p. m.....	785	.557	68.7	64.2	.493	25.435
		Sunset....	785	.510	58.7	50.8	.473	
	Dec. 7	9 p. m.....	785	.449	25.5	25.5	.449	
	Dec. 8	Sunrise....	785	.405	15	15	.384	
		9 a. m.....	785	.434	26.4	26.8	.378	
Station 6.....	Dec. 8	12 m.....	785	.448	50.6	56.3	.353	
Camp 81.....	Dec. 8	3 p. m.....	785	.388	57.7	55.9	.340	25.256
		3 p. m.....	790	.383	57.7	55.9	.382	25.273
		Sunset....	785	.342	45.5	44	.336	25.240
		Sunset....	790	.332	45.5	44	.357	
		9 p. m.....	790	.290	29.5	30.6	.315	
		9 p. m.....	785	.284	29.5	30.6	.275	
	Dec. 9	Sunrise....	785	.176	27	27.5	.127	
		Sunrise....	790	.182	27	27.5	.164	
		9 a. m.....	790	.187	31.8	32.5	.150	
		9 a. m.....	785	.194	31.8	32.5	.124	
Camp 82.....	Dec. 10	7 a. m.....	785	.110	33.0	33.0	.048	24.959
		7 a. m.....	790	.118	33.0	33.0	.086	25.001
		9 a. m.....	790	.141	43.7	44.0	.067	
		9 a. m.....	785	.132	43.7	44.0	.035	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 82.....	Dec. 10	12 m.....	785	25.128	48.5	49.8	25.034		
		12 m.....	790	.123	48.5	49.8	.068		
		3 p. m.....	790	.063	58.6	59.9	.054		
		3 p. m.....	785	.063	58.6	59.9	.023		
		5 p. m.....	785	.084	52.3	53.0	.053		
		5 p. m.....	790	.074	52.3	53.0	.084		
		9 p. m.....	790	.066	48.5	49.5	.044		
		9 p. m.....	785	.068	48.5	49.5	.016		
		7 a. m.....	785	.076	43.5	43.8	24.990		
	Dec. 11	7 a. m.....	790	.086	43.5	43.8	25.033		
		9 a. m.....	785	.146	50.0	49.9	.036		
		9 a. m.....	790	.134	50.0	49.9	.049		
		12 m.....	785	.153	58.0	59.0	.043		
		12 m.....	790	.176	58.0	59.0	.106		
		3 p. m.....	785	.151	52.2	52.3	.126		
		3 p. m.....	790	.148	52.2	52.3	.153		
		5 p. m.....	785	.170	48.6	49.2	.157		
		5 p. m.....	790	.206	48.6	49.2	.225		
		9 p. m.....	785	.228	39.3	42.6	.196		
		Dec. 12	9 p. m.....	790	.220	39.3	42.6	.218	
			7 a. m.....	785	.260	35.8	38.0	.191	
	7 a. m.....		790	.250	35.8	38.0	.211		
	9 a. m.....		785	.260	37.9	38.5	.177		
	9 a. m.....		790	.250	37.9	38.5	.198		
	12 m.....		785	.241	46.7	47.8	.156		
	12 m.....		790	.208	46.7	47.8	.155		
	3 p. m.....		785	.134	49.5	50.0	.115		
	3 p. m.....		790	.130	49.4	50.0	.142		
	5 p. m.....		785	.096	46.5	47.8	.099		
	5 p. m.....		790	.108	46.6	47.8	.137		
	9 p. m.....		785	.092	40.0	42.0	.060		
	9 p. m.....		790	.082	40.8	42.0	.080		
	Dec. 13		7 a. m.....	785	.050	41.6	42.0	24.969	
			7 a. m.....	790	.042	41.2	42.0	.992	
		9 a. m.....	785	.058	42.0	43.5	.966		
		9 a. m.....	790	.052	42.4	43.5	.990		
		12 m.....	785	.052	60.1	60.8	.938		
		12 m.....	790	.046	58.5	60.8	.967		
		3 p. m.....	785	24.990	59.2	59.2	.950		
		3 p. m.....	790	.992	59.0	59.2	.983		
		5 p. m.....	785	.972	47.0	47.6	.964		
		5 p. m.....	790	.976	46.5	47.6	25.000		
9 p. m.....		785	25.004	39.5	40.0	24.972			
9 p. m.....		790	.002	41.5	40.0	.997			
Dec. 14		7 a. m.....	785	.024	30.0	30.8	.969		
		7 a. m.....	790	.020	30.0	30.8	.996		
		9 a. m.....	785	.062	51.0	44.5	.950		
	9 a. m.....	790	.072	43.5	44.5	25.007			
	12 m.....	785	.060	42.0	42.0	24.986			
Station 4.....	Dec. 14	12 m.....	790						
Camp 83.....	Dec. 14	3 p. m.....	785	.058	44.5	44.0	25.050	25.186	
		3 p. m.....	790	.054	44.5	44.0	.077	25.233	
		5 p. m.....	785	.052	36.2	36.0	.068		
		5 p. m.....	790	.046	36.5	36.0	.092		
		9 p. m.....	785	.062	28.0	28.5	.056		
		9 p. m.....	790	.054	28.0	28.5	.079		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.			
Camp 83.....	Dec. 15	7 a. m.	785	25.030	24.5	25.0	24.987				
		7 a. m.	790	.026	24.6	25.0	25.014				
		9 a. m.	785	.073	38.5	37.4	24.982				
		9 a. m.	790	.086	41.8	37.4	25.026				
		12 m.	785	.058	42.5	43.7	24.973				
		12 m.	790	.070	47.0	43.7	25.016				
		3 p. m.	785	.052	32.5	.....	.071		
		3 p. m.	790	.052	32.5	.....	.103		
		5 p. m.	785	.094	33.0	33.0	.122				
		5 p. m.	790	.094	33.0	33.0	.148				
	Dec. 16	9 p. m.	785	.132	30.0	30.2	.122				
		9 p. m.	790	.140	29.9	30.2	.161				
		7 a. m.	785	.218	7.5	.....	.214		
		7 a. m.	790	.212	7.5	.....	.238		
		9 a. m.	785	.232	34.0	37.5	.158				
		9 a. m.	790	.300	46.8	37.5	.228				
		Station 2.....	Dec. 16	12 m.	785	.344	36.5		35.0	.283	
				Camp 84.....	3 p. m.	785	.328		40.0	40.2	.330
		Camp 84.....	Dec. 16	3 p. m.	790	.330	44		40.2	.364	25.333 25.367
				5 p. m.	785	.296	32.0		31.9	.320	
5 p. m.	790			.298	31.5	31.9	.354				
9 p. m.	785			.305	12.0	.....	.335		
9 p. m.	790			.303	11.8	.....	.329		
Dec. 17	7 a. m.		785	.334	8.0	.....	.329		
	7 a. m.		790	.336	8.0	.....	.361		
	9 a. m.		785	.422	27.0	31.0	.363				
	9 a. m.		790	.416	25.7	31.0	.393				
	Station C.....		Dec. 17	12½ p. m.	785	.382	44.5	51.0	.302		
Station 7.....	Dec. 17	3 p. m.	785	.426	49.5	54.9	.405	25.390 25.419			
		Camp 85.....	5 p. m.	785	.419	47.5	46.5		.409		
Camp 85.....	Dec. 17	5 p. m.	790	.416	46.5	46.5	.439				
		9 p. m.	785	.372	20.5	21.9	.382				
		9 p. m.	790	.368	20.5	21.9	.411				
		Dec. 18	7 a. m.	785	.376	8.5370		
			7 a. m.	790	.372	8.5399		
	8 a. m.		785	.403	12.7	.....	.382		
	8 a. m.		790	.398	16.9	.....	.398		
	9 a. m.		785	.442	28.5	31.0	.380				
	9 a. m.		790	.438	28.1	31.0	.408				
	10 a. m.		785	.456	32.5	34.0	.378				
	10 a. m.		790	.458	34.4	34.0	.408				
	11 a. m.		785	.456	36.6	.....	.356		
	11 a. m.		790	.458	37.6	.....	.388		
	12 m.		785	.448	42.5	48.2	.372				
	12 m.		790	.447	43.4	48.2	.401				
	1 p. m.		785	.435	48.1	49.5	.387				
	1 p. m.		790	.430	47.5	49.5	.414				
	2 p. m.		785	.424	48.9	51.0	.385				
	2 p. m.	790	.424	54.5	51.0	.415					
	3 p. m.	785	.430	50.9	53.9	.407					
3 p. m.	790	.432	55.0	53.9	.431						
4 p. m.	785	.416	48.0	44.5	.409						
4 p. m.	790	.412	46.0	44.5	.441						
5 p. m.	785	.399	39.4	38.5	.408						
5 p. m.	790	.400	37.5	38.5	.444						
6 p. m.	785	.386	30.5	30.5	.404						

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 85.....	Dec. 18	6 p. m.	790	25.390	31	30.5	25.438	
		7 p. m.	785	.389	29.5	29	.400	
		7 p. m.	790	.390	29.9	29	.430	
		8 p. m.	785	.394	22	22	.407	
		8 p. m.	790	.394	21.9	22	.438	
	Dec. 19	9 p. m.	785	.386	12	.....	.417	
		9 p. m.	790	.392	12	.....	.454	
		7 a. m.	785	.388	10.5	.....	.377	
		7 a. m.	790	.392	11.5	.....	.413	
		9 a. m.	785	.426	22.8	23.5	.377	
Station A.....	Dec. 19	12 m.	785	.412	35.9	36	.383	
	Camp 86.....	Dec. 19	3 p. m.	785	.344	42	40.9	25.294
Camp 86.....	Dec. 19	3 p. m.	790	.338	42	40.9	.367	25.320
		6 p. m.	785	.324	35	35.2	.332	
		6 p. m.	790	.318	35	35.2	.357	
		9 p. m.	785	.284	20	20.5	.258	
		9 p. m.	790	.280	20	20.5	.285	
	Dec. 20	7 a. m.	785	.290	10	.....	.280	
		7 a. m.	790	.280	10.1	.....	.301	
		9 a. m.	785	.326	29.5	30	.262	
		9 a. m.	790	.318	27	30	.290	
		Camp 87.....	Dec. 20	12 m.	785	.322	51.6	57	.226	25.243
Camp 87.....	Dec. 20	3 p. m.	785	.312	54.5	55.2	.282	
		3 p. m.	790	.310	51.6	55.2	.317	25.273
		5 p. m.	785	.314	42.5	42	.316	
		5 p. m.	790	.308	42	42	.341	
		9 p. m.	785	.314	45.5	.....	.296	
	Dec. 21	9 p. m.	790	.307	33.5	34	.320	
		7 a. m.	785	.294	33.5	34	.244	
		7 a. m.	790	.286	27.5	27.5	.276	
		9 a. m.	785	.318	34.6	34.8	.244	
		9 a. m.	790	.302	40.3	34.8	.255	
12 m.		785	.264	53.7	54.6	.164		
12 m.		790	.288	54.3	54.6	.217		
3 p. m.		785	.274	55.5	52	.242		
3 p. m.		790	.268	52.5	52	.273		
5 p. m.		785	.278	46.7	45.8	.270		
Dec. 22	5 p. m.	790	.264	45.7	45.8	.289		
	9 p. m.	785	.268	38.5	39.5	.239		
	9 p. m.	790	.272	39.5	39.5	.271		
	7 a. m.	785	.250	27.5	27.5	.200		
	7 a. m.	790	.244	27.5	27.5	.226		
	9 a. m.	785	.282	37.7	.....	.199		
	9 a. m.	790	.274	38.7	.....	.226		
	Station A.....	Dec. 22	12 m.	785	.053	51.2	.....	24.959
	Station 17.....	Dec. 22	3 p. m.	785	24.716	49.5	.....	.696
	Camp 88.....	Dec. 22	7 ¹ / ₂ p. m.	790	.676	39.5	37.8	.685	24.703
9 p. m.			790	.687	37.7	.....	.690	
Dec. 23		7 a. m.	790	.726	28	30	.705	
Station 7.....	Dec. 23	9 a. m.	790	.767	28.5	30	.735	
		12 m.	785	.170	28.6	.....	.136	
		3 p. m.	785	23.966	35.7	.....	23.755	
Station 12.....	Dec. 23	5 p. m.	785	.966	23.2	.....	24.006	
Camp 89.....	Dec. 23	7 a. m.	785	.966	3.5	.....	23.983	23.983
		9 a. m.	785	24.039	26.7	26.7	.977	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 89.....	Dec. 24	9 a. m.	790	23.991	20.5	26.7	23.977	24.003	
		12 m.	785	24.005	45.5	51.6	.925		
		12 m.	790	23.980	44	51.6	.934		
		3 p. m.	785	.962	47.2	53.8	.950		
		3 p. m.	790	.940	47.2	53.8	.959		
		6 p. m.	785	.928	33.3	34.9	.953		
		6 p. m.	790	.906	34	34.9	.948		
		9 p. m.	785	.876	15.3	.....	.908
		9 p. m.	790	.862	15.5	.....	.904
	Dec. 25	7 a. m.	785	.924	5.5	5.5	.922		
		7 a. m.	790	.934	6.5	5.5	.960		
		9 a. m.	785	24.050	28.5	33	.998		
		9 a. m.	790	.050	26.5	33	24.022		
		12 m.	785	.048	38.5	39	23.982		
		12 m.	790	.047	39.8	39	24.099		
		3 p. m.	785	.028	42.5	46.2	.026		
		3 p. m.	790	.034	43	46.2	.062		
		5 p. m.	785	.012	35	37	.031		
		5 p. m.	790	.018	36.2	37	.065		
		9 p. m.	785	.020	17	.....	.038
		9 p. m.	790	.034	17	.....	.383
	Dec. 26	7 a. m.	785	.034	3037		23.983
		7 a. m.	790	.022	3056		24.003
		9 a. m.	785	.080	21	25	.034		
9 a. m.		790	.074	21.6	.....	.058	
12 m.		785	23.958	50.7	.....	23.874		
Station C.....	Dec. 26	12 m.	785	.430	45.5	.....	.417
Station F.....	Dec. 26	2.40 p. m.	785	.482	39.7	40.3	.491		
Camp 90.....	Dec. 26	5 p. m.	785	.510	35.5	36.3	.488		
		9 p. m.	785	.528	29	30	.475		
	Dec. 27	7 a. m.	785	.567	32.1	33.2	.498	23.488	
		9 a. m.	785	.298	44	.....	.122
Station 13.....	Dec. 27	12 m.	785	.122	37.5	.....	.132
Station D.....	Dec. 27	3 p. m.	785	.028	29.5	30.2	.019	22.888	
Camp 91.....	Dec. 27	9 p. m.	785	.006	23.5	23.5	22.964		
		Dec. 28	7 a. m.	785	.062	46.8960	
9 a. m.	790		.020	44.8	.....	.955	
12 m.	785		.008	61.5	71	.896			
12 m.	790		22.986	60.8	71	.906			
3 p. m.	785		.964	48.5	51.6	.950			
3 p. m.	790		.952	49	51.6	.969			
Sunset—	785		.939	42	47.7	.934			
6 p. m.	790		.920	42.3	47.7	.956			
9 p. m.	785		.938	44.9	45.3	.897			
9 p. m.	790		.916	45.3	45.3	.906			
Dec. 29	7 a. m.		785	.854	36.5	37.5	.786		
	7 a. m.		790	.828	36.7	37.5	.790		
	9 a. m.	785	.886	38.5	39.5	.803			
	9 a. m.	790	.848	37.5	39.5	.798			
	12 m.	785	.844	41.7	45.2	.773			
	12 m.	790	.815	42.6	45.2	.773			
	3 p. m.	785	.811	43.7	45.9	.808			
	3 p. m.	790	.806	43.7	45.9	.834			
	6 p. m.	785	.814	38	38.7	.817			
	6 p. m.	790	.806	38.5	38.7	.849			

METEOROLOGICAL OBSERVATIONS—Continued

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 91.....	Dec. 29	9 p. m....	785	22.828	28	29.5	22.822	
		9 p. m....	790	.816	29.6	29.5	.838	
Camp 91.....	Dec. 30	7 a. m....	785	.802	12.5	.....	.783	
		7 a. m....	790	.820	12.7	.....	.832	
		9 a. m....	785	.852	30	31	.787	
		9 a. m....	790	.854	30.5	31	.819	
		12 m....	785	.898	41.2	49	.828	
		12 m....	790	.886	41.6	49	.846	
		3 p. m....	785	.914	32	.....	.935	
		3 p. m....	790	.908	32.9	.....	.958	
		5 p. m....	785	.920	24.5	25.6	.961	
		5 p. m....	790	.911	25	25.6	.985	
		9 p. m....	785	.918	17.5	.....	.934	
		9 p. m....	790	.914	18	.....	.960	
Camp 91.....	Dec. 31	7 a. m....	785	.986	15	.....	.962	
		7 a. m....	790	.976	15.6	.....	.982	
		9 a. m....	785	23.054	33.4	39.5	.982	
		9 a. m....	790	.040	33.6	39.5	23.013	
		9 a. m....	790	.040	33.6	39.5	23.013	
Station 7.....	Dec. 31	12 m....	785	22.910	47.5	45	22.928	
Camp 92.....	Dec. 31	3 p. m....	785	23.013	48.5	44.5	23.000	23.002
		Sunset—	785	22.980	34.5	34.8	.001	
Camp 92.....		5 p. m....	790	.980	37.8	34.8	.024	23.022
		9 p. m....	785	22.026	30	30.2	.016	
		9 p. m....	790	.018	30	30.2	.039	
		7 a. m....	785	.048	29.5	29	22.995	
		7 a. m....	790	.032	29.5	29	23.009	
Camp 92.....	Jan. 1	9 a. m....	785	.086	39.9	41	.000	
		9 a. m....	790	.076	40.6	41	.019	
		12 m....	785	.180	51	55	.090	
		3 p. m....	785	.184	55.7	49.5		
		5 p. m....	785	.166	35.5	36.2	.184	
Camp 93.....	Jan. 1	5 p. m....	790	.162	37	36.2	.208	
		9 p. m....	785	.140	32.6	33.9	.124	
		9 p. m....	790	.134	33	33.9	.149	
		7 a. m....	785	.144	24.5	24	.100	
		7 a. m....	790	.130	24.6	24	.116	
Camp 93.....	Jan. 2	9 a. m....	785	.190	39	41.6	.106	
		9 a. m....	790	.178	37.5	47.5	.108	
		12 m....	785	.424	51.5	47.5	.233	
		3 p. m....	785	.704	42	50	.703	
		7 a. m....	785	.632	20.9	20	.596	23.493
Camp 94.....	Jan. 3	7 a. m....	790	.620	21	20	.615	
		9 a. m....	785	.642	46.9	47.5	.541	
		9 a. m....	790	.632	47	47.5	.562	
		10 a. m....	785	.646	51.2	.....	.529	
		10 a. m....	790	.650	51	47.5	.565	
		11 a. m....	785	.522	50	.....	.395	
		11 a. m....	790	.616	51.5	47.5	.517	
		12 m....	785	.518	53.5	.....	.421	
		12 m....	790	.604	57.4	47.5	.530	
		1 p. m....	785	.500	57.4	61	435	
		1 p. m....	790	.594	59	61	559	
		2 p. m....	785	.588	56	.....	548	
		2 p. m....	790	.572	55.9	61	563	
		3 p. m....	785	.574	51	53	555	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 94.....	Jan. 3	3 p. m....	790	23.582	54	53	23.587		
		4 p. m....	785	.550	49.4	.....	.544	
		4 p. m....	790	.542	46	53	.587		
		5 p. m....	785	.556	33.9	.....	.577	
		5 p. m....	790	.520	36	53	.568		
		7 p. m....	785	.504	31.5	.....	.516	
		7 p. m....	790	.506	32	53	.543		
		8 p. m....	785	.514	36.5	.....	.495	
		8 p. m....	790	.520	36.5	53	.532		
	Jan. 4	9 p. m....	785	.500	30.5	33	.489		
		9 p. m....	790	.500	31	33	.519		
		7 a. m....	785	.412	30	30.1	.357		
		7 a. m....	790	.380	30.5	30.1	.355		
		9 a. m....	785	.442	39.7	38.9	.357		
		9 a. m....	790	.424	37.9	38.9	.393		
		12 m....	785	.370	41	42.4	.300		
		12 m....	790	.372	41.8	42.4	.332		
		3 p. m....	785	.340	43	43	.338		
		3 p. m....	790	.330	43.4	43	.358		
		5 p. m....	785	.322	29.5	30	.341		
		5 p. m....	790	.299	35	30	.349		
		9 p. m....	785	.312	29.5	30	.303		
		9 p. m....	790	.296	30.5	30	.316		
		Jan. 5	7 a. m....	785	.268	27.8	28	.217	
	7 a. m....		790	.276	28	28	.256		
	9 a. m....		785	.294	35.8	36	.214		
	9 a. m....		790	.286	36	36	.239		
	12 m....		785	.264	43.6	46.7	.189		
	12 m....		790	.257	44.2	46.7	.212		
	3 p. m....		785	.244	35	36	.259		
	3 p. m....		790	.238	35.6	36	.283		
	6 p. m....		785	.272	34	35	.298		
	6 p. m....		790	.265	34.5	35	.317		
	9 p. m....		785	.263	32.5	34.2	.248		
	9 p. m....		790	.254	34.9	34.2	.264		
	Jan. 6		7 a. m....	785	.336	22	23	.298	
			7 a. m....	790	.336	22.6	23	.360	
			9 a. m....	785	.376	22.6	24	.322	
		9 a. m....	790	.386	23.5	24	.383		
		12 m....	785	.388	28.5	30.1	.341		
		12 m....	790	.398	29.6	30.1	.493		
		3 p. m....	785	.440	28.5	28.5	.468		
3 p. m....		790	.436	29.5	28.5	.555			
5 p. m....		785	.482	23	22.9	.527			
5 p. m....		790	.480	23.5	22.9	.597			
9 p. m....		785	.586	28.2	23	.579			
9 p. m....		790	.560	22.3	23	.661			
Jan. 7		7 a. m....	785	.654	11.5	.....	.638	
		7 a. m....	790	.646	11.5	23	.693		
		9 a. m....	785	.736	30	34.5	.665		
	9 a. m....	790	.726	29.5	34.5	.690			
	12 m....	785	.732	38.7	43.7	.666			
	12 m....	790	.728	40.5	43.7	.742			
	3 p. m....	785	.717	38.5	40.5	.742			
	3 p. m....	790	.708	40.5	40.5	.742			
	9 p. m....	785	.674	27	.....	.675		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 94.....	Jan. 7	9 p. m....	790	23.692	25.5	40.5	23.762	
	Jan. 8	7 a. m....	785	.724	30.6	31.5	.667	
		7 a. m....	790	.718	31	31.5		
		9 a. m....	785	.732	35.8	37	.709	
Station C.....	Jan. 8	9 a. m....	790	.708	36	37		
		12 m....	785	.764	51	.....	.672	
Camp 95.....	Jan. 8	5 p. m....	785	.976	41	.....	.932	
		9 p. m....	785	.974	35	35.3	.953	
	Jan. 9	7 a. m....	785	.924	19	.....	.893	
Station 6.....	Jan. 9	9 a. m....	785	.960	42.5	44.2	.868	
		12 m....	785	24.032	50	.....	.942	
Station 13.....	Jan. 9	3 p. m....	790	.286	49.5	.....	24.257	
Camp 96.....	Jan. 9	Sunset....	790	.362	37.8	37.8	.406	
		3 p. m....	790	.368	28.6	29.8	.392	
	Jan. 10	Sunrise....	790	.382	29	28.5	.360	
		9 a. m....	790	.428	34.5	34.7	.384	
Station 14.....	Jan. 10	9 a. m....	784	.454	34	34.7		
		12 m....	784	.714	43.6	42.9	.625	
Camp 97.....	Jan. 10	3 p. m....	784	25.008	45	49	.957	24.885
		Sunset....	784	.....	38.3	38	.999	
		9 p. m....	784	24.988	26.5	26.8	.974	
	Jan. 11	7 a. m....	784	25.010	20.5	20.5	.964	
		7 a. m....	790	.....	.....	.....	.....
		9 a. m....	784	.026	34.3	40	.939	
		9 a. m....	790	.....	.....	.....	.....
		12 m....	784	24.984	55.6	63	.868	
		12 m....	790	.970	55	54.5	.897	
		3 p. m....	784	.930	59.2	48	.898	
	Jan. 12	3 p. m....	790	.904	63.5	59.9	.904	
		5 p. m....	784	.688	41.5	42.5	.885	
		5 p. m....	790	.862	42	42.5	.896	
		9 p. m....	784	.826	25	27	.815	
9 p. m....		790	.806	25	27	.838		
7 a. m....		790	.734	16	.....	.741	24.840	
12 m....		784	.930	55	54.5	.815	24.879	
Camp 98.....	Jan. 12	3 p. m....	784	.904	63.5	59.9	.842	24.000
		3 p. m....	790	.894	62.5	59.9	.877	
		5 p. m....	784	.890	48.5	49	.866	
	Jan. 13	5 p. m....	790	.864	49.5	49	.881	
		9 p. m....	784	.876	27	27.5	.861	
		9 p. m....	790	.858	27.5	27.5	.884	
		7 a. m....	784	.898	20.5	21	.852	
Station A.....	Jan. 13	7 a. m....	790	.879	21.5	21	.874	
		9 a. m....	784	.930	4.30	.....	.824	
		12 m....	784	25.020	52	56	.911	
Station 15.....	Jan. 13	3 p. m....	784	.084	60	58	25.030	
Camp 99.....	Jan. 13	Sunset....	784	.171	52.5	53	.....	24.998
		9 p. m....	784	.166	47	43.5		
	Jan. 14	7 a. m....	784	.086	44.5	43.3		
		9 a. m....	784	.080	48	48		
		9 a. m....	790	.056	47.2	48		
		12 m....	784	.038	51	51		
		12 m....	790	.992	51	51		
		3 p. m....	784	.980	50	51		
		3 p. m....	790	.....	.....	.....	.....
	Jan. 15	7 a. m....	784	24.928	26.5	27		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.		
Camp 99.....	Jan 15	7 a. m.	790	24.872	27	27				
		9 a. m.	784	.972	33	32.5				
		9 a. m.	790	.950	33	32.5				
		12 m.	784	.992	38	38				
		12 m.	790	.970	39	38				
		3 p. m.	784	.011	37.2	36.9				
		3 p. m.	790	.962	37	36.9				
		Sunset.	784	.998	32.5	32.5				
		Sunset.	790	.962	32.5	32.5				
		9 p. m.	784	25.046	25	26				
	9 p. m.	790	.....	25	26				
	Jan. 16	7 a. m.	784	.003	10	.....	25.042	24.998	
		7 a. m.	790	.024	11	.....	25.052	24.977	
		9 a. m.	784	.116	30	33.5				
9 a. m.		790	.088	30.5	33.5					
Camp 100.....	Jan. 16	12 m.	784	.212	41.2	.....	.127	25.153
		3 p. m.	784	.200	43	.....	.183	
		5 p. m.	784	.193	29	.....	.283	
	Jan. 17	7 ¹ / ₂ a. m.	784	.291	32	.....	.217	
		9 a. m.	784	.378	55.5	.....	.243	
		12 m.	784	.340	57	.....	.229	
		3 p. m.	784	.326	59	.....	.272	
		5 p. m.	784	.281	39.5	.....	.277	
	Jan. 18	9 p. m.	784	.280	21.5	.....	.277	
		9 a. m.	784	.270	42.5	.....	.165	
	Jan. 19	7 a. m.	784	24.895	35.5	24.815			
		9 a. m.	784	.935	44826			
	Camp 101.....	Jan. 19	3 p. m.	784	.660	35	33		.662	
			5 p. m.	784	.702	29	29		.722	
8 p. m.			784	.706	24.5	24	.701			
Jan. 20		7 a. m.	784	.892	8.5	.....	.873	
		9 a. m.	784	.996	19.5	22	.942			
Station 5.....		Jan. 20	12 m.	784	.704	20.0667		
			3 p. m.	784	.814	20.5	20	.850		
Camp 102.....		Jan. 20	Sunset.	784	.554	10616		
	9 p. m.		784	.544	5	.....	.599	
	Jan. 21	7 a. m.	784	.582	.....	.....	.581	
Station 5.....	Jan. 21	9 a. m.	784	.564	35.5	28.5	.554			
		12 m.	784	.608	39.5	37.5	.528			
Camp 103.....	Jan. 21	3 p. m.	784	.998	43.5	43.7	.981	24.995		
		3 p. m.	783	25.006	54.5	43.7	.964			
		5 p. m.	784	24.992	32.2	34	25.002			
	Jan. 22	5 p. m.	783	25.010	33.7	34	.002			
		9 p. m.	784	24.986	20.5	.....	24.985		
		9 p. m.	783	.944	21.5	23	.991			
		7 a. m.	784	25.064	26.3	26	25.005			
		7 a. m.	783	.070	26	26	.012			
	Jan. 22	9 a. m.	784	.084	32	33.5	.002			
		9 a. m.	783	1.02	32	33.5	.020			
		12 m.	784	24.946	47.7	.....	24.846		
Station 14.....	Jan. 22	3 p. m.	784	.556	45.5	43.9	.537			
Station 17.....	Jan. 22	Sunset.	784	.528	45.5	.....	.509	
Camp 104.....	Jan. 22	9 p. m.	784	.536	25	26	.525	24.467		
		7 a. m.	784	.508	26	26.8	.450			
	Jan. 23	9 a. m.	784	.536	44.5	42.5	.427			
Station 6.....	Jan. 23	12 m.	790	23.957	55	57	23.887			

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 105.....	Jan. 23	3 p. m....	790	24.426	54	54.8	24.429	24.381
		3 p. m....	784	.485	55.7	54.8	.442	24.376
		5 p. m....	790	.392	39	48.9	.433	
		5 p. m....	784	.442	40	48.9	.438	
		9 p. m....	790	.400	37	38	.405	
	Jan. 24	9 p. m....	784	.418	37	38	.350	
		7 a. m....	790	.366	38.9	39.9	.323	
		7 a. m....	784	.402	39.7	39.9	.314	
		9 a. m....	790	.396	58	50	.317	
		9 a. m....	784	.429	58	50	.306	
Station D.....	Jan. 24	12 m....	790					
Camp 106.....	Jan. 24	3 p. m....	790	.750	56.5	55.1	.748	24.709
		3 p. m....	784	.767	56	55.1	.722	24.689
		5 p. m....	790	.712	42.5	43.1	.744	
	Jan. 25	5 p. m....	784	.761	42.3	43.1	.752	
		9 p. m....	790	.682	39.5	40.9	.682	
		9 p. m....	794	.740	39.5	40.9	.697	
		7 a. m....	790	.682	35.5	35	.651	
		7 a. m....	784	.654	35	35	.576	
		9 a. m....	790	.650	52.5	47	.566	
		9 a. m....	784	.668	47.5	47	.552	
		12 m....	790	.590	48.9	48.9	.530	
		12 m....	784	.618	49.5	48.9	.516	
		3 p. m....	790	.528	45	44.1	.551	
		3 p. m....	784	.554	45	44.1	.534	
		Jan. 26	5 p. m....	790	.520	40.5	40	.558
	5 p. m....		784	.534	40	40	.532	
	9 p. m....		790	.522	34	34	.534	
	9 p. m....		784	.540	34	34	.509	
	7 a. m....		790	.634	11.5	11	.640	
	7 a. m....		784	.651	11	11	.626	
	9 a. m....		790	.734	36.6	49	.685	
	9 a. m....		784	.756	38.5	49	.660	
	12 m....		790	.792	39.5	48	.754	
	12 m....		784	.800	40	48	.719	
	3 p. m....		790	.786	44	42.5	.810	
	3 p. m....		784	.800	40	42.5	.790	
	5 p. m....		790	.780	32.5	31.5	.840	
	5 p. m....		784	.798	32	.....	.811	
	Jan. 27		9 p. m....	790	.840	18.5	18	.886
		9 p. m....	784	.845	18.5	18	.848	
7 a. m....		790	.940	22	21	.934		
7 a. m....		784	.976	21.5	21	.928		
9 a. m....		790	.999	35	40	.953		
9 a. m....		784	25.030	35.5	40	.940		
12 m....		784	.082	46.5	48	.990		
Station 7.....		Jan. 27	3 p. m....	784	.292	56	59	25.247
Station 15.....		Jan. 27	Sunset...	784	.364	45	45	(a)
Camp 107.....	Jan. 27	9 p. m....	784	.370	.....	30.5	.....	25.312
		Sunrise...	784	.336	26.5	27	.....
		9 a. m....	784	.360	47	50.5	.....
		3 p. m....	790	.276	59.5	65	25.267	25.279
Camp 108.....	Jan. 28	3 p. m....	784	.344	in sun	65	.270	25.263

(a) Single corrected readings mislaid.

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 108.....	Jan. 28	5 p. m....	790	25.250	50.5	51.5	25.265	
		5 p. m....	784	.278	50	51.5	.250	
		9 p. m....	790	.290	40	40	.284	
	Jan. 29	9 p. m....	784	.312	40	40	.267	
		7 a. m....	790	.254	29	28.5	.232	
		7 a. m....	784	.320	28	28.5	.257	
		9 a. m....	790	.354	61	54	.249	
		9 a. m....	784	.352	51.6	54	.226	
		12 m....	790	.314	58.7	60.5	.231	
		12 m....	784	.326	59.5	60.5	.199	
		3 p. m....	790	.310	62	67	.293	
		3 p. m....	784	.324	61	67	.266	
		5 p. m....	790	.299	50.5	51	.313	
		5 p. m....	784	.318	50	51	.290	
		9 p. m....	790	.308	40.8	41	.306	
		9 p. m....	784	.320	40.6	41	.273	
		Jan. 30	7 a. m....	790	.346	30	31	.321
	7 a. m....		784	.367	30	31	.299	
	9 a. m....		790	.418	59.5	49	.316	
	9 a. m....		784	.414	49	49	.293	
Station B.....	Jan. 30	12 m....	784	.320	58	59	.197	
Station F.....	Jan. 30	3 p. m....	784	.388	69.5	68	.312	
Camp 109.....	Jan. 30	5 p. m....	784	.360	52	49.6	.327	25.247
		9 p. m....	784	.388	42	42.5	.278	
	Jan. 31	7 a. m....	784	.296	29	30	.235	
		9 a. m....	784	.273	51	50	.148	
Station 10.....	Jan. 31	12 m....	784	.430	70	74	.272	
Camp 110.....	Jan. 31	4 p. m....	784	24.976	72.6	73.9	.904	24.818
		5 p. m....	784	.950	57	57.2	.907	
		9 p. m....	784	.924	49.5	49	.858	
	Feb. 1	7 a. m....	784	.800	41	41	24.708	
		9 a. m....	784	.854	58	63.5	.714	
Station 1.....	Feb. 1	10 $\frac{1}{4}$ a. m.	784	.792	62	.....	.633	
		10 $\frac{1}{4}$ a. m.	783	.782	61.7	.....	.623	
Station 6.....	Feb. 1	3 p. m....	784	25.984	73	69.5	25.897	
Camp 111.....	Feb. 1	5 p. m....	784	26.332	60	62	26.278	26.362
		9 p. m....	784	.340	41	43	.291	
		9 p. m....	783	.334	41.5	.....	.346	
	Feb. 2	7 a. m....	784	.432	35.5	36	.352	26.353
		7 a. m....	783	.418	35.5	.....	.338	
		9 a. m....	784	.478	57.1	51	.336	
		9 a. m....	783	.490	55	.....	.353	
		12 m....	784	.506	65.5	.....	.361	
		12 m....	783	.532	71.5	70.2	.375	
		3 p. m....	784	.458	67.5	67.5	.382	
	Feb. 3	5 p. m....	784	.460	53.5	54	.422	26.420
		7 a. m....	784	.466	38	38.5	.379	
		7 a. m....	790	.460	38.1	.....	.416	
		9 a. m....	784	.428	59.5	61	.381	
9 a. m....		790	.512	57	.....	.413		
12 m....		784	.516	68.6	68	.365		
12 m....		790	.509	67.6	.....	.404		
3 p. m....		784	.474	69.5	68.8	.393		
		3 p. m....	790	.460	68	.....	.425	
		5 p. m....	784	.457	61.5	62.1	.401	
		5 p. m....	790	.442	61.5	.....	.428	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 111.....	Feb. 3	9 p. m.	784	26.440	44	46	26.384	
		9 p. m.	790	.440	45	.....	.427	
	Feb. 4	7 a. m.	784	.445	41	41.1	.341	
		7 a. m.	790	.428	41.2	.....	.371	
Station 1.....	Feb. 4	9 a. m.	784	.644	55	56	.507	
Camp 112.....	Feb. 4	3 p. m.	784	27.182	73	75	27.091	27.107
		5 p. m.	784	.150	63.4	63.5	.098	
		8 ¹ / ₂ p. m.	784	.142	39.5	40.5	.100	
	Feb. 5	7 a. m.	784	.118	37	37.8	.033	
Station A.....	Feb. 5	9 a. m.	784	.270	49.5	52.5	.045	
Station 5.....	Feb. 5	12 m.	784	.688	63.5	62.4	.556	
Station 19.....	Feb. 5	3 p. m.	784	.836	69.5	69.2	.750	
Camp 113.....	Feb. 5	5 p. m.	784	.844	63.6	64	.778	27.752
		9 p. m.	784	.818	50.5	52.2	.744	
	Feb. 6	7 a. m.	784	.828	39	40	.738	
		9 a. m.	784	.908	63	61	.748	
Station A.....	Feb. 6	12 m.	784	.950	71	70.2	.788	
Station B.....	Feb. 6	3 p. m.	784	28.040	77.5	80	.934	
Camp 114.....	Feb. 6	5 p. m.	784	.124	64.6	63	28.055	28.030
		9 p. m.	784	.080	40.5	42	.031	
	Feb. 7	7 a. m.	784	.072	30.5	32	.003	
Station A.....	Feb. 7	9 a. m.	784	.232	69	63	.057	
Camp 115.....	Feb. 7	12 m.	784	.294	75.2	74.5	.121	28.146
		3 p. m.	784	.234	73.5	69	.136	
		3 p. m.	790	.190	69.5	.....	.147	28.166
		5 p. m.	784	.220	62.5	63	.156	
		5 p. m.	790	.182	62	.....	.162	
		9 p. m.	784	.226	56	56.4	.138	
		9 p. m.	790	.200	56.2	.....	.155	
	Feb. 8	7 a. m.	784	.284	44.5	42.9	.180	
		7 a. m.	790	.264	44.7	.....	.202	
Station 1.....	Feb. 8	9 a. m.	784	.352	63	60.2	.191	
Station 8.....	Feb. 8	12 m.	784	.401	72	73	.234	
Camp 116.....	Feb. 8	3 p. m.	784	.418	81	75	.301	28.302
		3 p. m.	790	.392	74	.....	.336	
		5 p. m.	784	.361	65.2	66	.290	28.334
		5 p. m.	790	.363	65	.....	.335	
		9 p. m.	784	.390	55.4	55.5	.304	
		9 p. m.	790	.376	55	55.5	.333	
	Feb. 9	7 a. m.	784	.422	42.5	42.5	.313	
		7 a. m.	790	.390	42.5	42.5	.334	
Station A.....	Feb. 9	9 a. m.	784	.490	60.5	63	.335	
Camp 117.....	Feb. 9	12 m.	784	.526	77.5	79.8	.345	28.363
		3 p. m.	784	.474	76.1	77	.370	
		3 p. m.	790	.470	78	77	.404	28.400
		5 p. m.	784	.441	63.2	63.5	.375	
		5 p. m.	790	.433	63.6	63.5	.410	
		9 p. m.	784	.438	43.5	44.9	.382	
		9 p. m.	790	.436	44	44.9	.420	
	Feb. 10	7 a. m.	784	.446	42	42.9	.348	
		7 a. m.	790	.420	41.5	42.9	.368	
		9 a. m.	784	.500	55	55	.358	
Station A.....	Feb. 10	12 m.	784	.545	71	70.6	.381	
Camp 118.....	Feb. 10	3 p. m.	784	.546	71.5	72	.456	28.443
		3 p. m.	790	.542	71.5495	

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METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.	
Camp 118.....	Feb. 10	Sunset ..	790	28.529	64.4	.....	28.500	
		Sunset ..	784	.540	65	65	.468		
		9 p. m....	784	.558	63	64.9	.451		
	Feb. 11	9 p. m....	790	.534	63.5	.....	.469	
		Sunrise ..	790	.468	57.7	.....	.373	
		Sunrise ..	784	.540	56.5	57.5	.405		
Station A.....	Feb. 11	9 a. m....	784	.581	56	56.8	.437		
	Feb. 11	12 m....	784	.642	59	60	.508		
Camp 119.....	Feb. 11	3 p. m....	784	.650	56	57.2	.596	28.529	
		3 p. m....	790	.627	57.8	.....	.613	28.557
		Sunset ..	790	.592	57.2	.....	.583	
	Feb. 12	Sunset ..	784	.615	56	57	.566		
		9 p. m....	784	.574	55	56.8	.487		
		9 p. m....	790	.567	55	.....	.523	
		Sunrise ..	790	.598	48	.....	.527	
		Sunrise ..	784	.604	47	49.8	.481		
		9 a. m....	784	.678	63.6	69	.515		
	Station A.....	Feb. 12	9 a. m....	790	.660	63.8540	
		Feb. 12	12 m....	784	.728	72	69	.560	
	Camp 120.....	Feb. 12	3 p. m....	784	.750	71.5	72	.657	28.670
Sunset ..			784	.736	64	64.7	.667		
Sunset ..			790	.692	67.5	.....	.657	28.670
Feb. 13		9 p. m....	790	.700	56	.....	.654	
		9 p. m....	784	.746	57	56.5	.654		
		Sunrise ..	784	.750	32.5	34	.677		
		Sunrise ..	790	.740	32.5	.....	.700	
		9 a. m....	784	.818	53.5	51	.681		
		Feb. 13	12 m....	784	.966	61.2	59.5	.828	
Station A.....		Feb. 13	3 p. m....	784	.982	62.3	62	.911	28.910
			3 p. m....	783	29.008	62.3937	28.969
			3 p. m....	790	28.958	63928	28.976
	Feb. 14	Sunset ..	784	.966	58.5	59.5	.910		
		Sunset ..	783	.973	59.5	.....	.913	
		Sunset ..	790	.954	58.5	.....	.940	
		Sunrise ..	783	29.074	40	.....	.980	
		Sunrise ..	790	.042	40	40	.991		
		9 a. m....	790	.074	53.7	54.9	.978		
	Camp 121.....	Feb. 14	9 a. m....	783	.116	50.8984	
			12 m....	790	.016	62.8915	
			12 m....	783	.072	59.6	64.5	.936	
Feb. 15		3 p. m....	783	.026	61.5	63	.957		
		3 p. m....	790	28.988	63	.....	.958	
		Sunset ..	783	29.032	56	56	.982		
		Sunset ..	790	28.974	56	.....	.967	
		9 p. m....	790	29.026	50	50	.994		
		Sunrise ..	790	.108	45	45.3	29.044		
Station A.....		Feb. 15	9 a. m....	790	.146	53.8050	
			9 a. m....	783	.188	49.3	53	.060	
			12 m....	783	.289	58.5155	
Station 7.....	Feb. 15	3 p. m....	783	.262	66.2	61	.181		
	Feb. 15	Sunset ..	783	.266	62.3	59.5	.194	29.054	
Camp 122.....	Feb. 15	9 p. m....	783	.167	41.3	41.7	.115		
		Sunrise ..	783	.046	41	41.4	28.964		
Station 2.....	Feb. 16	9 a. m....	783	.077	52	53.9	.942		
		12 m....	783	.024	63.7	.....	.876	
Camp 123.....	Feb. 16	3 p. m....	783	.102	70.5	70	29.015	29.003	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 123.....	Feb. 16	Sunset... 783	29.064	67	.....	28.980		
		9 p. m. ... 783	.040	51	54	.963		
Camp 124.....	Feb. 17	Sunrise . 783	.128	47.7	48.7	29.029		
		9 a. m. ... 783	.182	60.5	.....	.030		
		9 a. m. ... 790	.142	58	.....	.039		29.039
		12½ p. m. ... 783	.282	63.5	.....	.150		
Station B.....	Feb. 17	3 p. m. ... 783	.303	55.2	.....	.249		29.240
Camp 125.....	Feb. 17	9 p. m. ... 783	.320	50.5	.....	.279		
		Sunrise . 783	.286	45.6	46.5	.193		
		9 a. m. ... 783	.510	54.5	.....	.368		
		12 m. ... 783	.520	56.4	55.1	.390		29.521
Camp 126.....	Feb. 18	3 p. m. ... 783	.560	54	53.7	.509		
		Sunset ... 783	.574	52.7	53.3	.526		
		9 p. m. ... 783	.638	42.5	44.3	.582		
		Sunrise . 783	.656	30.5	31	.601		
Station A ⁽¹⁾	Feb. 19	Sunset ... 783	.700	61.5	60.9	.629		29.617
		9 p. m. ... 783	.660	45.5	.....	.605		
		Sunrise . 783	.634	38	.....	.605		
		9 a. m. ... 783	.826	57.2	.....	.676		
Station C.....	Feb. 20	12 m. ... 783	.839	64.6	.....	.688		
Station A ⁽²⁾	Feb. 20	3 p. m. ... 783	.796	68.5	.....	.705		
Camp 127.....	Feb. 20	Sunset ... 783	.756	68.5	.....	.586		29.663
		Sunset ... 790	.732	69	.....	.683		29.686
		9 p. m. ... 783	.784	49.5	.....	.708		
		9 p. m. ... 790	.740	50.3	.....	.707		
Station A.....	Feb. 21	7 a. m. ... 783	.804	52.3	49.5	.678		
		7 a. m. ... 790	.746	47.5	.....	.670		
		9 a. m. ... 783	.820	53.5	.....	.680		
		12 m. ... 783	.828	69.3	.....	.663		
Camp 128.....	Feb. 21	3 p. m. ... 783	.790	71.7	.....	.693		29.737
		Sunset ... 783	.788	64.2	.....	.709		
		9 p. m. ... 783	.786	57	.....	.691		
		Sunrise . 783	.918	53.5	.....	.798		
Station 5.....	Feb. 22	9 a. m. ... 783	.936	54.5	.....	.794		
		12 m. ... 783	.991	69.7	.....	.824		
		Sunset ... 783	.800	61.3	61.7	.729		29.689
		Sunset ... 790	.774	64	.....	.738		29.688
Camp 129.....	Feb. 23	Sunrise . 783	.750	41.3	.....	.667		
		Sunrise . 790	.696	41.2	.....	.641		
		8 a. m. ... 783	.771	48.3	.....	.650		
		12 m. ... 783	.780	70.6	.....	.612		
Station 7.....	Feb. 23	3 p. m. ... 783	.474	71	.....	.378		
Camp 130.....	Feb. 23	Sunset ... 783	.618	68.8	.....	.527		29.486
		9 p. m. ... 783	.558	58.5	.....	.461		
		Sunrise . 783	.590	55.6	.....	.475		
		8 a. m. ... 783	.640	62.7	.....	.482		
Station 3.....	Feb. 24	12 m. ... 783	.556	61	.....	28.417		
Station 5.....	Feb. 24	3 p. m. ... 783	.120	65.5	.....	29.040		
Station 8.....	Feb. 24	Sunset ... 783	.642	65.2	.....	.562		
Camp 131.....	Feb. 24	9 p. m. ... 783	.738	51.3	.....	.659		29.669
		Sunrise . 783	.774	45.5	.....	.680		
Camp 132.....	Feb. 25	9½ a. m. ... 783	.866	58	.....	.713		29.599
		12 m. ... 783	.856	64.6	.....	.706		
		Sunset ... 783	.701	70	68	.607		
		9 p. m. ... 783	.636	54.5	55.5	.550		
	Feb. 26	Sunrise . 783	.582	36	37.5	.513		

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Camp 132.....	Feb. 26	9 a. m....	783	29.664	59.5	62.3	29.510	
Station A.....	Feb. 26	12 m.....	783	.710	66.2	.....	.554	
Camp 133.....	Feb. 26	3 p. m.....	783	.676	72.7	71.2	.577	29.577
Camp 134.....	Feb. 28	8 $\frac{1}{4}$ a. m....	784	.632	60.5	.....	.475	29.527
		Sunset....	784	.524	61.9	.....	.453	
		9 p. m.....	784	.588	50	.....	.512	
	Mar. 1	Sunrise....	784	.652	37.2	.....	.580	
		9 a. m.....	784	.774	59.7	.....	.618	
Camp 135.....	Mar. 1	12 m.....	784	.724	59.5	.....	.587	29.691
		3 p. m.....	784	.746	61.2	.....	.676	
		Sunset....	784	.748	55.6	.....	.694	
		9 p. m.....	784	.762	41.7	.....	.707	
	Mar. 2	Sunrise....	784	.864	40.7	.....	.792	
Station B.....	Mar. 2	9 a. m.....	784	.646	51	.....	.513	
Station 4.....	Mar. 2	12 m.....	784	.026	65.7	.....	28.873	
Station D.....	Mar. 2	3 p. m.....	784	28.508	60.5	.....	.444	
Camp 136.....	Mar. 2	6.10 p. m.	784	27.900	49.5	.....	27.855	27.824
		9 p. m.....	784	.890	44.5	.....	.832	
	Mar. 3	Sunrise....	784	.856	43	.....	.786	
Station 2.....	Mar. 3	9 a. m.....	784	.900	44.7	.....	.785	
Camp 137.....	Mar. 3	12 m.....	784	.372	69.3	.....	.216	27.179
		3 p. m.....	784	.280	60.2	.....	.220	
		Sunset....	784	.264	54.7	.....	.211	
		9 p. m.....	784	.216	44.6	.....	.160	
	Mar. 4	Sunrise....	784	.150	40.7	.....	.086	
Station B.....	Mar. 4	9 $\frac{1}{2}$ a. m....	784	26.548	53.5	.....	26.410	
Station F.....	Mar. 4	12 m.....	784	.342	59	.....	.212	
Station P.....	Mar. 4	3 p. m.....	784	25.809	55	.....	25.763	
Camp 138.....	Mar. 4	Sunset....	784	.682	55.6	.....	.630	25.596
		9 p. m.....	784	.684	47.8	.....	.620	
	Mar. 5	Sunrise....	784	.596	38.2	.....	.539	
Station D.....	Mar. 5	9 a. m.....	784	.286	46.2	.....	.172	
Camp 139.....	Mar. 5	12 m.....	784	.180	52.8	.....	.069	25.067
		3 p. m.....	784	.146	52	.....	.109	
		9 p. m.....	784	.106	37	.....	.068	
	Mar. 6	Sunrise....	784	.064	31	.....	.024	
Camp 140.....	Mar. 6	9 p. m.....	784	26.031	35.5	.....	.997	26.008
	Mar. 7	Sunrise....	784	.076	38.5	.....	26.020	
Station D.....	Mar. 7	9 a. m.....	784	.416	45.5	.....	.302	
Station 9.....	Mar. 7	12 m.....	784	.204	54.5	.....	.088	
Station B.....	Mar. 7	2.40 p. m.	784	.822	56	.....	.767	
Camp 141.....	Mar. 7	Sunset....	784	27.832	57.5	.....	27.771	27.749
		9 p. m.....	784	.814	55	.....	.729	
	Mar. 8	Sunrise....	784	.831	49	.....	.747	
Station D.....	Mar. 8	9 a. m.....	784	28.702	55.5	.....	28.558	
Station A.....	Mar. 8	12 m.....	784	.250	69	.....	.093	
Camp 142.....	Mar. 8	Sunset....	784	.939	72.5	.....	.826	28.889
		9 p. m.....	784	.888	46	.....	.824	
	Mar. 9	Sunrise....	784	29.086	47	.....	29.018	
Station D.....	Mar. 9	9 a. m.....	784	.133	69.7	.....	28.951	
Camp 143.....	Mar. 9	1 $\frac{1}{2}$ p. m....	784	28.894	85.5	.....	.774	28.762
		3 p. m.....	784	.874	82.2	.....	.752	
		Sunset....	784	.860	68.5	.....	.771	
		9 p. m.....	784	.872	56	.....	.782	
	Mar. 10	Sunrise....	784	.838	44.6	.....	.761	
Station O.....	Mar. 10	9 a. m.....	784	.732	58.7	.....	.579	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading.	Mean.
Station 6.....	Mar. 10	12 m.	784	28.580	84.7	.....	28.380	
Station D.....	Mar. 10	3 p. m.	784	.500	78.5	.....	.389	
Camp 144.....	Mar. 10	Sunset.....	784	.420	69.5	.....	.328	28.290
	Mar. 11	Sunrise....	784	.333	47.6	.....	.252	
Camp 145.....	Mar. 11	Sunset.....	784	27.994	55	.....	27.939	28.001
		9 p. m.	784	.988	47.5	.....	.923	
	Mar. 12	Sunrise....	784	28.034	37.7	.....	.976	
		9 a. m.	784	.098	47.5	.....	.978	
		12 m.	784	.120	58.7	.....	.988	
		3 p. m.	784	.118	64.3	.....	28.045	
		Sunset.....	784	.124	52.2	.....	.076	
		9 p. m.	784	.150	30.7	.....	.125	
	Mar. 13	Sunrise....	784	.089	27	.....	.056	
Station 1.....	Mar. 13	8½ a. m.	784	.092	52.3	.....	27.964	
Station 4.....	Mar. 13	12 m.	784	27.910	74.3	.....	.739	
Camp 146.....	Mar. 13	Sunset.....	784	.722	60	.....	.....	} 27.748
	Mar. 14	Sunrise....	784	.776	29.8	.....	.....
Station 5.....	Mar. 14	8¾ a. m.	784	.782	49.3	.....	27.657	
Station 8.....	Mar. 14	12 m.	784	.632	66.5	.....	.481	} 27.405
		3 p. m.	784	.598	63	.....	.529	
Camp 147.....	Mar. 14	Sunset.....	784	.434	51.5	.....	.389	} 27.409
		9 p. m.	784	.457	46.5	.....	.394	
	Mar. 15	Sunrise....	784	.516	44	.....	.444	
Station 4.....	Mar. 15	10 a. m.	784	.426	49.5	.....	.294	
Station 5.....	Mar. 15	12 m.	784	.370	58.5	.....	.242	} 27.300
		2¼ p. m.	784	.362	62.5	.....	.219	
Camp 148.....	Mar. 15	9.40 p. m.	784	.1137	38.8	.....	.....	} 26.414
	Mar. 16	Sunrise....	784	26.504	37.5	.....	.....
Station 4.....	Mar. 16	.....	784	25.448	55.5	.....	25.311	
Station 6.....	Mar. 16	12 m.	784	27.026	57	.....	26.910	
Camp 149.....	Mar. 16	Sunset.....	784	.428	53.5	.....	27.377	} 27.338
		9 p. m.	784	.426	43.7	.....	.370	
	Mar. 17	Sunrise....	784	.424	42.6	.....	.356	
		9 a. m.	784	.442	50.7	.....	.315	
		12 m.	784	.410	44.7	.....	.315	
		3 p. m.	784	.340	43.5	.....	.320	
		Sunset.....	784	.386	42.5	.....	.364	
	Mar. 18	Sunrise....	784	.354	42	.....	.287	
Station 1.....	Mar. 18	9 a. m.	784	.854	44	.....	.741	
Station 2.....	Mar. 18	12 m.	784	.892	45.5	.....	.784	
Station F.....	Mar. 18	3 p. m.	784	28.472	47.5	.....	28.440	
Camp 150.....	Mar. 18	Sunset.....	784	.670	47	.....	.635	} 28.696
	Mar. 19	Sunrise....	784	.764	45	.....	.688	
		9 a. m.	784	.838	66.7	.....	.666	
		12 m.	784	.820	61.5	.....	.681	
		3 p. m.	784	.798	52.2	.....	.759	
		Sunset.....	784	.804	50.5	.....	.760	
		9 p. m.	784	.818	47	.....	.751	
	Mar. 20	Sunrise....	784	.788	37.5	.....	.732	
Station D.....	Mar. 20	9 a. m.	784	29.026	54.5	.....	.855	
Station 9.....	Mar. 20	12 m.	784	.274	67.6	.....	29.117	
Station P.....	Mar. 20	3 p. m.	784	.472	65.5	.....	.391	
Station H.....	Mar. 20	Sunset.....	784	.754	57	.....	.689	
Camp 151.....	Mar. 20	9 p. m.	784	.824	47.5	.....	.755	} 29.731
	Mar. 21	Sunrise....	784	.764	36.7	.....	.708	
Station D.....	Mar. 21	9 a. m.	784	.798	62.3	.....	.634	

METEOROLOGICAL OBSERVATIONS—Continued.

Station.	Date.	Hour.	Number of barometer.	First reading.	Attached thermometer.	Air thermometer.	Corr. reading	Mean.
Camp 152.....	Mar. 21	12 m.....	784	29.710	68.2	29.549	29.603 29.635
		12 m.....	790	.670	65.7	.....	.560
		3 p. m.....	784	.672	68.5	.....	.583
		3 p. m.....	790	.642	67	.....	.599
		Sunset....	784	.670	55	.....	.611
		Sunset....	790	.638	52.2	.....	.630
		9 p. m.....	784	.708	49.5	.....	.634
		9 p. m.....	790	.686	50	.....	.653
	Mar. 22	Sunrise...	784	.606	42	.....	.536
		Sunrise...	790	.684	42	.....	.657
		9 a. m.....	784	.826	65	.....	.....
		9 a. m.....	790	.782	62.5	.....	.662
		12 m.....	784	.744	67	.....	.586
		12 m.....	790	.720	67	.....	.605
		3 p. m.....	784	.703	64.5	.....	.624
		3 p. m.....	790	.683	63	.....	.650
		Sunset....	784	.700	55.2641	
		Sunset....	790	.672	56.1653	
		9 p. m.....	784	.742	51.5664	
		9 p. m.....	790	.721	50.9686	

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ERRATA.

- Page 11, line 13, for "blue" read "red."
 13, 6, for "one" read "two."
 13, 6, for "sucie" read "sucr6."
 14, 8, for "thirty" leave blank until observations are re-examined.
 15, lines 48 and 49, for "universally" read "unusually."
 20, line 3, for "thirty" read "ten."
 24, 6, "and fifty" erase.
 24, 31, for "an" read "a."
 25, 40, for "last" read "east."
 25, lines 45 to 50, erase the whole sentence beginning "Already has been mentioned," and ending "Maria."
 26, lines 7, 8, and 31, }
 29, line 35, }
 31, 41, }
 56, 1, }
 57, lines 28 and 29, } for "cactacæ" read "caetacem."
 57, line 35, }
 61, 1, }
 69, 14, }
 70, 45, }
 26, 34, }
 27, 49, }
 28, 22, }
 28, lines 48 and 51, } for "Rio Santa Maria" read "Bill Williams Fork."
 29, line 13, }
 75, 11, }
 82, lines 18, 24, and 29, }
 28, line 3, for "1542" read "1540."
 28, 15, for "Cuhaus" read "Cuchans."
 28, lines 27 and 28, for "Yatapais, Cuhaus, and Amachaves," read "Yampais, Cuchans, and Mojaves."
 29, line 25, for "four thousand and nine hundred" read "5292."
 30, 25, for "twenty" read "sixty-six."
 30, 26, for "one hundred and three" read "ninety-seven."
 30, 26, for "seven" read "eight."
 31, 20, for "25.4" read "25.4 in."
 31, 35, place a comma after "marble."
 31, 28, for "seven" read "eight."
 32, lines 12, 13, and 19, } for "Cocomengo" read "Cocomongo."
 39, line 47, }
 32, 40, for "fet-neat" read "feet; neap."
 32, 44, for "plaza" read "playa (port.)"
 33, 12, }
 99, 28, } for "Rio Santa Maria (Bill Williams Fork)" read "Bill Williams Fork."
 45, 47, for "firteen" read "fifteen."
 46, 2, for "Moteo" read "Mateo."
 53, 19, }
 69, 26, } for "Iarrae" read "Iarrea."
 56, 34, for "statue" read "stature."

- 60, 13, for "Yampai, Tonto, Ganotero," read "Yampais, Tonto, Garrotero."
- Page 61, line 2, }
 66, 39, }
 66, 47, } for "Picos" read "Pecos."
 71, 17, }
 74, 51, }
- 61, 13, for "hoemorrhagic" read "hemorrhagic."
 61, 14, for "lena amarillo" read "leña amarilla."
 62, 45, for "suscle" read "muscle."
 65, 10, for "pendleri" read "Fendleri."
 65, 27, for "highlands" read "highland."
 66, 43, for "Yūñi" read "Zuni."
 66, 45, for "fructescro" read "fructescens."
 67, 23, for "pitahayçe" read "pitahaya."
- 68, lines 8, 9, and 10, }
 69, 1 and 43, } for "the Santa Maria" read "Bill Williams Fork."
- 75, 1, for "Santa Maria" read "Bill Williams Fork."
 75, 45, for "Barnardino" read "Bernardino."
 76, 43, for "was lost" read "it was lost."
 79, 31, for "soms" read "some."
 80, 44, for "is" read "are."
 83, 29, for "where snow" read "where much snow."
 84, 4 to 9, for "The San Francisco forests," &c., to "section," read "Near the headwaters of Rio San Francisco there are forests of pine, interspersed with cedar thickets. These extend to the head of Bill Williams Fork. Thence to the Colorado, and even to the base of Sierra Nevada, although there are many mezquites and alamos in the valleys of the streams, and some cedars upon the hills, a general scarcity of fuel prevails."
- 85, 36, for "89,540" read "67,161."
 85, 31, for "17,721,000" read "13,320,265."
 86, 20, for "89,500" read "67,161."
 86, 20, for "17,721,000" read "13,320,265."
 86, 24, for "166,230,000" read "161,829,265."
- 101, under column of "Remarks," for "Puerto" read "Poteau."
 102, camp 48, for "Tucumcari creek" read "Branch of Fossil creek."
 102, camp 49, for "Branch of Fossil creek" read "Tucumcari creek."
 103, camp 75, for "Willow creek (Rio de la Jara)" read "Rio de la Xara."
 104, camp 105, for "do." read "Cañon creek."
 104, camp 109, for "do." read "White Cliff creek."
 104, camp 114, for "Big Sandy creek" read "Bill Williams Fork."
 104, camp 120, for "mouth of Big Sandy creek" read "near mouth of Rio Santa Maria."
 104, camps 121, 122, and 126, for "Rio Santa Maria" read "Bill Williams Fork."
 105, camp 147, add "do."
 105, camp 148, for "Cajon Pass" read "north of Cajon Pass."
 105, camp 149, add "south of Cajon Pass."
 111, camp 68, for "+975.20" read "+24.8."
 115, station D, between camps 148 and 149, for "+820.10" read "-820.10."
 107, opposite Napoleon, for "81.60" read "91.60."
 107, opposite Little Rock, for "310.40" read "320.40."
 107, opposite Fort Smith, for "460.30" read "470.30."
 107, opposite camp 3, for "-222.20, 336.30" read "-134.60, 423.90."
 107, opposite camp 4, for "432.40" read "520.00."
 107, opposite camp 6, for "532.50" read "622.10."
 107, four miles from camp 4, for "89.70, 624.20" read "+64.80, 686.90."
 107, camp 5, for "+53.70, 677.90" read "-53.70, 633.20."
 107, station 8, for "-3.50, 674.40" read "+19.00, 652.20."
 107, station 17, for "-33.60, 640.80" read "-13.30, 638.90."
 107, camp 6, for "-44.90" read "-43.00."

REPORT
OF
EXPLORATION OF A ROUTE FOR THE PACIFIC RAILROAD,

NEAR THE THIRTY-SECOND PARALLEL OF LATITUDE,

FROM

THE RED RIVER TO THE RIO GRANDE,

BY BREVET CAPTAIN JOHN POPE,

CORPS OF TOPOGRAPHICAL ENGINEERS.

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Washington, D. C., October 17, 1904

That I have the honor to acknowledge the receipt of your letter of the 10th inst. in relation to the proposed purchase of the land owned by the United States in the vicinity of the mouth of the Rio Grande, and in reply to inform you that the same has been referred to the proper authorities for their consideration.

I am, Sir, very respectfully,
Your obedient servant,
J. M. [Name]

REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE

THE RIO GRANDE RIVER TO THE RIO GRANDE

The following is a list of the lands owned by the United States in the vicinity of the mouth of the Rio Grande, and in reply to inform you that the same has been referred to the proper authorities for their consideration.

WASHINGTON, D. C., *October 17, 1854.*

SIR: I have the honor to transmit herewith a report and maps of the survey of a route for the Pacific railroad, near the thirty-second parallel, from Red river to the Rio Grande.

My instructions required me to examine also the military features of the route; and in this fact, and the short time at my disposal, is to be found my apology for the voluminous character of the report.

I am, sir, respectfully, your obedient servant,

JNO. POPE,

Brevet Captain Top. Engs., in charge Exploring Expedition.

HON. JEFF. DAVIS,

Secretary of War, Washington, D. C.

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CHAPTER XI.—Diary continued.

CHAPTER XII.—Diary continued.

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REPORT.

CHAPTER I.

Methods pursued in determining the data upon which are based the maps and reports of the survey.

To enable the department to judge advisedly of the amount of confidence due to the results of an exploration of this character, it would seem proper to set forth the organization of the exploring party, and to describe in full the instruments used and the methods pursued in determining the data upon which these results are based.

As the object of this exploration was eminently practical in its character, and had in view the investigation of a specific question, I have thought it advisable, in determining upon a plan for the report, to give the prominent place to the practical results which have a direct bearing upon the construction of the railroad, and to set them forth under proper heads, as briefly as is consistent with clearness. For this purpose I have carefully avoided embarrassing the subject with a narrative of the daily incidents of the expedition, which must be more or less irrelevant, or involving it in obscurity by the introduction of detailed descriptions, under scientific and technical names, of the specimens collected in the various departments of science. I have only introduced into the report such extracts from these subjects as are necessary to illustrate some point having an immediate and important bearing upon the question of the railroad, and have collected into an appendix the diary of the expedition and the reports upon the geology, botany, and natural history of the route.

Method of determining the geographical position of the route.—Of this duty I took charge myself, and the following plan was adopted: Seven principal points were selected along the line, as nearly at equal intervals as it was possible to place them, and at each of those points the latitude and longitude were carefully and absolutely determined, by a complete series of astronomical observations. The sextant was the only instrument I had for this purpose, and it was therefore necessary to determine the longitude by the method of "lunar distances." At least seventy lunar distances of the sun, and of stars east and west of the moon, were observed at each principal point; and the latitude was determined in all cases by at least one hundred and fifty altitudes of stars north and south of the zenith. At each of these points the chronometer was carefully rated, by observing equal altitudes of the sun, and altitudes of east and west stars, for several successive days. Twenty intermediate points were determined along the line, by at least sixty altitudes of north and south stars for latitude, and twenty alti-

tudes of east and west stars for the error of the chronometer. As the rate of the chronometer was carefully determined at each principal point, and the chronometric longitudes of intermediate places were referred directly and at short intervals to the points thus absolutely determined, the time observations may be considered as furnishing at least very close approximations. Twenty-seven points along the route, at intervals not to exceed twenty-five miles, were thus astronomically determined; and as the observations exhibit no error on their face, and the results determined by the computations of several able and experienced computers are in all respects satisfactory, the position of the line of survey may be considered fixed with some considerable degree of accuracy. I have also, in the preparation of the maps, used some determinations of latitude and longitude made by the boundary commission and by Colonel J. E. Johnston, of the topographical engineers.

For tracing the line of survey over the short distances between the astronomical positions, the compass fixed in position was used, and the lengths of the compass courses measured with a viameter, which had been carefully compared with the measurements by the chain. As all error in measurement or bearing was confined to the short distances between the fixed points, the details of the route may, I think, be considered sufficiently accurate.

All the astronomical observations, with the results of the computations in each case, are appended to this report. The instruments used were—sextant, eight inches diameter, by Gambey, Paris; chronometer No. —, by Parkinson & Frodsham.

Determination of the profiles.—The profiles of the route, and of the experimental lines on each side of it, were determined by a continuous series of angles of elevation and depression, observed with a theodolite. This method is unusual in the survey of lines so extended, and is a much more detailed and tedious process than that usually adopted.

Although liable to errors in the determination of absolute altitudes above the sea-level, this method is probably more accurate than that by the barometer for determining the relative heights of points not remote from each other, and covering, as it does, every foot of the route, it exhibits every feature of the country and every undulation of its surface with a detail absolutely unknown to any process other than that of the level.

The results, which have been compared at a few particular points with barometric determinations, exhibit an approximation sufficiently close to be convincing of their general accuracy. With this duty, in connexion with the compass courses of the route, and of the prominent features of the country contiguous to it, I charged Lieutenant Garrard, 1st dragoons, my principal assistant, and he executed it with a zeal and ability worthy of every commendation. A table of the observations, with the deduced results, is appended. The instruments used were—theodolite, made by W. & E. Jones, London; odometer, for measurement of distances.

The following maps accompany the report, viz :

1st. A general map on a scale of ten miles to one inch, or $\frac{1}{100000}$, exhibiting the route surveyed and the country contiguous to it. The upper and lower sides of the map are faced; the first with a profile of

the route from El Paso to the Red river, and the second with geological section along the route. The profiles are made upon the same horizontal scale as the map, with a vertical scale of 2,000 feet to the inch, or $\frac{1}{2}$ inch. As the line of survey has nearly an east and west direction, corresponding points on the line projected above and below exhibit the geological character of the country and the altitude above the sea. The left side of the map is faced with a profile of the route from Doña Ana, which intersects the line from El Paso at the Waco Tanks, and the right side with a profile of the route from the emigrant crossing of the Pecos to the Big Springs of the Colorado. Although the arrangement somewhat detracts from the appearance of the map, I have thought it a good one, as all required information can be at once obtained without the necessity of referring to separate sheets.

Map No. 2. A map and profile of the Guadalupe Pass, on a scale of 5,000 feet to the inch, or $\frac{1}{5}$ inch; vertical scale of profile, $\frac{1}{5}$ inch.

Map No. 3. Map and profile of the pass through the Waco mountains, on a scale of 5,000 feet to the inch, or $\frac{1}{5}$ inch; vertical scale of profile, $\frac{1}{5}$ inch.

Geology and geological profile of the route.—It was impossible to secure the services of a geologist to accompany the party; and it became necessary, therefore, to adopt some method for collecting specimens in this department of science, which would enable a skilful geologist, who had not been over the country, to arrive at a sufficient knowledge of its geological structure. The plan determined upon was in every respect satisfactory, as will be seen from the geological report and accompanying profile. Specimens were collected from the strata of the ridges and mountain-ranges, from all outcrops, and from the surface of the ground and beds of streams, and were labelled as follows: first, locality; second, distance from summit; third, position of the stratum from which it was taken relatively to the others, and its inclination to the horizon. Many specimens of minerals and of mineral water were also collected; and the results will be found fully set forth in the report of the geologist to whom they were submitted.

Captain C. L. Taplin, my second assistant, was charged with the duty of making this collection, and its successful results are a sufficient evidence of his industry and intelligence.

The geological report and profile were made by Jules Marcou, esq., an experienced and skilful geologist. He informs me that the collection is in all respects excellent; and that of the twelve species of fossils, eight are entirely new.

Botanical department.—The collections in this department of science were not restricted to what was new or undescribed, as I considered it quite as interesting to know that the flora of this region were the same as those common to other parts of the country, or that they were different. It was, therefore, established as a rule to collect everything; it being as easy at the conclusion of the survey to reject what was superfluous, as it would be difficult to replace what was wanting.

A complete collection of the grasses of the country was made, as their quality and quantity had an immediate and important bearing upon the determination of its agricultural character.

The entire collection, which is large, was made by Dr. W. L. Dif-

fenderfer, who accompanied the expedition as surgeon and naturalist ; and has been submitted for examination to Dr. John Torrey, of New York, whose interesting report upon the subject will be found in the appendix.

Natural history department.—The collections in this department were divided among several persons.

The birds and small animals, which required careful preparation to be safely transported, were prepared and arranged by Dr. Diffenderfer ; and the collection of fishes, reptiles, and insects, was made by Lieutenant L. H. Marshall, 3d infantry, to whom I am greatly indebted for the unceasing interest he manifested in the success of the expedition, and for his untiring labors in completing a collection which has been pronounced excellent.

This collection was submitted to Professor S. F. Baird, of the Smithsonian Institute, and his report is also attached.

Soils.—I considered it important to collect specimens of soils at all interesting points along the line, and a full collection was therefore made both from the valleys and the table-lands. The plan pursued was to collect at all places where the character of the surface changed, and each specimen collected consisted of three bundles attached together and labelled: 1st, surface soil; 2d, soil six inches below the surface; and 3d, soil one foot below the surface. In this manner the character and relative value of the soils from all the valleys and table-lands between the Rio Grande and Red rivers were determined.

This collection, with the mineral waters, was placed in the hands of Professor James C. Booth, of Philadelphia, and his report, with the analysis in each case, will be found in the appendix.

A full set of meteorological observations was kept by Dr. Diffenderfer. This table exhibits, for the months of February, March, April, and May, the temperature of the air at sunrise, at 9 o'clock a. m., at 12 m., and at 3 and 9 o'clock p. m., for each day, and, at every camping place, the temperature of the earth three feet beneath the surface; also the direction and character of the winds, the state of the atmosphere, the condition and character of the vegetation, and the temperature and description of the watering-places at each encampment.

I consider these tables eminently useful in exhibiting the climate of the country, and the character and extent of the wood and water along the route.

The diary of the expedition, which is also appended, although it contains much that is irrelevant and uninteresting, will nevertheless serve a useful purpose in filling up details of the features of the country, and the character of the route for each day, and may be of service to such persons as are inclined to pursue this route to the valley of the Rio Grande.

Such have been the persons employed, and, briefly, the instruments used and the methods pursued in determining the data upon which the maps of this survey have been made, and upon which are based the opinions expressed in the report.

As not only the results deduced from these data, but the observations by which the data themselves were determined, are appended in a tabular form to the report, the value of the opinions, and the accuracy of

the results to which they owe their weight, can be at once examined and verified.

There are many other subjects which fell under the observation of the party, and concerning which much information has been collected; but as their importance is remote from the question of the Pacific railroad, I have not thought it advisable to embody them in the report. The object of the expedition was strictly and eminently practical, and the question to be solved had been thoroughly examined for other localities in the United States, and was well understood in all its details; and in conveying information upon such a subject, I have considered it in all respects advisable to avoid embarrassing or encumbering it with any matter not directly pertinent.

With these opinions the report of this survey has been written, and I only regret that it is not more perfect.

CHAPTER II.

General description of the country along the route.

In glancing at the topographical features of the immense plains which extend westward from the frontiers of Arkansas and Missouri, the first great peculiarity which strikes the attention is the remarkable interruption to their vast monotony presented by the belt of country between the 32d and 34th parallels of latitude. The great deserts, commencing about the meridian of 97°, extend over a distance of six hundred miles, to the eastern base of the Rocky mountains.

In this whole extent they are badly watered by the few sluggish streams which intersect them, many of which disappear altogether in the dry season, and are destitute absolutely of timber, except a sparse growth of dwarf cotton-wood along the streams.

From the northern frontier of the United States, at the parallel of 49°, this immense region of desert country extends without interruption as far to the south as the parallel of 34°. At this parallel its continuity is suddenly and remarkably interrupted.

Between the 32d and 34th parallels of latitude a broad belt of well-watered, well-timbered country, adapted in a high degree to agricultural purposes, projects for three hundred and twelve miles, like a vast peninsula, into the parched and treeless waste of the plains, and, at its western limit, approaches to within less than three hundred miles of the Rio Grande, at El Paso. The eastern line of this immense region of fertile country is the western limit of the timbered or well-watered country on the north; and this striking peculiarity of the country along the 32d parallel is most specially to be noticed, as a matter of paramount importance in selecting any route for a railroad or wagon-road across this continent.

The four great rivers of Texas—the Red river, the Trinity, the Brazos, and the Colorado—taking their rise at the eastern base of the “Staked Plain,” intersect this wooded peninsula at nearly equal dis-

tances apart; and the Red river having its head of navigation far to the north of it, the other three streams are navigable for steamboats to points not remote from its southern limit.

In selecting any route for emigration, or for the construction of a railroad, and in the establishment of the chain of military posts designed for its protection and for operations against Indians, much time, labor, and expense are avoided by so locating the route that it shall approach, at as many points as possible, the navigable waters of the streams which drain the country. This subject is so plain and so well understood as to require no detailed explanation, and a glance at the country will suffice to exhibit what facilities of this kind are presented by the route along the northern frontier of Texas.

We find that the navigable waters of the three principal streams of Texas—the Trinity, the Brazos, and the Colorado—approach to within comparatively short distances of the line of the 32d parallel of latitude, and that this parallel intersects the Red river at a point very far below the head of its navigation. The importance of this extremely favorable natural feature of the country cannot be over-estimated.

With this brief reference to the two great peculiarities of the region west of the Mississippi, which are observable at a glance, I will proceed to a general description of the southern portion of New Mexico, and that portion of Texas contiguous to the line of survey, and which properly come within the range of the exploration intrusted to my command.

This description will be as brief as in my judgment is consistent with clearness, and will only embrace such subjects as have an immediate bearing upon the duties with which I have been charged.

The valley of the Rio Grande between the parallels 37° and 32° north latitude, comprises more than nine-tenths of all the settlements of New Mexico, and contains a population of about 50,000 persons. The only other settlements in the Territory, with the exception of three or four small villages west of the river, lie along and very near to the great road from Santa Fé to Independence, and in no case are found farther from the valley of the Rio Grande than seventy miles.

That portion of the country which properly comes within the scope of this expedition extends from the parallel of 32° 30' to the parallel of 31° 30', and embraces the extreme southern portion of New Mexico, including the Mesilla and Doña Ana valleys, with their villages, and a portion of the county of El Paso in Texas, including the village of Franklin, opposite the Mexican town of El Paso, and the villages of Isletta and San Elizario, lower down on the river.

The only arable land in this distance of eighty-five miles is that portion of the immediate valley of the Rio Grande which can be irrigated from the river; and, in consequence, the entire population, not probably exceeding eight thousand, is confined within these limits. Considerable crops of grain, principally corn and wheat, are raised; but the wealth of the inhabitants is in their herds of cattle and mules, sheep and goats. The peculiarly favorable character for grazing of the table-lands, east and west of the valley of the river, induces, or rather renders necessary, the herding of their stock many miles from the settlements; and to protect these people and their property thus ex-

posed from the Indians who infest the country, the military posts in this section of country have been established.

The Mesilla valley, so called, is about ten miles in length along the west bank of the river, and from two to three miles in breadth to the base of elevated table-lands which enclose the valley of the Rio Grande. The two villages of Mesilla and San Tomas—the first with a population of about three thousand, the second of about three hundred—are the only villages of the valley. A few detached settlements occur, and would, probably, swell the entire population of the valley to three thousand five hundred persons.

Doña Ana, opposite the northern extremity of the Mesilla, is the oldest town in this part of the country, having been first settled in 1842. Las Cruces, Las Tortugas, and the military post of Fort Fillmore, are the only settlements between Doña Ana and El Paso, and the population of the valley opposite the Mesilla does not exceed fifteen hundred.

Molino, two miles above, and Franklin, opposite El Paso, are the first settlements which are found south of Fort Fillmore; the ranch of Frontera having been abandoned. With the towns of Isletta, twelve miles, and the town of San Elizario, twenty-five miles below Molino, they number about three thousand souls.

The valley of the Rio Grande above Doña Ana, although by far the richest and best timbered portion of New Mexico, has for many years remained uninhabited as far up as the little village of San Antonio—one hundred and fifteen miles—in consequence of its peculiar position, midway between powerful bands of Apache Indians, occupying the mountains east and west, and from obstacles of ground along the river, which have induced all the travel across the famous "Jornada del Muerto," which occupies two-thirds of the entire distance. The great highway from New Mexico to Chihuahua leaves the river where the obstacles to travel along its banks begin to present themselves; and, traversing a high, arid plain—without wood, with little water, and with very indifferent grass—again descends upon the valley, at a distance of about eighty miles; having only effected a gain in distance of about fifteen miles. The military commander of the department of New Mexico has constructed a good road along the banks of the river, and has established a military post (Fort Thorne) in the valley, and opposite the centre of the Jornada; and all government trains and movements of troops are now required to pursue this route. These wise measures will soon put an end to the dangers and privations of the road across the desert, and will speedily lead to a settlement of the richest portion of the valley of the Rio Grande.

The full advantages of these measures, and the impolicy of undertaking any system of improvements which shall interfere with them, will be fully set forth in a subsequent part of this report.

Of the country between the valleys of the Rio Grande and the Red river.—Of the country between the valley of the Rio Grande at the 32d, and the valley of the Red river at the 34th parallel of latitude, nature has made three great divisions, which present characteristics distinct from each other in every respect.

The first of these divisions embraces the region between the Rio

Grande and the Pecos, a distance of one hundred and sixty-nine miles; the second the country occupied by the Llano Estacado, between the valley of the Pecos and the well-watered and fertile lands of Texas, at the headwaters of the Colorado, a distance of one hundred and twenty-five miles; and the third, considerably more extensive than the first two together, extends from the headwaters of the Colorado to the valley of the Red river, at the parallel of $33^{\circ} 45'$.

Of the country between the valleys of the Rio Grande and the Pecos.—The country between the valleys of the Rio Grande and the Pecos consists of elevated table-lands destitute of wood and water, except at particular points, but covered with a luxuriant growth of the richest and most nutritious grasses known to this continent.

This region is intersected by three ranges of mountains, nearly parallel to each other, and having a general direction north and south.

The first of these is the range of the Organ mountains, which, commencing on the east side of the Rio Grande, about one mile north of the town of El Paso, extends to the northward along the east side of the "Jornada del Muerto," until, under other names, it unites with the immense ranges of the Rocky mountains, which extend indefinitely to the north.

There are several passes through these mountains from the valley of the Rio Grande, but they are rough and difficult of access from their abrupt inclinations. The approach from the eastward, however, is effected without difficulty, by passing to the south of this range, and intersecting the river about one mile above the town of El Paso. Next in order to the eastward are the Hueco or Waco mountains, twenty-four miles from the river. This range extends much farther to the south, but along the present travelled route presents passes easy of access. This ridge unites itself, at a short distance above the 32d parallel, with the Sacramento and White mountains, which, continuing to the north, are lost in the main chain of the Rocky mountains. The most easterly range is that of the Guadalupe mountains, one hundred and eight miles from the Rio Grande, and fifty-four miles west of the Pecos. This ridge, although higher and more rugged than either of the others, seems isolated from any connexion with the mountains. It extends with a decreasing altitude, but with more difficult passes, at least forty miles south of the route pursued by the survey, but sinks into the valley of the Pecos about sixty miles north of the 32d parallel. The route through these mountains, although rough in some places for want of work, is of easy passage, and offers grades which, although steep and requiring heavy work, are nevertheless practicable for a railroad. Three hard and elevated table-lands, ascending in order to the eastward, occupy this region, their longest lines being to the southeast, and their greatest width to the northeast, with a very gentle inclination through long distances to the eastward, and an abrupt descent to the westward, their highest lines being in every case very near their western limits. The three ranges of mountains above mentioned occupy the summit-levels of these table-lands, and the highest point of the road between the Rio Grande and the Pecos is the summit of the Guadalupe Pass.

Water is found at intervals, not to exceed twenty-eight miles, between

the Rio Grande and the Guadalupe mountains, and from the western base of the mountains to the Pecos abundant springs of water, both fresh and mineral, occur at much shorter intervals.

Timber of large size is only found immediately contiguous to the 32d parallel on the east side of the Guadalupe range, where abundance of pine of the largest size faces their eastern slope; but fuel of the best quality, and which is alone used on the lower Rio Grande, is furnished by the roots of the mezquite.

The table-lands are covered with the mezquite brush, whose roots are numerous beyond conception, and are of a size varying from one inch to five inches in diameter. As a fuel they are uncommonly fine, and are alone used in the settlements from Doña Ana to San Elizario. As many persons, from ignorance of this fact, have suffered for wood in the midst of this abundance, it is proper to state here that all the table-lands of New Mexico furnish this fuel, and that it can be procured with very little trouble in any part of the country.

The grama-grass, which exists in the most profuse abundance over the entire surface of these table-lands, is nutritious during the whole year, and the plains between the Rio Grande and the Pecos seem intended by nature for the maintenance of countless herds of cattle. Although little protection from Indian depredations has been afforded, and incalculable quantities of stock have been driven off by them, the number appears to be undiminished; and as the original cost is small, and the expense of feeding nothing, cattle and horses are the most abundant possessions of the people of New Mexico.

A good wagon road, with water at convenient intervals, and offering facilities for travel available at any season of the year, leads from the valley of the Rio Grande at El Paso to the Pecos, near the 32d parallel.

The valley of the Pecos at this parallel of latitude is a level plain of fertile soil, about two miles in width, destitute of timber, and bordered on each side by table-lands about fifty feet high, which descend into it by very gentle inclinations. The river itself is about forty yards wide, and, with a general direction to the southeast, it traverses its valley from side to side in a very tortuous course. Its bed is a compact limestone, over which it descends, with a depth of about two feet, through numberless rapids, and at one point near the mouth of Delaware creek, over a fall of two and a half feet. The valley is very fertile and susceptible of a high state of cultivation, the uniformity of its surface and the peculiar character of the stream affording unlimited facilities for irrigation.

A short distance below the 32d parallel the valley widens to several miles in extent; the rocky bed of the river disappears, and is replaced by falling banks ten feet in height, and by a soft muddy bottom. The few fording places below the mouth of Delaware creek are very unfavorable at the best season of the year, and during high water are absolutely impracticable. From the accounts of those who have crossed the river by the route from San Antonio to El Paso, and from my own examination of it for one hundred miles below the 32d parallel, it is quite certain that no point below affords anything like the facilities for fording as does the crossing at the mouth of Delaware creek.

Of the Llano Estacado.—Upon the eastern or left bank of the river commences the “Llano Estacado,” or Staked Plain, which derives its name from a tradition that, in early times, the Spaniards had staked a road upon it from San Antonio, in Texas, to Santa Fe, in New Mexico. This famous desert, without wood or water, extends from the vicinity of the 30th to about the 35th parallel of latitude, is about one hundred and seventy-five miles across at its point of greatest width, and divides the Rio Grande and its tributaries from the affluents of the Mississippi and the streams of eastern Texas.

From the statements of persons who had crossed it near its northern and southern limits, I was prepared to find it a hard table-land, elevated from six hundred to one thousand feet above the level of the streams which border it on both sides, and faced on the east and west by abrupt rocky precipices.

To my surprise, however, the inclination from the Pecos was exceedingly gentle, and the summit-level was attained at a distance of thirty-five miles without an abrupt ascent at any point, and without the appearance of any of the marked characteristics which had been attributed to it. The descent from its summit to the headwaters of the Colorado was so gentle as only to be perceptible to instrumental survey, and there was nothing to mark its eastern limit except the existence of the tributaries of that stream. Neither bluff nor uncommon swell of ground marks its existence as you approach from the east or west, nor is its uniformity of surface disturbed at any point between the Pecos and the Colorado.

That this singularly favorable combination of circumstances only exists along the line of the 32d parallel is verified by the reports of Captain Marcy, who examined it at the head of Red river, and of Marcy and Simpson, who crossed it on the parallel of 35°, and by my own examination of it to the south. To the north, its eastern side is faced by an abrupt precipice five hundred or six hundred feet high, difficult of approach, and absolutely impracticable of ascent. On the south it is intersected by a range of hills of white drift-sand, absolutely destitute of vegetation, and seventy feet above the general level of the plain.

These hills, over a distance of thirteen miles, present steep ascents, through short distances, in many places, and the loose, movable character of the sand, and its depth, render the passage through it with loaded wagons next to impossible. On approaching from the east or west, these hills bear every appearance of the sand-ridges along the coasts of South Carolina and Florida, and the first hard wind will destroy the traces of the most numerous party. The shifting character of the sand, and its great depth, would render the construction of a railroad through it exceedingly difficult, and it would require constant labor to prevent the road from being buried under the drifting sand.

The Llano Estacado along the line of the 32d parallel (as indeed everywhere else) is destitute of wood and water, except at particular points during the rainy season; but a close examination of its geological features—the detailed results of which will be found in their appropriate place—exhibits the practicability of boring artesian wells at as many points on its surface as would be desirable. The peculiarly

favorable character of the ground along the route of the 32d parallel, the directness of this route over it, and the difficulties to the north and south, would seem to present inducements eminently favorable to the construction of these wells. For thirty miles east of the Pecos the surface of the plain is hard, and covered with grama-grass; and from thence to a point about thirty miles west of the head of the Colorado the hard surface alternates with patches of dark red sand, covered with a coarse bunch-grass, about two and a half feet high. Although the sand packs readily into a hard surface, the passage over it for the first time with loaded wagons, and embarrassed by the bunches of high grass, was laborious in the extreme.

The Llano Estacado presents no inducements to cultivation under any circumstances; but with a supply of water at reasonable intervals, it would offer, though in a less degree than the table-lands to the west, facilities for the raising of stock.

Of the country between the Llano Estacado and the valley of the Red river.—The space between the eastern base of the Staked Plain and the Red river, at the parallel of 34°, is occupied by that portion of northern Texas drained by the tributaries of the Colorado, the Brazos, the Trinity, and the Red rivers. With rapidly increasing advantages as you proceed eastward from the Llano Estacado, this region is well-timbered, well-watered, and possessed of a soil of extreme fertility, capable of sustaining a dense population. The entire country is so gently undulating in its surface, and presents such an abundant and well-distributed supply of wood and water, that it can be traversed in any direction with trains of wagons, and is of so genial a climate that little choice of the seasons is considered desirable in undertaking an expedition through it. A great portion of the timber of the region intersected by the Colorado and its tributaries along this route is the mezquite, which, about thirty feet in height, and from six to ten inches in diameter, divides about equally with the prairie lands this entire district of country. The Brazos and its tributaries are better supplied with oak timber of a larger size; the country is more undulating; and the water more abundant. Immense coal-beds, of good quality, crop out along the valley of the river, and every natural advantage of soil and climate is offered to the emigrant. A military post (Fort Belknap) has been established upon this stream, near the 33d parallel. But by far the richest and most beautiful district of country I have ever seen, in Texas or elsewhere, is that watered by the Trinity and its tributaries. Occupying east and west a belt of one hundred miles in width, with about equal quantities of prairie and timber, intersected by numerous clear, fresh streams and countless springs, with a gently undulating surface of prairie and oak openings, it presents the most charming views, as of a country in the highest state of cultivation, and you are startled at the summit of each swell of the prairie with a prospect of groves, parks, and forests, with intervening plains of luxuriant grass, over which the eye in vain wanders in search of the white village or the stately house, which seem alone wanting to the scene.

The delusion was so perfect, and the recurrence of these charming views so constant, that every swell of the ground elicited from the party renewed expressions of surprise and admiration.

It may seem strange that a region suggestive of such florid description should still remain so nearly uninhabited; but it must be remembered that this part of Texas is yet but partially explored, that it is far from the markets, and that it is still infested by bands of hostile Indians. A full knowledge of its startling beauty, and of its amazing fertility, and the construction of facilities of communication with a market, will soon convert this charming region into a reality, of which nature has exhibited so beautiful a presentment.

Over a very gentle dividing ridge we descended upon the tributaries of the Red river, and a great increase in quantity and size of timber was immediately apparent. At least four-fifths of the country drained by the tributaries of Red river are covered with timber, and of a size and quality to be favorably compared with any timbered region on this continent.

The immediate valley of Red river is from two to five miles in width, without prairie in its whole extent in the neighborhood of Preston, covered with large timber of every description, and possessed of a soil of amazing fertility. At some points the surface is covered with a white or red sand, about three inches in depth, below which is a fat, dark, vegetable mould, from three to six feet thick, and of the most astonishing richness.

The valley is being rapidly settled by cotton-planters from Tennessee and Mississippi; and although the immediate bottom-lands along the river are exceedingly difficult of settlement and culture, from the immense size and quantity of the timber, they are nevertheless preferred to the prairie lands in the vicinity, in consequence of the exceeding fertility of the soil. The river, at the 34th parallel, is about eight hundred yards wide, and is susceptible of steamboat navigation for five or six months of the year.

Proceeding from this point to the eastward, over a country well-watered, well-timbered, and of great fertility, and inhabited by whites and partially civilized Indians, who cultivate the soil, we reach, at a distance of one hundred and fifty miles, the western frontier of Arkansas.

Of the seven hundred and eighty miles of distance from the western line of Arkansas to the valley of the Rio Grande, at El Paso, nearly five hundred miles traverse a fertile, well-watered, and abundantly timbered region; and of the remaining two hundred and eighty, one hundred and sixty are through a country which, although of little agricultural value, except in the immediate valley of the Pecos, is nevertheless admirably adapted to the raising of stock, and offers every desirable facility for travel, at any season of the year.

There is but one military post (Fort Belknap, on the Brazos) along the immediate line of this route—the chain of frontier posts in Texas gradually departing from it to the south. In the southern part of New Mexico, there is no post east of the valley of the Rio Grande; and the distance between the nearest posts in Texas and New Mexico is five hundred and eleven miles.

A brief review of these remarks exhibits the fact, that by procuring water on the "Staked Plain," a route for emigration or for military pur-

poses is presented, from the frontiers of Arkansas to the valley of the Rio Grande, which, for more than half the entire distance, traverses a region fertile, well-watered, well-timbered, and of mild climate.

The vast importance of such a route, and one which can be thus protected, cannot too forcibly be dwelt upon, when the dreadful sufferings and hardships experienced by the immense emigration to California since 1849 are duly considered. The establishment of such a route will put an end forever to dangers and privations which have proved fatal to so many of our citizens, and will not only facilitate our military operations in the Indian country, but will open to settlement and cultivation a region eminently adapted to agricultural purposes.

To exhibit briefly the character of the country along the immediate line of survey, I append a few extracts from the note books of the expedition.

Extracts.

February 21.—Waco Tanks. Rain-water in natural tanks; wood and grass. From El Paso to Waco Tanks, country has a very gentle slope; is covered with fine grama-grass, and has a sandy soil.

February 22.—Sierra Alto. No water; brush for wood; good grass. North and west of the cañon of the Sierra Alto, a range of hills with sloping sides. Road to-day rocky.

February 23.—Sierra de los Álamos. Springs on the side of the mountain; good grass; cacti for wood; country gently undulating; road good.

February 24.—Las Cornudas. Water in natural tanks; wood and grass; country rolling; road rocky in places.

February 25.—No water; cacti for wood; fine grass; country level; road good.

February 26.—Ojo del Cuerbo. Fine springs—water slightly sulphureous; small brush for wood; poor grass; country gently rolling; road generally good—rocky in places. Ground near the salt lakes covered with a white efflorescence of salt.

February 27.—West face of Guadalupe mountains. No water; cacti for wood; fine grama-grass; country ascending; road not very good; some sand.

February 28.—Head of cañon in the Guadalupe Pass. Springs; grass and wood not very good; road rocky and bad.

March 1.—Pinery, on the east slope of the Guadalupe mountains. Water, wood, and grass in the greatest abundance. Fine pine forests on the mountain-sides; road not very good; rocky in places.

March 2.—Independence spring. Fine springs; thickets of scrub-oak, and good grass; road gravelly and good; country with a gently descending slope.

March 3.—Head of Delaware creek. Several mineral springs, and one remarkably fine one of fresh water; dwarf cedar in the vicinity; good grass; country rolling; road rocky in places.

March 6 and 7.—On Delaware creek. Water, wood, and grass; country undulating; road good.

March 8.—On the Pecos, at the mouth of Delaware creek. Water, (slightly brackish;) fine grass; roots of mezquite for wood; road good.

April 8.—On the Llano Estacado. No water; fine grass; brush and roots for wood; country ascending and undulating; road, for a few miles, rocky; the remainder of it good and firm; from the Pecos to this camp, country covered with fine grama-grass.

April 9.—On Llano Estacado. No water; grass not very good; roots and brush for wood; country undulating; sandy for a portion of the distance; grass not very good in the sand, but good elsewhere; abundance of game where the grass is good; saw chain of white sand-hills towards the south, about thirty miles off.

April 10.—On Llano Estacado.—No water; good grass; roots for wood; country gently undulating and sandy. In the sand the grass was a coarse red bunch-grass, about two feet and a half high. Range of white sand-hills towards the south, in sight all day.

April 11.—Sulphur springs of the Colorado. Water and grass good; roots in abundance in the vicinity, for wood; country nearly level; road hard and good; fine grass all day; game and mustangs seen all day.

April 12 and 13.—On the open plain. No water; wood and grass; country rolling, and dotted with groves of mezquite; covered with grama-grass, and intersected with numerous small streams—tributaries of the Colorado.

April 14.—Colorado river. Water, wood, and grass. The Colorado at this point is a running stream—water of a reddish color; steep red-clay banks, and about fifteen feet wide; country undulating; rocky in places; near here there are many detached mounds of red-stone.

April 15, 16, 17, 18, and 19.—Country gently undulating; large forests of mezquite; every few miles small streams of water—tributaries of the Clear and Double Mountain forks of the Brazos; fine grass everywhere; road good.

April 20.—On a large creek. Water, wood, and grass abundant; country undulating, with groves of mezquite scattered over it; on this creek large elm trees; road good.

April 21, 22, 23, and 24.—On Clear fork of Brazos. Water, wood, and grass good. Clear fork is a running stream, of about twenty yards in width, and has a narrow valley heavily timbered with pecan, elm, and other trees; country rolling and rocky; few trees, except on the Clear fork; road not good.

April 25 and 26.—From the Clear fork of the Brazos to the Brazos. Country rolling, mostly covered with trees; oak of several varieties, mezquite, and other trees; numerous small streams; good grass; good road. The Brazos at this point is about ten inches deep in the channel; water brackish.

From *April 26 to May 16.*—Country between the Brazos and Preston, on Red river, is gently undulating; contains a rather larger proportion of timber than prairie, and is intersected with numerous clear running streams of fresh water, which descend into the Brazos and Trinity on the south, and the Red river on the north. Fine grass and good camping places everywhere; road good.

CHAPTER III.

Of the Indian Tribes.

The Apaches.—This is by far the most numerous tribe of Indians in New Mexico, and extends along both sides of the Rio Grande, from the southern limits of the Navajo country at the parallel of 34°, to the extreme southern line of the Territory, and from thence over the States of Chihuahua, Sonora, and Durango, of Mexico. Their range eastward is as far as the valley of the Pecos, and they are found as far to the west as the Pimos villages on the Gila. They are divided into numerous bands, each of which takes its name from the district of country in which it is most frequently found, and all of which are under the control of separate and independent chiefs. They are greatly the most difficult to control of the Indians of New Mexico, as they not only infest the entire southern portion of the Territory, but carry their plundering forays as far south as the city of Durango itself. The valley of the Rio Grande below the parallel of 33° 30' is midway between the haunts of the White Mountain or Mezcalero and Copper Mine or Gila Apaches; and in consequence, along the valley of the river, and along the route over the "Jornada del Muerto, most of their depredations have been committed. They lie in wait along that portion of the route remote from settlements, for small parties and unprotected trains; and having plundered both the men and the wagons, they retreat rapidly to the fastnesses of the mountains east and west of the river. Their country is nearly destitute of game—is little adapted to cultivation, even were the Indians disposed to till the soil, and no treaties nor inducements can for any length of time restrain their plundering expeditions into the settlements of New Mexico. These Indians are wholly different in their characteristics from any with whom we have been brought into contact in the valleys of the Mississippi or Missouri. They are much less intelligent and less bold, and have none of the warlike tastes or accomplishments, of the Pawnee or the Sioux. Their sole object is plunder, and they are totally destitute of the ambition or the courage to distinguish themselves by warlike achievements. The principal aims of their greatest war expeditions have been directed to the plundering of small ranchos, and the driving off of herds of stock, and the murder of a miserable and helpless shepherd is matter of immense exultation.

They carry off the children from these ravaged settlements, and either adopt them into the tribe or make slaves of them.

In this habit they are closely imitated, or have been set the example, by the people of New Mexico, and it is very doubtful whether a settlement can be found in the valley of the Rio Grande not possessed of Indian slaves. These poor creatures are bought and sold like horses or mules, and it seems rather too much to expect that the Indians shall deliver up the Mexican prisoners in their possession to the authorities which countenance openly the sale and slavery of numbers of their tribe. So far as three years' experience in the country has enabled me to judge, it has seemed to me that the amount of robbery is about

equal between the lower classes of New Mexicans and the Indians, whose herds of stock are frequently together, and that protection from plunder, which we are expending so much money to secure the former, could with equal justice be extended to the Indian.

It is difficult to say upon which side plundering predominates, although all depredations committed by the Indians, tenfold exaggerated, are duly laid before the authorities.

Those tribes of Apaches which I have named, occupying the fastnesses of the mountains east and west, descend upon the valley of the Rio Grande as far to the north as the town of Socorro, and as far to the south as the San Elizario of Texas. They drive off great quantities of stock, and make good their retreat to the mountains, before intelligence of their presence can be communicated to the commanders of the military posts along the river. They have absolutely no object but plunder, or perhaps the desire to recover their own, and have never, to my knowledge, been known to attack a larger number of persons than ten. The great difficulty of controlling or chastising them has consisted in the impossibility of overtaking or bringing them to an engagement. Upon the approach of a body of armed men, they scatter to all points of the compass, over the mountains and by-paths of the country, and only reunite at some point far removed from danger. On their wiry and active ponies they scale heights apparently impracticable, and rush at headlong speed through the most difficult and dangerous passes of the mountains.

A company of seventy-five men can traverse their country in any direction without encountering danger or resistance. Against such Indians as these it is plain that military expeditions cannot succeed, and instead of endeavoring to *punish*, it would seem wiser to take measures to *prevent* their depredations.

The changes in the present military arrangements which seem to me desirable for this object, will be duly suggested. Efforts have been made to induce these Indians to settle in the vicinity of the posts, and to cultivate fields, but so far without hope of success.

It is almost impossible to arrive at any correct notion of their number; but from all I could learn, they cannot exceed seven thousand persons.

The Lipans.—Of these Indians I know but little. Their range is far to the south of the 32d parallel; and although small parties have been occasionally seen in the valley of the Pecos and near to the Guadalupe mountains, their visits have been so rare and seemingly so objectless as to render it but little important that they should be enumerated among the tribes of Indians who infest this region of country. They number, probably, five hundred souls.

The Camanches.—The Camanches—the Arabs of the deserts of North America—have long occupied an important place among the Indian nations of this continent. In conjunction with the Sioux or Dacotahs of the North, they have for many years maintained an almost undisputed sway over the immense regions between the Rocky mountains and the frontiers of the western States. They are variously estimated at from 15,000 to 40,000 persons; but probably one-half of the larger estimate will fully include their entire population. Many small tribes

under different names, but speaking the same language, and fragments of bands whose power and influence have long since passed away, live among them in friendly or dependent relations. In their hunting expeditions among the buffalo, they roam as far to the north as the 38th parallel of latitude; and, passing the Rio Grande five hundred miles from their homes, they invade the dominions of Mexico to within two hundred and fifty miles of her capital. In small parties, and unsupported, they penetrate into the densest settlements of the northern States of Mexico; and in broad day-light, and nearly unopposed, they carry off into captivity hundreds of human beings, and thousands of horses and mules, and lay under contribution populous towns, and even large cities. They are objects of the extremest terror to the Mexican; and it is even related that a single Camanche alone, and at mid-day, dashed at speed into the public square of the city of Durango, and by his mere presence caused the hasty closing of the stores and public places of the city, and the rapid retreat of a population of thirty thousand souls to their barred houses. He remained an hour roaming through the deserted streets, and was only captured by being lassoed from the window of a house as he was riding triumphantly but carelessly from the suburbs. Such an occurrence must appear amazing to the last degree to an American, who has been accustomed to deal with the Indian upon terms of advantage; but in the Mexican, the sight of a half-naked Camanche, with his shaggy horse and his quiver of arrows, produces a paralysis of fear, from which he seems never to recover. These wretched people, shut up in their barred and grated villages, will look forth despairingly, but without even an inclination to resist, upon one-third of their number of half-armed Camanches, ravaging the fields and haciendas under their very eyes, and carrying off into hopeless captivity the miserable women and children who have not succeeded in making good their escape. Under the uncontrollable influence of this singular and despicable apprehension, it does not seem strange that they should have attached so much value to our protection from these Indians, nor that they should have insisted with so much earnestness upon inserting such a provision into the treaty of Guadalupe Hidalgo. The women who are thus carried off from their homes, become the wives or servants of their captors; and the men, after a probation more or less lengthy, are adopted into the tribe, most generally in a dependent condition.

Of the many I have seen thus held in captivity, I have never yet met one who was willing to return to his home or his country. In the women this feeling is not difficult to understand. They have all been subjected to the inhuman but invariable outrages which are perpetrated by Indians upon their female prisoners at the moment of capture; and they afterwards most probably form attachments to the warriors who have taken them to wife, and by whom they have borne children, who enjoy every privilege of the most favored of the tribe. In the men the feeling is more difficult to comprehend. Their cowed and sullen look, and shuffling, timid manner, sufficiently betray the position they occupy; and their avowed reluctance to return to their homes is probably due to a fear of the punishment which the expression of such a wish would be certain to bring upon them.

It would be tedious and out of place, in a report which has in view merely the military precautions proper to be observed in reference to them, to enter into a detailed description of the character and manners and customs of these Indians; and my remarks concerning them will probably be more brief than so prolific a subject would seem to justify. The description of the route of this expedition has a direct bearing, however, upon this entire tribe of Indians, as their nomadic and restless habits induce them to roam continually through the immense region over which they claim control.

The Camanches are small of stature; quick and sprightly in appearance and action; and in all cases, where I have seen them, they wear moustaches and heads of long hair instead of shaving to the scalp-lock, as is the custom with the more northern races. Although sufficiently courteous in their communications with the whites, they nevertheless exhibit a half-defiant, half-scornful air, as if their friendly expressions were more the result of convenience than of necessity. Over the subordinate bands of Indians who live among them they invariably maintain an undisputed supremacy, neither consulting them nor allowing from them an expression of opinion upon any matter which they have under consideration. During the summer months nearly the whole tribe migrates to the north, to hunt buffalo and wild horses on the plains of the upper Arkansas, but return in the autumn with the proceeds of their hunting expeditions to pass the winter in the timbered country along the valleys of the upper Colorado, Brazos, and Red rivers. Since the establishment of military posts on the frontiers of Texas, and the consequent advance of settlements into their country, the Camanches have been brought into much more constant and familiar intercourse with the whites, and have begun to contract that passion for ardent spirits which has proved so fatal to their race. The stringent laws of the United States have prevented, as far as it has been possible, the introduction of spirituous liquors into the Indian countries in the territories over which the general government has control; but the State of Texas recognises no Indian title to lands within her borders, and no laws interdict the traffic of ardent spirits, which present an attraction entirely irresistible to the Indian.

To this fatal policy, or rather want of policy, on the part of the State, many of the late Indian difficulties in Texas undoubtedly owe their origin; and until some district of country is set apart for the Indian tribes, governed by the same strict laws in reference to intercourse with them which now prevail in the Territories of the United States, constant and harassing troubles with the Indians will continue to mark the history of Texas.

Up to the period of the occupation of the country by the troops of the general government, the Camanches were accustomed to equip large expeditions, which, traversing the State of Texas by various routes, and passing the Rio Grande at numerous points in its course, even as low down as Matamoras, laid waste the northern States of Mexico. The establishment of a chain of military posts enclosing the extreme settlements has seriously interrupted their hitherto unmolested progress to the Rio Grande, and they have been compelled to conduct their marauding parties to the frontiers of Mexico by routes much far-

ther to the west. The broad trail, which seems now in most constant use, crosses the Pecos at the Horse-head crossing, and, skirting the eastern base of the Llano Estacado along the line of the extreme western watering-places, conducts to the valleys of the upper Brazos and Red rivers, and to the plains of the upper Arkansas, by a route which at no point approaches to within two hundred miles of a military post.

The good effect of the chain of military posts in Texas has been thus far exhibited, and it would seem the part of wisdom to continue such a line as nearly as possible to the valley of the Rio Grande. The present military stations, although continued in a southerly direction to the river, leave a district of country unoccupied, at least five hundred miles in breadth, between El Paso and the nearest post in Texas.

This distance is by far too great to insure any efficient moral effect upon the Indians, whose marauding parties now pursue a route traversing this unoccupied region; and it would seem that the continuation of the chain of military posts by the most practicable route to the Rio Grande, should be an object for early consideration. At the headwaters of the Colorado, and on the broad trail along the eastern base of the Staked Plain, to which I have referred, we came upon an encampment of about fifty Kiowa Indians, returning from a plundering incursion into Mexico, with at least a thousand horses. They did not seem to relish our approach—in the fear, probably, that we would relieve them of part of their plunder; and immediately after we came in sight, they hastily collected their baggage and animals, and took the trail to the north, firing the prairies as they went off.

Heavy clouds of smoke during the day, and a lurid glow in the western sky at night, exhibited to us, for several days, the progress of the fire towards the valley of the Pecos. The only Indian who approached us evidently did so to reconnoitre, and was exceedingly anxious to know whether we had seen any Camanches, of whose vicinity he seemed to entertain a good deal of anxiety. Although the Kiowas live with the Camanches upon friendly terms, it was plain that this party was fearful of being compelled at least to disgorge a portion of their plunder, in the way of tribute to their more powerful friends.

The range of the Camanche Indians extends over the plains of the Arkansas from the vicinity of Bent's fort, at the parallel of 38°, to the Gulf of Mexico, and they occupy the country along the route of this expedition from the eastern base of the Llano Estacado to about the meridian of longitude 98th.

The Kiowas.—Of the many small bands and fragments of tribes which are found living with the Camanches, by far the most powerful are the Kiowas, who probably do not number more than fifteen hundred. Although similar in appearance, and almost identical in manners and customs, with the Camanches, they are, doubtless, from their equivocal position, much more deceitful and unreliable in their professions, and are absolutely destitute of most of the chivalric characteristics which distinguish the Camanche brave.

They hunt the buffalo in company, and parties of the Kiowas always accompany the plundering expeditions of the Camanches into the States of Mexico. They are divided into several sub-tribes, under the control of independent chiefs, and portions of them, even during the

winter months, occupy the valley of the upper Arkansas, and of its tributary, the Purgatory river. The "Big Timbers" of the Arkansas, and the bushy shores of the Purgatory, afford them fuel and shelter from the storms, and they find an abundant supply of food in the immense herds of buffalo which pass the winter along the banks of the Arkansas. In common with all the Indians of the plains, they maintain a continual warfare with the Indians of the mountains; and the Utah Indians, who inhabit the fastnesses of the Raton and Sangre de Christo, frequently avail themselves of the absence of the Camanches, during the summer, to make descents from the mountains upon the small parties of Kiowas who remain in the valley of the Arkansas.

The surplus horses and mules which are brought from Mexico are traded among the Arapahoes and Cheyennes, and with these Indians they maintain a kind of equivocal peace, which is solely dependent upon the success of their plundering expeditions in the south.

A small fragment of what are known as the Apaches of the Plains also live among the Camanches, but are so few in number, and of so little influence, as to require but a bare mention in this paper.

The Tonkawas, Wacos, Wichitas, Caddoes, &c.—The valley of the Brazos, and the country from thence to the Red river, along the route, are occupied by the several small tribes of Indians above mentioned, probably not numbering in all one thousand persons. They are peaceable and friendly, and for several years past have committed no depredations.

In most cases they cultivate small farms, and are dependent for subsistence upon agricultural products rather than the spoils of war or the chase. They are easily held in control by the military post (Fort Belknap) established upon the Brazos.

The country between the Red river and the western frontier of Arkansas (one hundred and fifty miles) is occupied by the semi-civilized tribes of Choctaws, Chickasaws, and Cherokees, who, several years since, were emigrated to their present homes from Georgia, Alabama, and Mississippi. They occupy houses, cultivate fields, and approach nearly, in the matter of costume and manners, to the whites who live among them. They are fond of drinking and gambling, and although occasional fatal quarrels occur with each other, they are in other respects harmless.

It will be observed that in this brief account of the Indian tribes which are found along this route, I have confined myself to a mere statement of their estimated numbers and the districts of country which they occupy.

My instructions required me to report upon the military features of the route, and in this respect such information concerning the Indians was necessary to explain fully the military dispositions which, in my judgment, will be advisable to insure security to the emigrant and the settler.

I have therefore supposed, that however interesting to those curious in such matters might be a detailed account of their manners and customs, their appearance and costume, a vocabulary of their languages and wild and irreconcilable traditions concerning their origin and his-

tory, such things could have little practical bearing upon the duties with which I was charged, and would, therefore, be little appropriate to this report.

CHAPTER IV.

Military character of the route.

From the period of the establishment of this government, the policy to be observed in respect to the Indian tribes within our borders, and the selection of sites for the military posts designed to secure the objects of this policy, have been questions surrounded by difficulties.

Kind treatment, the payment of annuities which enable the Indian to live without resort to plunder, and the maintenance of friendly and peaceful relations—which now seem the fixed policy of the government—have to some extent simplified the question of military positions, although neither the prosperity of the Indian nor the security of the white man seems to have been greatly promoted.

So long as the Indians to be controlled occupied the fertile valleys of the Mississippi and its tributaries, a glance at the map exhibiting the districts of country occupied by the various tribes was sufficient to determine the positions of the military posts designed for their control. The entire region then occupied by the Indians over whom we claimed jurisdiction was so amazingly fertile, and of such vast natural advantages, that the military posts which insured even partial security became at once *nuclei* for settlements, which increased in number and prosperity with such surprising rapidity, and so soon superseded the necessity of military protection, that the posts themselves became almost encampments of troops, whose movement to the westward was, although gradual, uninterrupted. The incorporation of New Mexico and California, the occupation of Utah and Oregon, and the acquisition of the immense deserts which separate them from the valley of the Mississippi, have surrounded this question with difficulties which, up to this time, have not been entirely overcome.

The necessity of occupying, with the small force at our command, an immense region of country doomed by nature to perpetual sterility, possessing not one requisite for the support of a military post, and far from points where even the necessaries of life can be procured, yet, traversed by several great highways of travel and emigration to our possessions in New Mexico and on the Pacific, and infested by bands of hostile Indians whose number is yet unknown to us, has brought other and new elements into the consideration of our military arrangements.

Every day renders more manifest the necessity of providing more ample means of accommodation and protection to the immense rush of emigration from the valley of the Mississippi to the Pacific ocean; and a consideration of this subject would seem to point to the establish-

ment of some one great highway for this purpose, which should be common to all the emigrants.

With the small force of our regular army, and in view of the immense difficulty and enormous expense of supplying or maintaining a chain of military posts across the plains, it would be clearly impossible to occupy or render secure more than one such line; and the selection of a route affording as many facilities as possible for travel, and for the supply of the posts, would seem to be a matter of primary consequence.

While our possessions were confined to the fertile and comparatively limited region along the valleys of the Mississippi and its tributaries, the establishment of routes for emigration was a matter requiring little consideration; but occupying, as we now do, the immense deserts which extend from the frontiers of the western States to the Rocky mountains—over which thousands of emigrants are constantly pushing forward to the Pacific, who require protection in a country in which it is next to impossible to establish military posts—the determination of a route which should accommodate their necessities and insure their safety should be a matter for careful examination.

The immense ranges of the Rocky mountains, and the vast deserts to the eastward, extending in uninterrupted barrenness to the frontiers of the western States, are but partially explored, and the Indian tribes which roam through them almost unknown. The military posts which have been established seem to have been mere experiments, which, judging from daily accounts of the sufferings of the emigrants, and the repeated and fatal attacks of the Indians, appear to have been attended with but partial success.

A brief statement of the important requisites to be considered in the establishment of military posts in the Indian country, and in the selection of a great route to the Pacific for emigration and for military purposes, seems to me necessary to the explanation of the suggestions which I shall offer in reference to the establishment of military posts along the route, the exploration of which has been intrusted to me.

Of the establishment of military posts in the Indian country.—There are several elements which enter into the selection of a site for a military post among Indians: first, that it should be so placed as to exercise the greatest amount of control over the Indians; second, that it shall be easy of access from its depots of supplies and military stores; and, third, that it shall, if possible, in view of these primary objects, be situated in a country adapted to settlement and cultivation. To locate a post advisedly, therefore, a knowledge of the number, character, and habits of the Indians, and of the districts where they most commonly live, and full information of the agricultural and topographical features of the country, are important requisites.

Indian depredations are never committed in the vicinity of their homes, or the places where they leave the women and children during expeditions for plunder. They organize parties far from the points at which they design to commence their forays, and return, after months of danger and hardship, to enjoy the spoils of their expeditions. A post in the immediate vicinity of where they are in the habit of wintering, and of leaving their women and children during these expe-

ditions for plunder, would undoubtedly, in a great measure, restrain their incursions far into the interior, since they fully understand that their outrages in the settlements would be visited with equal severity upon those who were left behind defenceless.

A military post established with this view would be infinitely more conducive to the security of the settlements in its rear than half a dozen posts within the settlements themselves.

The principal object of a military post in the Indian country is undoubtedly to restrain depredations, by a display of military force, but many results of equal or even greater importance are the consequence of its establishment. The Indians are brought into familiar contact with the whites, and an acquaintance springs up from which naturally results a traffic of commodities which is mutually advantageous. The Indian begins to indulge in luxuries unknown to him before, and which he afterwards relinquishes with great reluctance. The supplies of presents, provisions, &c., which are provided by the government, enable him to indulge in these luxuries and in an idleness very attractive to him, and obviate entirely the necessities, hunger and nakedness, which have prompted his expeditions for plunder.

With all these advantages to himself which result from the establishment of a post and the payment of reasonable annuities, which enable him to live without work, and with the certainty that his women and children are constantly in the power of the troops, it seems nearly incredible that he should undertake expeditions for plunder, the very success of which would jeopard, with such extreme probability of destruction, his wife and family and possessions, and would certainly deprive him of the power of indulging his indolence, and cut him off from the use of luxuries which have become necessary.

There is no doubt but that judicious management, at a military post in the Indian country, will completely effect these results. It would be well also for the mounted troops to be kept moving about in the country during the season for field service, keeping as nearly as desirable in the vicinity of the Indians, and in fact, to some extent, conforming during the summer to their wandering habits. The moral effect of the troops would thus be continually felt, and the Indians would be forced to keep their warriors constantly on hand to defend them from attacks which might at any time be made upon them.

Another well known effect of military posts, heretofore, has been to attract settlers, who cultivate the country in the vicinity, and who are able in a short time to supply most of the necessities of the garrisons. A very few years (as experience has already sufficiently demonstrated) find these settlements so prosperous and with so large a population that military protection is no longer required, and the garrison can safely be moved farther into the Indian country, to produce, in time, the same results.

The settlements not only commence in the immediate vicinity of the posts themselves, but gradually creep along the routes from their depots of supplies, and the whole region between the line of extreme settlements and the chain of posts would soon be occupied by the hardy pioneers of western settlement. The Indians would, as has heretofore been the case, retire before them, and would, after the lapse of a very

few years, find themselves beyond the line of posts. By this process our western States have been settled, and hence the very great importance of establishing military posts, where it can be done with a view to military considerations, in a fertile, well-watered region, adapted to settlement and cultivation. There are few places to which the Indians of the plains can retire for protection against the hardships and sufferings of a winter on the prairies, and the policy of occupying these positions with military posts is sufficiently apparent. A state of war, or the commission of depredations, which almost always occur in the winter months, when the difficulty of procuring supplies of food and clothing is greatest, would effectually debar them from access to the shelter of the timbered region and deprive them of the assistance of the government; and it seems clear that a powerful influence would be thus brought to bear in restraining their depredations.

In the establishment of a chain of military posts for combined action, a view must be had also to the advantage of so locating the line of posts that it shall divide the tribes upon which it is intended to operate, and thus prevent any combined action. The reluctance with which wild Indians cross a well-beaten road for the purpose of committing depredations, is well known to all conversant with their habits, and the establishment of well-beaten routes to connect the posts along the line is a matter of the first consequence. It enables the garrisons to concentrate promptly, should the necessity ever arise; and being constantly traversed by troops, it absolutely cuts off any party of Indians which has crossed it on plundering expeditions. This route should be plain and well-beaten, and constantly traversed between the posts by an armed force. The posts should be placed along it at intervals, certainly not to exceed one hundred and seventy-five miles, if it be possible to avoid it. With such a chain of posts through the centre of the Indian country the greatest moral effect is produced; the safety of the route between the posts is secured, and the Indian tribes are divided from any combined action against the settlements. The chain of military posts along the frontier of Texas has already exhibited the beginning of these results. The Camanches, who have been in the habit heretofore of traversing the State by various routes to the Rio Grande, are now confined to one which carefully avoids crossing or approaching the chain of posts: their depredations have been of much less extent or consequence; and wherever the posts have been placed in a country adapted to agriculture, settlements have been commenced. The Indians are beginning to frequent the posts for trade, and are gradually assuming the dependent condition which I have stated above to be the inevitable result of association with the whites and indulgence in their luxuries.

When people of such different races and of such diverse interests are brought into contact, difficulties must be anticipated; but the military arrangements I have suggested would effectually destroy the possibility of general warfare, or combined or powerful expeditions for plunder.

Such are some of the important elements which enter into the selection of sites for military posts in the Indian country, and such are a few of the results which they produce. The establishment of a line of posts across the plains would necessarily determine the travelled routes across this continent, and I have therefore considered it proper to enter

fully into the subject, that the facilities for this purpose, presented by the route I have explored, may be fully estimated.

Of the selection of a route across the plains.—So long as the transportation to California by sea continues to be so difficult and expensive, and the value of stock of all kinds in that State so great, a vast excess of emigration, which is in a great measure confined to persons whose means are limited, must pursue the overland routes. The emigrants expect and are entitled to protection by the government, and the consideration of the measures to effect this object has become of vast importance.

The almost insuperable difficulties which surround the establishment of a line of military posts on the plains, which are exposed, without fuel or the means of constructing shelters, to all the rigors of the seasons, and far from points where even the necessaries of life are to be procured, forced to occupy a region possessing neither agricultural nor mineral resources, and doomed by nature to perpetual solitude, would seem to render it a matter of the extremest importance to shorten such a line as much as possible, and with that view to select a route which should cross these deserts at their narrowest point.

A consideration of secondary, but still of great consequence, would point to the location of the route through a region in which the extremes of heat and cold are least known, and in which unexpected difficulties or unavoidable delays would not subject the emigrant to extreme sufferings from cold and hunger, which have proved fatal in so many instances.

In a military point of view this would seem nearly of equal importance. Although the departure and movement of military expeditions across the plains can be arranged with a foresight which will secure them against the probability of such exposure, yet, as a question of expediency, it would be far wiser to select a military route which can be traversed without difficulty at any season of the year.

A very hasty examination of the country exhibits the fact that the vast deserts between the valley of the Rio Grande and the frontiers of the Western States contract to their least width along the belt of country between the 32d and 34th parallels of latitude. The average distance of six hundred and fifty miles over these vast deserts is here reduced to less than three hundred miles, and along a route where the extremes of heat and cold are absolutely unknown.

For three hundred and eleven miles west of the eastern line of the prairies, the belt of country along the 33d parallel presents absolutely a combination of all the favorable circumstances which I have suggested as necessary to the establishment of a chain of military posts. The line of posts along the route traverses the heart of the country occupied by the most powerful tribe of Indians west of the Mississippi; intersects the wooded districts in which they are forced to seek shelter from the horrors of a winter on the prairies; separates the Indians of Texas from those of the northern plains; presents numerous points, offering every facility of wood, water, and grass, for the establishment of a military post; crosses the principal rivers of Texas at no great distance from the heads of their navigation, at which can be established depots of

supplies; traverses a region of fertile soil and abundant timber, affording every advantage to the settler, and of mild and genial temperature at every season of the year; and, finally, avoids more than one-half the desert country between the Rocky mountains and the valley of the Mississippi. It commences on the Red river at a point navigable by steamboats, and connects by a good road, constantly travelled, with the Arkansas river below the head of its navigation.

The only obstacle on this route, and one which alone has prevented it from becoming the great and only highway across the plains, is the want of water on the Llano Estacado, over a distance of one hundred and twenty-five miles; but this difficulty, as will be exhibited hereafter, is obviated so easily, and at so little expense, that it cannot weigh as a feather in the balance against the unrivalled advantages of this route.

Of the three hundred miles of desert along the route, nearly two hundred are through a region affording water in abundance and fuel entirely sufficient for camping purposes; and the whole distance of three hundred miles is occupied by a country profusely overgrown with the mezquite and grama grasses—by far the best and most nutritious grasses on this continent.

It is quite unnecessary to dwell upon the importance of the remarkable advantages peculiar to this route, and I therefore proceed, with these opinions, to suggest the military arrangements which seem to me most judicious.

Of the present military posts, and proposed changes.—The military posts which now enclose the settlements of Texas, considering the very large intervals between them, and the weakness of their garrisons, have been attended with wonderful success, although not situated, as, in my judgment, they should be, with a view to combined action with the military arrangements in New Mexico. The chain of posts in Texas is separated from the line of posts in New Mexico along the valley of the Rio Grande by a distance of nearly five hundred miles; and this great space, by far too extensive to be rendered secure by the present military arrangements, is traversed only once or twice during the year by the trains of supplies and military stores for the posts on the Rio Grande.

Any protection other than from their own combinations, is therefore only afforded to the emigrants and to the immense trains of the traders in New Mexico, Chihuahua, and Sonora, at long intervals; and the almost daily accounts of loss of life by sufferings, and from the attacks of Indians, are due to the defective disposition of the troops.

The post (Fort Belknap) which has been placed on the upper Brazos, near the 33d parallel, is in all respects well situated upon the line which I have suggested, and is garrisoned by two companies of the 7th infantry and one company of the 2d dragoons.

Mounted troops are far more efficient than infantry at frontier posts; and I would therefore suggest the propriety of replacing one of the infantry companies by a company of mounted men. This post is about one hundred and seventy-five miles from Fort Washita, and a somewhat less distance from Fort Arbuckle, on the verge of the Chickasaw and

Choctaw country, and settlements have gradually advanced towards it to a distance of fifty miles from the valley of the Red river, at the little village of Preston. Settlements have been commenced in the vicinity of the post, and also at a distance of thirty-five miles to the west, and in a few years the wants of the garrison will be readily supplied by them.

The Indians of the small friendly tribes I have mentioned have also established their villages in the neighborhood.

For all the military purposes required, this post is admirably placed, and is only defective, as I have stated above, in its garrison.

About one hundred and thirty-five miles to the southwest we find Fort Chadbourne, on a small tributary of the Colorado, and about twelve miles from the river.

In view of the reasons I have suggested, this post is out of position, and I therefore recommend that it be thrown forward to the northwest, to the intersection of the line from Fort Belknap to El Paso, with the broad trail to the Rio Grande along the eastern base of the Llano Estacado, and which is now the highway of the Camanches and Kiowas of the northern plains. It would thus be brought more directly into contact with the Indians, and nearer to the timbered regions of the Brazos and Red rivers, in which they pass the winter; would occupy the broad trail of their plundering expeditions to the Rio Grande; would separate the northern from the southern Camanches; and, independently of these advantages in a military view, it would occupy a point on the proposed route of travel to the Rio Grande at El Paso.

The main Colorado and many of its tributaries offer desirable sites for a military post as far west, at least, as the 101° of longitude, and somewhat farther if necessary. The mezquite, of large size, is found forming extensive forests, and furnishing an excellent and abundant fuel. Building-stone and lime exist on the spot, and water is found in springs and running streams at almost any point. There is no timber so high up on the Colorado which is fit for the lumber used in the construction of quarters; but as the buildings would necessarily be of stone, it would be requisite to haul but little lumber from points below.

In view of the insufficiency of the military forces in Texas, I have suggested the throwing forward of Fort Chadbourne to the northwest; but there is little question but that another post could be advantageously established between this new position and Fort Belknap, on some tributary of the Double Mountain fork of the Brazos. Good roads should at once be made, connecting these posts with each other, and with the heads of navigation of the Brazos and the Colorado, by the valleys of these streams. I would also suggest, in this connexion, the removal of Fort Arbuckle, which seems of little practical use in its present position, to a point in the valley of the Red river, and considerably farther to the west, and of connecting it by good roads with these two posts, and with Fort Smith or Fort Gibson, on the Arkansas. It would be thus placed on the southern frontier of the "Great Plains," and in the region occupied by the Camanches and Kiowas of the northern prairies during the winter months.

By these arrangements a very fertile and extensive region along the northern frontier of Texas would be thrown open to settlements, which

would soon supersede the necessity of the posts. The interval of three hundred miles between the new position of Fort Chadbourne and the valley of the Rio Grande, could be occupied by a post to be established at or near the head of Delaware creek, one hundred and seventy-six miles west of Fort Chadbourne, and one hundred and forty-five miles east of El Paso.

At this point water is furnished in abundance from pure and mineral springs, which form the sources of this stream; grass is good and very abundant over the entire country, and the building-material, of stone or adobe, is furnished in the immediate vicinity. Sufficient wood for fuel is found in the mezquite and dwarf cedar, which cover the ridges in the neighborhood, and lumber to be used on the quarters could be procured from the forests of pine which line the eastern face of the Guadalupe mountains, at a distance of twenty miles. I would suggest that Fort Fillmore, on the Rio Grande, which can be advantageously broken up, as will be immediately exhibited, be removed to this point.

By these arrangements we have a continuous line of posts, at convenient intervals, from the frontiers of Arkansas to the Rio Grande at El Paso, or Doña Ana, separating the Indians of the prairies from those of Texas, confining the Apaches of New Mexico to the mountain ranges to the north, and without increase of the military force. By procuring water on the "Staked Plain," we have a route across the plains to the valley of the Rio Grande, more than half of which traverses a well-watered, well-timbered and fertile country, and one which a very few years will find settled to within three hundred miles of El Paso.

A brief examination of the approaches to this route from the east, and a comparison with the present military road through Texas to El Paso, will readily exhibit its immense advantages.

The great route of emigration to Texas, from Illinois, Missouri, Arkansas, Kentucky, and Tennessee, and the southern route to California, cross the Red river at the little village of Preston, and at the town of Clarksville, one hundred miles lower down.

A broad and well-beaten road also leads from Preston down the valley of the Red river, connecting the towns and settlements. The Red river, as I before stated, is navigable many miles above the town of Preston, and steamboats yearly carry down the cotton and other products of the valley. The point of departure from the Red river is easily accessible, both by land and water, and the distance thence to the Rio Grande, at El Paso, over the route I have described, is six hundred and thirty-nine miles.

The present depot of military supplies for Texas and the Rio Grande, as high up as the town of Doña Ana, has been established at La Vaca bay, and from thence, by the present military route to El Paso, is a distance of seven hundred and fifty miles. Nearly five hundred miles of this distance is through a country destitute of timber, and badly watered, and, although the depot is more easily reached from the east than the proposed point of departure on Red river, yet is not only much farther from the frontier posts of Texas, but communicates with them by a route far inferior in all respects.

For the defence of the Rio Grande settlements, from the northern terminus of the "Jornada del Muerto" to El Paso, a distance of one hundred and forty-two miles, there are at present four military posts, garrisoned by nearly half the military forces in the department of New Mexico. Commencing at the north, these posts are, first, Fort Conrad, which, under another name, has been moved down to the northern terminus of the "Jornada;" Fort Thorne, in the valley of the river and opposite the centre of the "Jornada," a distance of sixty miles from Fort Conrad; Fort Fillmore, at the Bracita, fifty-four miles lower down; and Fort Bliss, opposite El Paso, and forty miles below Fort Fillmore.

The garrisons are in order as follows: Fort Conrad, one company of infantry, and one company of dragoons; Fort Thorne, same garrison; Fort Fillmore, three companies of infantry, and one company of dragoons; and Fort Bliss, four companies of infantry. We have distributed at intervals of less than sixty miles four military posts, comprising nearly one-half of the troops in the Territory, and for the protection of about one-eighth of the population.

The establishment of Fort Thorne I consider in all respects a wise arrangement. A road has been made connecting it with Fort Conrad, and with the town of Doña Ana, and all military movements and trains are required to pursue this route. The road over the "Jornada" has for many years been the scene of Indian depredations upon travellers and trains of wagons; and as, from its character, it can never be settled, it is likely to require for all time strong military dispositions for its security. Water is very scarce; there is no wood, and the grass is very indifferent.

The small gain in distance (fifteen miles) by no means compensates for these disadvantages, and nothing but the natural indolence of the Mexicans has ever diverted the travel from the valley of the river. That portion of the valley which bounds the "Jornada" on the west, is among the finest portions of the arable country in New Mexico, and even partial security will soon secure its settlement and cultivation. The route along the river will then be as safe as any portion of the Territory, and the dangers of the "Jornada del Muerto" will only be mementoes of the past. It would be impolitic in the extreme to attempt any boring for water on this desert, as the road along the river furnishes every possible facility of wood, water, and grass; and the constant use of this route would redeem from solitude the best portion of the Rio Grande. The very success in supplying water on the "Jornada" would render necessary the perpetual maintenance of a strong military force for the defence of the route over it, whereas the settlement and cultivation of the valley of the river would soon leave the forces at Fort Thorne disposable for other purposes. The commander of the department of New Mexico has, in my judgment, exhibited great wisdom in establishing this post, and its good effects are already beginning to be perceptible.

Fort Fillmore, which once occupied an important position opposite the valley and town of Mesilla, has, since the late treaty, entirely lost its consequence, and since the establishment of Fort Bliss, forty miles below, has become absolutely unnecessary. I

therefore suggest that it be at once moved to the head of the Delaware creek, east of the Guadalupe mountains, and that its garrison be changed to two companies of dragoons and one of infantry. The establishment of this post would effectually cut off from the settlements below El Paso, and from the route to that place, the Indians of the White and Sacramento mountains, who have been constantly in the habit of carrying their forays into that part of the country; and with these troops in their rear, and near their places of retreat in the mountains, they would be extremely cautious about extending their depredations to the valley of the Rio Grande above.

I suggest these military arrangements after much reflection, and after careful examination of the country and full knowledge of its necessities; and taken in connexion with a great highway of travel across the plains, I think they will be found by experience to be in every respect advantageous.

CHAPTER V.

Agricultural and mineral resources of the route.

As I have represented at some length in the preceding chapters the facilities presented by this route for a great highway of travel across the plains, and for the establishment of military posts for its security, and for military operations against the Indians, not only in view of the great practicability of the country for such purposes, but in consequence of its extremely favorable agricultural features, I consider it proper to enter in some detail into the examination of this subject.

The opinions I shall express are not based upon the results of superficial observation, but will be found confirmed by an analysis of the soils, and an examination and description of the specimens of grasses and other vegetation which were collected at short intervals.

To the results of these examinations by scientific men, and which will be found under the head of botany and soils, in the appendix to this report, I refer for the amount of confidence to be placed in my statements.

It seems proper to state here that the region of the agricultural resources of which I am about to give a hasty sketch, lies entirely to the west of the limits of possible settlement in the Indian territories west of Missouri.

I will say, first, that with a considerable train of wagons, drawn by mules and heavily loaded, I left Doña Ana on the 12th February—a season of the year the worst possible, when the old grass was in its most unfavorable condition and the new grass had not begun to spring up, and traversed this route for the first time, over an unbroken country, without losing, during the whole expedition, one single animal.

The mules arrived at Preston, on the Red river, after a journey of this character of six hundred and fifty miles, in better order than when

they started; and at no time during the entire journey were they in worse condition than when they left the valley of the Rio Grande.

This simple fact, which will be found confirmed in the journals of the expedition, speaks more strongly than volumes of opinions in establishing the remarkable advantages of the country for the support of stock.

The grama and mezquite grasses, which cover the entire surface, are short and curly, growing very thickly and almost matted, and form a firm spongy sod. They do not dry up and lose their strength and nutriment during the winter, as is the case with the grasses further east, but actually "cure" where they grow, like hay which has been prepared by the farmer. To this singular fact, and to the extreme abundance of the grass, is undoubtedly due the complete success of the expedition; and the journey across the plains with such successful results, during the most unfavorable months, exhibits conclusively the practicability of traversing this route at any season of the year.

Of the valley of the Red river.—This valley is fourteen miles in width from the point at which the route of survey intersected its first tributary, to the crossing of the river at Preston.

About four-fifths are covered with large timber—a few patches of prairie of limited extent, only, sufficing to interrupt its continuity. The immediate valley of the river is about one hundred feet below the gently receding bluffs which border it, and is overgrown by timber of the largest size and best quality—oak, pecan, hickory, elm, &c.

Although the bottom-land is covered with this timber, growing so thickly as absolutely to prevent any passage through it even on horse-back without constant cutting, it is preferred by cotton-planters who have the force to clear it, to the prairie or more sparsely timbered districts to the west. It possesses a soil of black vegetable mould, of such astonishing fertility that it well repays the labor of clearing the land; and I was told by one of the planters who had just commenced making a settlement, that there was no cotton land in America to compare with it. The resources of the valley are so great, and the soil so exhaustless, that it is beginning to attract planters from the cotton-growing States along the Mississippi; and although it is farther from the markets and remote from the conveniences of life, they find it to their interest to make the change.

The occupation of the eastern side of the river by half-civilized Indian tribes who interpose between it and the frontier of Arkansas, is a serious obstacle to the rapid settlement of the valley.

It is of course forbidden to the whites to own land, or occupy themselves in making farms in the Indian country; and the existence of the very unsatisfactory state of things in regard to law and order on the eastern, seriously retards the settlement of the western side of the valley.

There is little or no security from robbery and outrage of any character, as the facilities for escape into the Indian country east of the river, and the impossibility of securing or punishing a fugitive from justice, have attracted, and will continue to attract, the outlaw and the vagabond.

The valley of the river between 32d and the 34th parallels of

latitude is a thickly timbered region of fertile soil, well watered and possessing a mild and healthy climate. It produces abundantly all the cereals, and is admirably adapted to the cultivation of cotton. The pasturage is very fine, and is only interrupted by the seasons for two or three months of the year.

Valley of the Trinity, and its tributaries.—The valley of the Trinity, between the waters of the Brazos and Red river, is about one hundred and seventeen miles in width, and contains about equal proportions of prairie and timbered lands along the line of the survey, but a considerably larger proportion of timber lower down. It is a gently rolling country of prairie and oak openings, and presents the most beautiful undulations of surface. The groves of oak timber are so agreeably distributed that each elevated summit of the country affords the most beautiful landscapes, which seem far more appropriate to a well settled than to a sparsely populated country. It is intersected by numerous fresh-running streams and countless springs, and seems, in soil, climate, water, and timber, to present every attraction to the emigrant. It is intersected by the two remarkable strips of very thick timber known as the upper and lower Cross Timbers, extending from the "Canadian Fork" of the Arkansas to about the 32d parallel.

The first of these—the lower Cross Timbers—is about fifteen miles through from east to west, and commences about twenty miles west of the Red river at Preston; and the second, about eight miles across, is about forty miles farther to the west. The principal growth of these two belts of timber are the post-oak, black-jack, ash, hackberry, pecan, &c. It would be very difficult to find a region of country in the United States of more fertile soil, or one in which the timbered and prairie lands were more beautifully and advantageously distributed. It is settled, though thinly, for fifty miles west of Preston, and connects with that place by the military road, joining the chain of posts along the northern frontier of Texas. The small village of Gainesville is on a tributary of the Trinity, and about forty miles west of the Red river.

Valley of the Brazos.—Separated by a very gentle dividing ridge, we find the valley of the Brazos extending one hundred and fifty miles westward to the summit between its waters and those of the Colorado. It is in all respects similar in character and natural features to the valley of the Trinity, but rather more heavily timbered to a point near the head of the Clear fork. Fort Belknap is placed on the east or left bank of the river, one hundred and seventy miles from Preston, and exercises a beneficial control over the Indian tribes which inhabit the valley.

The river opposite the fort is seven hundred and thirty-eight feet in width, with a gravelly bed; and when we passed, in April, with a depth of only a few inches. In the immediate vicinity of the post the bluff banks of the stream approach each other to within six hundred yards, and all the material for constructing a bridge is at hand.

The gently rolling country east and west dips with a gradual slope, in most cases of about fifty feet, to the immediate bottom-lands along the river, which do not exceed a mile in width. The valley of the Brazos is also being rapidly settled since the establishment of the

post, and thirty-four miles to the west, in the valley of the Clear fork, we came upon a house and a farm of several hundred acres under cultivation. As we proceed to the west from the Clear fork, the oak and ash timber become much scarcer, until, near the last tributary of the Double Mountain fork of the river, we lose it entirely. It is then replaced by dense groves of large mezquite, which cover at least two-thirds of the country to a point a few miles east of the dividing ridge of the waters of the Brazos and those of the Colorado.

Very extensive fields of bituminous coal crop out along the bluff banks of the main Brazos. The coal is of good quality, and is used in the blacksmith shops at Fort Belknap. The abundance of timber of all kinds common to the valley of the river deprives these coal-beds of the importance they would otherwise possess; but a settlement of the country and the establishment of factories would soon bring them into important notice.

The water of the river is slightly bitter and salty, in consequence of having cut through the immense gypsum region to the west; but animals prefer it to that of the springs or fresh-running streams. Pure water is found in great abundance in the numerous tributaries of the river which intersect its valley at every mile or two, and many springs are found throughout the entire country. Water is readily obtained by digging wells at any point of the surface.

The country drained by the Brazos and its tributaries is more uneven in its surface, and more densely timbered, than either the Trinity to the east or the Colorado to the west, and with a climate in all respects delightful; it is a very fertile region, eminently adapted to agricultural purposes.

Valley of the Colorado.—Passing the dividing ridge, we descend upon the tributaries of the Colorado about twenty-seven miles from the main stream. This valley, from the summit of the dividing ridge to the eastern base of the "*Llano Estacado*," is about sixty-seven miles in width, and is intersected in that distance by many small running streams, tributary to the Colorado, and from two to six miles apart. The east side of the valley is about equally divided into "prairie" and forests of mezquite timber, and is much less undulating in surface than the country to the east. The mezquite becomes less abundant on the west side of the river, probably not occupying more than one-fourth of the country, until at the base of the "Staked Plain" it disappears altogether. The soil of the valley of the Colorado is good, but less moist and fertile than that of the valley of the Brazos. The rain is not so abundant as in the valleys of the streams to the east, but falls in sufficient quantity to obviate the necessity of irrigation, as was sufficiently evinced in the fact that although we traversed it at the very driest season of the year, most of the small tributaries of the river were running streams, and few were without water. The Colorado itself was about forty feet in width, and with a rapid current traversed its valley from side to side in a very tortuous course. The low and gently-sloping ridges on each side were faced with red sandstone, and the soil was a rich, red loam, which, although light, was very fertile.

Limestone and other building-material, with the exception of timber large enough for joists and planking, are readily obtained at any point

of the valley ; and its agricultural features, although not so eminently favorable as those of the country to the east, are nevertheless good.

The mezquite, a hard and durable wood, grows in extensive forests, is about thirty feet high, and from four to ten inches in diameter.

For fuel, or for ties for railroad, it is eminently adapted, and exists in an abundance which many years will diminish but little. The yearly burning of the prairies has very seriously obstructed the growth of this timber, as was sufficiently apparent in the scorched and blackened forests west of the Colorado ; but settlement and a protection from these yearly conflagrations will readily put a stop to this destruction, and will insure a vast increase of timber over this region within a few years.

The entire region thus drained by the principal rivers of Texas is adapted, from soil and climate, to the cultivation of cotton, hemp, corn, wheat, and tobacco ; but from its peculiar character, cotton would doubtless be the most valuable and general of its productions.

I have not dwelt at much length upon the agricultural features of this region, since it differs but little from the settled districts of Arkansas or Missouri ; and I refer those who are desirous of more detailed knowledge of the character and productiveness of the soils to the tables of analyses appended to this report.

From the valley of the red river at Preston we have thus traversed, over a distance of three hundred and fifty-four miles, a belt of well-timbered and fertile country, which projects, like a great peninsula, into the vast deserts of the plains, and have reached a point within two hundred and eighty-five miles of the Rio Grande at El Paso. This remarkable natural feature of the country cannot have escaped the attention of the thousands of persons who, since the discovery of gold in California, have been seeking, with constantly-increasing interest, an easily practicable route to the Pacific, and the existence of the "Staked Plain," without water, which interposes between the western limit of this wooded peninsula and the valley of the Rio Grande, has proved, in the absence of the labor and expense of boring for water, which are beyond the means of the emigrant, an obstacle sufficient to counterbalance these advantages and to divert the emigration to different routes. This obstacle is readily and easily removed, and it is to be hoped, in every view, that the estimates for that purpose which I shall present will be favorably considered by the department.

The Llano Escatado.—Of the agricultural resources of the "Staked Plain" but little can be said. It is a high and nearly level table-land, elevated, at its highest line, about 4,700 feet above the level of the sea, and about 500 feet above the headwaters of the Colorado of Texas.

It is nearly two hundred miles in width at its widest point, and extends from the vicinity of the 30th to near the 35th parallel of latitude. On the line of survey it is one hundred and twenty-five miles in width from the valley of the Pecos to the head of the Colorado, and is destitute of water and of timber. Belts of dark-red sand alternate over its surface, with patches of hard, pebbly ground, upon which is imposed a thin layer of decomposed gypsum. Over the hard surface

the grama-grass is good and abundant, but the belts of sand are overgrown with a coarse bunch-grass about two and a half feet high.

More than one-half of the surface of the plain, along the line of survey, is hard and firm, and furnishes grama-grass in abundance, and the mezquite-root entirely sufficient to supply fuel for all parties crossing it, in whatever numbers. There is no evidence, in natural features, of its existence on approaching from the east or west, and the ascent to its summit and descent from it are so gentle as only to be perceptible to instrumental survey. There are many beds of small lakes and ponds which were dry in the month of March, but which probably contain water during the rainy seasons. There is no living water in its entire extent. It presents remarkable natural advantages of surface for a road, and a supply of water, which can be readily obtained by boring, would adapt it in a high degree to the support of stock.

Although altogether deficient in important agricultural resources, it is nevertheless rich in the immense beds of gypsum which crop out along the Pecos, in bluff banks of selenite fifty feet high, and of a translucency which renders it valuable to the people of New Mexico, who use it for glass. Numerous caves of pure gypsum, of dazzling whiteness within, are found in this entire gypsum formation, which extends over a distance of one hundred and fifty miles along the route, and forms probably the largest gypsum field in the world. As an article of commerce it would occupy an important place in estimating the resources of the country. With facilities for reaching a market it would, in consequence of its immense extent and the remarkable ease of procuring it, be of great value. It gives a bitter taste to the waters of the Pecos and to some tributaries of the Colorado, but not sufficient to make them unpalatable.

Valley of the Pecos.—The valley of the Pecos at the 32d parallel is from two to four miles in width, and is bordered on the east by the "Llano Estacado," and on the west by table-lands, which descend into it by very gentle inclinations. The bottom-lands are level and very fertile, and the river, with a general direction to the southeast, traverses the valley from side to side in thousands of sinuosities.

Its bed has a very great inclination, which for thirty miles at least above the 32d parallel, and fifteen below it, occasions continuous rapids, and in many places falls of two or three feet. The soil of the level bottom-lands, which occupy the bends of the river, is, as will be seen from the tables, of great fertility, and the peculiar character of the stream, and the great inclination of its bed, offer unlimited facilities for irrigating the whole of the arable land of the valley. There is no timber, other than the mezquite and a sparse growth of dwarf cedar; but fuel sufficient for a climate so mild and equable could easily be procured, as is the case along the valley of the Rio Grande, from the under-ground forests of mezquite-root on the table-lands.

About fifteen miles below the 32d parallel the river begins to change its character, passing from its rocky bed and a depth of only two feet over the rapids, to a soft muddy bottom and falling banks, and a depth probably at no place less than four or five feet, and in many places fifteen or twenty feet. Very little rain falls in the valley except during

the months of July and August, and the same system of farming would be necessary as in the valley of the Rio Grande. The expense of irrigation is very much over-estimated by those not conversant with such matters, and as an evidence of this error it is only necessary to say that corn was worth but 60 cents a bushel in the valley of the Rio Grande, above El Paso, during the months of February and March, while in the Indian country, east of the Red river, and in the State of Arkansas, it commanded a price varying from 70 cents to \$1 50. It must be remembered, also, that but an indifferent market for such products is offered in New Mexico, where the stock finds sufficient grazing during the whole year, and where it is entirely unusual to feed corn to animals.

The only sales, or certainly four-fifths of the sales, are made to the government and for military purposes; and it seems reasonable to suppose that a larger demand, by stimulating competition and increasing the crops, would considerably reduce the present prices.

The valley of the Pecos is eminently adapted to this kind of cultivation, and with a demand could supply corn or wheat in almost unlimited abundance. In common with all the low lands in New Mexico, it is wonderfully favorable to the cultivation of the grape, and only needs protection and a market to insure its settlement.

The river, although very tortuous in its course, has always sufficient depth of water for small stern-wheeled steamers from its mouth to a point near the 32d parallel.

Table-lands between the Pecos and the Rio Grande.—Passing from the valley of the Pecos along the northern bank of its tributary, the Delaware creek, we begin to ascend the elevated table-lands, towards the east base of the Guadalupe mountains. The ascent is extremely gentle along the banks of the creek to its head, about thirty miles from the Pecos; but from thence to the summit of the Guadalupe Pass, it is, although uniform, much more rapid. The valley of Delaware creek presents agricultural features altogether similar to those along the Pecos, and can be irrigated with almost equal facility. The creek itself is a succession of small lakes, ten or fifteen feet deep, connected by a swift running stream, and as it is ascended from the mouth the dwarf cedar becomes much more abundant along the ridges. It has its source in a limestone bluff about fifty feet above its valley, and issues from the base of the bluff from seven or eight springs, both pure and mineral. The largest of the pure springs bursts boldly out of the north side of the hill in a stream as large as a barrel, and after a course of probably fifty yards it unites with the small streams from the mineral springs. These springs, the analyses of which will be found in the appendix, contain sulphur in various proportions—in some barely perceptible, while in others it gives out an odor which is sufficiently perceptible at fifty yards. There are six of these sulphur springs. From the south side of the bluff issues a spring strongly impregnated with soda, and all the springs uniting in one of the small lakes or ponds of Delaware creek form a compound detestable both in smell and taste. The animals, to my surprise, greatly preferred this lake to the pure water of the spring.

That the mineral properties of these springs are very valuable and peculiar there can be no question, and the delightful air, and fine, bracing climate of the country, will render them, in the event of the construction of a railroad, a resort altogether preferable for health or pleasure to any now frequented in the United States.

To this point it is proposed to remove the present post of Fort Fillmore, and it is to be doubted if a more attractive spot in all respects can be found west of the Mississippi.

Beyond the immediate valley of Delaware creek the table-lands, which extend uninterruptedly to the valley of the Rio Grande, are, from the absence of rains at convenient intervals, entirely withdrawn from all prospect of cultivation; but overgrown as they are with the grama-grass, abundantly supplied with water, easily accessible, and favored with a climate mild and equable at all seasons of the year, they present advantages for raising and maintaining stock as remarkable as they are limitless.

Sixteen miles from the head of Delaware creek we find the Independence springs, which burst from the surface of the ground in a small valley or depression in the table-lands. They are two in number, and uniting at a short distance below, they flow off to the southeast in a small stream, which, within a few miles, becomes dry. There is a sparse growth of the hackberry and dwarf cedar in the neighborhood. These springs are about five feet in diameter; and although a pole ten feet long was thrust into them, the bottom was not reached. Five miles further to the west we reach the east base of the Guadalupe mountains, at a fine spring of pure water; and four miles further, at the southern base of the high peak, we find another large spring, which runs off to the south through a rocky ravine.

There is abundance of large pine timber in the ravines and gorges along the east face of the mountains, and the ridges to the south are overgrown with the dwarf cedar.

Twenty-three miles to the west, and at the western base of the mountain, we come upon the spring and two small lakes, slightly sulphureous, known as the "Ojo del Cuerbo," or Crow spring. These lakes cover four or five acres of ground, and although shallow, contain abundance of living water. Many wells have been dug in the vicinity, which supply water less impregnated with sulphur than the lakes. Twenty seven miles to the west are the "Cornudas," or Thorne's wells. These are natural tanks of immense size, distributed through a mass of rocks one hundred and fifty feet high, piled upon each other in the most singular and grotesque confusion. The water which falls during the rainy season percolates through the crevices of the rocks, and is received in immense rocky basins and reservoirs, capable of containing many thousands of gallons, and entirely sheltered from the sun. Some of these reservoirs are reached by the beds of streams, which issue from them when the basins overflow; others are in caves, and some far up the sides of the rocks. By a little labor in deepening and increasing the number of these cisterns, water could be accumulated to almost any extent. Eight miles further are the wells of the "Alamos." About five hundred yards from the route, and on the northern face of an isolated hill, there are seven wells of living water,

which, during the seasons of rain, overflow, and are discharged by a small rocky stream along the face of the hill. Twenty-five miles further are the "Waco tanks," in all respects similar to the "Cornudas." Twenty-four miles from thence we reach the Rio Grande at El Paso.

These immense table-lands, covered with the grama-grass—nutritious at all seasons of the year—and thus supplied with water, have been from time immemorial in undisputed possession of the Apaches, who occupy the valleys among the mountains; and notwithstanding constant danger and enormous losses, the Mexicans cannot refrain from pasturing their stock in this region of plenty.

The valleys between the Guadalupe mountains and the Waco and Sacramento range, and between these latter mountains and the Organ range, are occupied along their lowest lines by the Salt lakes, which supply the whole country with that commodity, and which have been the occasion of many bitter controversies.

The evaporation of the water leaves a deposit of pure salt several feet in depth, into which trains of wagons are driven and loaded. It is quite impossible to estimate the extent or value of these dry lakes; but the quantity of salt is so enormous, and so easily obtained, that, with cheap communications with a market, they would supply the United States at a cost far below the present market prices.

The three ranges of the Guadalupe, the Hueco, and Organ mountains, occupy the summits of these table-lands, and are, so far as investigations have extended in constant apprehension of attacks from Indians, prolific of the precious metals. The Sacramento and White mountains (a continuation of the Hueco range) have long been marked in old traditions, and recent statements, as regions rich in gold and silver; but the constant and immediate danger from Indians, who are to the last degree jealous of any encroachments upon their lands, has hitherto prevented any close examination.

On the west side of the Organ mountains, which bound the valley of the Rio Grande, valuable silver and lead mines are found, extending over a continuous distance of twenty-five miles. The want of means to open them, and the ignorance of mining, characteristic of the New Mexican, have altogether prevented any development of their richness, and it has only been within the last eighteen months that anything like a serious commencement has been made.

Mr. Stevenson has opened a mine about fifteen miles from the river, at Doña Ana, and notwithstanding the impossibility of getting an experienced miner, and the crude and imperfect manner of smelting he has been compelled to adopt, the results have been exceedingly profitable. The ore is powdered between two stones, and the smelting is done without one convenience common to the States. The refuse probably contains half as much silver as the original ore; and, notwithstanding this, from a mule-load of three hundred pounds of the ore he gets \$18 of silver.

Many specimens from these mines were brought in, and their analysis will be found in the appendix to this report.

Valley of the Rio Grande.—That portion of the valley of the Rio Grande, of the agricultural resources of which I shall present a brief sketch, is embraced between the southern terminus of the "Jornada

del Muerto" and the town of San Elizario, in Texas. The only cultivated lands within this distance of eighty-five miles are the immediate bottom-lands along the river, which can be conveniently irrigated.

At the northern extremity is the town of Doña Ana, on the river and about seven miles below the Jornada. Extending from this village a distance of fifteen miles along the east or left bank of the river are the towns of Las Cruces and Las Tortugas, and the military post of Fort Fillmore. Opposite we find the valley and town of Mesilla.

The settled portion of the Mesilla valley is about ten miles in length along the river, and from one to three miles in width, to the base of the table-lands. It contains a population of about 3,000, and notwithstanding its equivocal position during the disputed question of boundary, and the constant annoyances and discouragement to the inhabitants in consequence of so precarious a condition, it has thrived wonderfully, and now raises nearly double the amount of products of the valley on the east side of the river. The village of Mesilla contains a population of 2,500, although first settled as late as 1850, and doubtless the settlement of the vexed question of jurisdiction will give a renewed impulse to its progress.

The oldest town in this part of New Mexico is Doña Ana, which, although settled as early as 1842, is nevertheless the least populous and thriving of the villages I have named.

The post of Fort Fillmore has been established opposite the southern extremity of the Mesilla valley, and about fifteen miles below Doña Ana. The next settlements along the river, with the exception of the abandoned ranch of "Frontera," are the town of Molino, at the rapids of the Rio Grande, about fifty-four miles below Doña Ana and two miles above El Paso, and the town of Franklin, two miles below.

Molino has been but recently laid out into lots, but occupying the point at which a railroad must intersect the Rio Grande; and presenting by far the most practicable point for crossing the river within many miles, it bids fair to become a place of much consequence. Franklin, opposite El Paso, is at present occupied by four companies of the 8th infantry, and is almost entirely the property of Mr. James McGoffin, a wealthy and enterprising citizen of El Paso county.

The small villages of Isletta and San Elizario are twelve and twenty-five miles, respectively, below El Paso.

At Frontera, about five miles above El Paso, the Rio Grande commences to make its passage through the chain of mountains which intersect its course, and to a point immediately in the neighborhood of Molino it is bordered closely on both sides by a range of high and rugged mountains. At Frontera, four miles above, the range on the west side subsides into the vast level table-lands, which extend with little interruption many miles to the westward; but on the east side the mountains gradually depart from the river, becoming more rugged and lofty, until they unite on the "Jornada del Muerto" with the continuous ridges of the Rocky mountains. The river cuts through them between Frontera and Molino, by a succession of rapids, and at one place a perpendicular fall of two or three feet, and this passage has,

from the period of its discovery by the Spaniards, been known as El Paso. The Mexican *town* of that name is about two miles below the debouchure of the river from the mountains.

With the exception of the limited strip between Frontera and Molino, the immediate valley of the Rio Grande is from two to five miles in width, and perfectly level, and the river traverses it from side to side in many sinuosities.

These level bottom-lands can be readily irrigated from the river, and possess a soil which, although not deep, and containing rather too large a proportion of sand for the notions of farmers in the United States, is nevertheless extremely fertile, and well adapted to the production of all the cereal grains.

The system of irrigation renews the fertility of the soil by spreading over it every year a fat deposit several inches in thickness, which is brought down in suspension by the river, and to this deposit is undoubtedly due the fact that the Mexicans, for so many successive years, have been able to continue the same crops upon the land. The soil is only about four or five inches deep, and for cultivating it the Mexican implements have been conclusively shown, by experience of several years, to be the best.

The wooden plough which they use barely enters the earth sufficiently to turn up three or four inches in depth, and they thus never pass below the yearly deposits of the river. The iron plough, on the contrary, passes several inches below this, and turns up a soil, more than four-fifths of which is sand, and consequently of little productiveness. As an evidence of the results, it will suffice to say, that of two fields of the same size contiguous to each other and identical in soil, the one cultivated with great care by the government, after the American fashion, the other the property of an old Mexican, who cultivated it himself, without assistance, the products were little or nothing for the first, and a crop averaging from thirty to forty bushels of corn to the acre for the last.

The immediate valley of the river between Doña Ana and Frontera contains about 128,000 acres of arable land; and to form an estimate of its agricultural value, it will be sufficient to exhibit the products of the little strip of cultivated ground in the Mesilla valley for the year 1853. This can scarcely be considered a fair test, as the land was first settled in 1850, and the constant difficulties resulting from its equivocal relations with the two governments, and the impressment of the men into the Mexican army, have seriously interfered with its agricultural productions. There are about 16,000 acres in what is commonly known as the Mesilla valley, of which about 10,000 acres are under this partial cultivation.

The products for the year 1853 were as follows, viz:

Corn, 50,000 bushels, at 70 cents.....	\$35,000
Wheat, 7,000 bushels, at \$1.....	7,000
Beans, 15,000 bushels, at \$2.....	30,000

and melons, fruits, and vegetables, in the most unlimited profusion.

For a population, therefore, of about three thousand, we have pro-

ducts which, with a very indifferent market, and under very unfavorable circumstances, have been worth about \$80,000.

An approximate estimate can be formed from these data of what would be the value of the products of these lands, with proper encouragement of security and good markets.

The most valuable feature, however, of the valley of the Rio Grande, is yet but partially developed; and as it ministers to the luxuries rather than to the necessities of life, it cannot, in the absence of demand for such things, occupy a very important place in the present wealth of New Mexico. I refer to the peculiar adaptation of the valley to the culture of the grape. The east side of the Rio Grande is faced by chains of lofty mountains, at an average distance from the river of fifteen miles, which, at San Felipe at the north and El Paso at the south, impinge directly upon the banks. A semi-circular sweep of country is thus inclosed from the northern and eastern winds, and in consequence we find within it a very mild and equable climate, little subjected to the changes of the seasons. The river having a general course to the southeast, and the ranges of mountains on the east side being nearly parallel to it, the whole of this area has a southern and western exposure, and with a soil sufficiently fertile, and of great warmth, it is most wondrously adapted to the culture of the grape. It attains here a flavor and richness unknown to any grape I have ever seen in the United States, and is produced, where cultivated, in the most profuse abundance.

An examination of the character and climate of this region exhibits a striking resemblance to those of the south side of Madeira, and it is much to be doubted whether this portion of New Mexico and Texas is at all surpassed in the quality of its grapes, even by that favored island.

As I said before, grapes and wine being articles of luxury rather than of necessity, the people of New Mexico are little able to develop this rich agricultural feature of their country; and without facilities for reaching a market, this source of wealth is completely useless.

There are comparatively few vineyards in the country, but they produce most abundantly a delicious grape, and the wine, although very rudely and imperfectly manufactured, and drunk in the same year, and probably within a few months after fermentation, is of very fine flavor, and of several varieties. It is a matter of regret that no specimens of the wines were brought in for examination.

I am convinced that one of the most important elements of the future wealth of New Mexico is to be found in its peculiar adaptedness to the manufacture of wine, and it needs but opportunity and encouragement to confirm the truth of this opinion.

The excellent pastoral character of the table-lands, which have been before referred to, has made New Mexico, for the present, peculiarly a stock country; and the expense of maintaining all kinds of stock is so little, that the people are able to drive immense herds annually to California, and sell them at a very large profit. These expeditions are attended with great difficulty and some danger, and it is with much reluctance that the New Mexican overcomes his two besetting evils, timidity and indolence, sufficiently to induce him, even with the prospect of the largest gains, to undertake the journey to California.

Sheep and mules, because more easily taken care of, are probably the most numerous of their possessions of this kind; but the country is remarkably favorable to any kind of stock, both in climate and pasturage.

A brief review of this subject exhibits the three great natural divisions of the country along the route, to which I referred in the beginning of this report, and a detailed examination of them has shown but one strip of country which is not rich in wealth, either agricultural or mineral.

It would certainly be difficult to find, over a district of such immense extent, less desert country.

CHAPTER VI.

Of boring or digging for water on the " Llano Estacado."

The only natural obstacle presented by this route is the absence of water on the " Staked Plain," and to obviate this difficulty two methods can be proposed, and they will be considered separately.

The first is by digging wells, or constructing artificial tanks, and the second by boring artesian wells.

To justify the opinions I shall express as to the practicability and relative advantages of either process, a brief sketch of the conditions necessary to success in each case would seem to be necessary.

There are two classes of springs from which the two descriptions of wells above mentioned are supplied—first, the shallow, and second, the deep-seated springs.

The first of these is dependent for its supply of water upon the rains which fall upon the surface of the limited district of country in which these springs are found.

The water falling upon the surface of the ground percolates through the soil until it encounters a stratum of rock or clay, impervious to water, and follows the lowest lines of this stratum until it appears at the surface. It follows from these conditions that shallow springs are directly affected by the quantity of water which falls in the immediate neighborhood, and in consequence, during seasons of drought, they frequently become dry.

There are, of course, basins or circumscribed tracts of land, in which the immediate surface of the ground is impervious to water, and in such districts we find lakes, ponds, or swamps.

Deep-seated springs, on the contrary, are found beneath the impermeable stratum, which is the base of the shallow springs, and are only affected by the rain-fall remote from the points at which the springs burst out. The strata of the earth, originally deposited in a horizontal position, have been upheaved by natural causes along the lines of the mountain ranges, and the strata thus dislocated present over many miles of country, and most generally in the vicinity of the mountains, their edges exposed upon the surface.

Where the strata are composed of alternate beds of permeable and impermeable character, the rain which falls upon the edges exposed by dislocations, and the descent of the water occasioned by the melting of the snows on the mountains, would completely saturate the permeable stratum, and the water would continue to follow its line of greatest descent.

If we suppose a permeable stratum of this character to be interposed between two impermeable strata, the water must continue between them, until the stratum containing it is exposed at the surface at a lower level.

By boring, therefore, at any point of the surface of the upper stratum, water would be procured as soon as the water-bearing stratum was reached, which would rise in the shaft to the height of the point of exposure of the stratum at the upper surface, less friction and loss of water through fissures.

There are many circumstances to qualify this state of things, such as "faults," (or interruption of the continuity of the strata by breaks,) the giving out, as is sometimes the case, of the water-bearing stratum, &c. &c.; but most generally there is no great difficulty in ascertaining with some considerable certainty the prospects of success in these borings, before commencing the work.

These deep-seated springs are not nearly so much affected by the rain-fall as the land springs, since they not only receive their supply of water at remote points from this source, and from the melting of the mountain-snows, but they are sheltered from the air and sun, and protected from the consequent evaporation.

When the strata fulfilling these conditions, and out-cropping at high altitudes, can be traced continuously without interruption, the boring of artesian wells will always be successful.

I will therefore, with this brief sketch, proceed to examine the Staked Plain, with a view to the supply of water which can be procured from the two classes of springs above referred to.

Geological structure of the "Llano Estacado."—The upper geological formations of this plain are, first, the Jurassic, 700 feet thick; and second, the Trias, 3,000 feet thick.

Beginning at the upper surface of the plain, the Jurassic consists of super-soil, white limestone with fossils, yellow sandstone, blue clay, compact white limestone, oolitic, white sandstone, and red and variegated soft sandstones: the Trias, of red friable sandstones, with red and gray clay—in a word, variegated with interpositions of beds of sandstone and dolomite, or magnesian limestone.

The strata of the Jurassic and Trias outcrop at the eastern base of the Guadalupe mountains, and at an altitude of 800 feet above the highest line of the Llano Estacado. From their line of dislocation they have a very gradual dip to the east-southeast, and are uninterrupted as far, at least, as the headwaters of the Colorado of Texas, at which point the white oolitic limestone of the Jurassic outcrops, and from beneath it issue the springs forming the sources of the Colorado.

These strata, alternately permeable and impermeable to water, fulfil all the conditions necessary for the success of artesian wells. They are cut through by the Pecos, which interposes between the "Llano"

and the Guadalupe mountains, down to the white oolitic limestone of the Jurassic, which forms the bed of that river. In boring, therefore, upon the "Staked Plain," it would be necessary to pass entirely through the whole of the Jurassic above this limestone, or a distance of from four to seven hundred feet.

In confirmation of the belief that boring would be thus successful, I quote from the report of the geologist: "These rocks of the Llano Estacado, (the Jurassic and Trias,) dip gently to the east-southeast, and as the heads of the strata outcrop at the foot of the Rocky mountains, called here Sierra Guadalupe, Sierra Sacramento, &c., in boring artesian wells on any point of the Llano, abundant columns of water would be found to gush out over this immense plain; so that the want of water is not an objection to the establishment of a railroad on the Llano Estacado, for it may be obtained anywhere."

The upper surface of the Llano is very gently undulating, and contains many shallow basins, which fill with water during the rainy season—the months of August and September. The basins are so shallow, and so large a surface of water is exposed to evaporation, that these ponds are dry during a great portion of the year.

It would be easy to dig wells or tanks in the beds of the lakes, and by conducting into them by ditches and drains all the water which falls upon the surface, a very large supply could be accumulated. It is impossible to say how much, but certainly sufficient to supply all travelling purposes for the whole year. This process would be somewhat cheaper than that of boring, but the supply of water would be less certain and much less abundant.

Wells, also, dug at any point of the plain would supply water which has percolated through the loose permeable soil, and which is retained by the impermeable stratum of limestone below. The average depth of such wells would probably not exceed sixty feet, although at some points it might reach one hundred and fifty.

In all respects the artesian wells would be preferable. The water would, from what I have stated, be delivered at the surface, and would probably rise far above it; and instead of arrangements for drawing it up—which would require too much time and labor when large numbers of animals were to be supplied—the artesian wells would be the sources of running streams.

The tanks would also require to be protected from animals, and the "Llano Estacado" could only be occupied by the few domestic animals which could be watered by hand.

The process of boring artesian wells is well understood in this country; and by such means large districts of country have been redeemed from unproductiveness. The success of such wells upon the "Llano Estacado" would not only be of incalculable value to the travelling community, and in the construction of a railroad or wagon-road, but would open to occupation an extensive grazing region which is now doomed to solitude.

In the outfit of a party sent for the purpose of boring or digging, the expenses would be identical up to a certain point, and the number of persons required for each process about the same. It would be both economy and expediency for the government to conduct the work

through its own officers, in preference to making contracts for that purpose; and with this view it would be well to purchase boring instruments, provisions, and transportation.

One set of boring tools would be sufficient for many such wells, unless under extraordinary difficulties of ground, which are scarcely to be anticipated on the Llano Estacado.

The wagons would be necessary to haul water to the working-parties; and, at the conclusion of the work, both mules and wagons would command a price equal at least to two-thirds of their original cost.

In boring upon the Llano Estacado it would be preferable, if only one experiment is to be made, to establish the depot camp on the Pecos, for the reason that the comparative proximity of New Mexico would be an object in facilitating the supply of the party with materials and provisions. Should an appropriation sufficiently large, however, be devoted to this object, it would seem to me in all respects advisable to commence the work at both sides at the same time.

For entire convenience four wells, at intervals of twenty-five miles, would be necessary between the head of the Colorado and the Pecos, and the whole number could be bored at the same expense and in half the time as by commencing at one side only.

Allowing two months from the time of leaving the settlements to the commencement of the work, which I would consider sufficient, and an average depth of boring of six hundred feet, the time necessary for the completion of each well would be about six months. This time is arrived at by allowing an average depth of three feet for each day's boring. Through hard rock about eighteen inches a day can be made, and through sandstone and soft limestone about six feet. From what I have stated concerning the Staked Plain, a great proportion of the boring would be through soft sandstones and limestones. Some harder beds would be encountered, but of extent comparatively limited.

It would seem to me in all respects advisable to appropriate for the boring of all the wells required at once, since eight-tenths of the expense would be in the purchase of tools and transportation, and the cost of each additional well would only amount to the cost of provisions and the wages of the party.

I append below estimates for each process.

ESTIMATE FOR ARTESIAN WELLS.

Tools, rods, augers, chisels, derrick-irons, &c., &c., for boring 700 feet	\$1,250 00
Travelling forge and equipments	500 00
Wooden tubes for 700 feet	250 00
Pay and subsistence of men for eight months	8,016 00
Cost of wagons and mules for transporting provisions and tools	9,500 00
	<hr/>
	19,516 00
	<hr/> <hr/>

For each additional well.....	\$5,472 00
Total cost of four wells.....	35,932 00
From which deduct sale of mules, wagons, and boring instruments.....	7,400 00
Final cost.....	<u>28,532 00</u>

The estimates for tanks, or shallow wells, would approach nearly to the same sum. The cost of tools would be less, and the time would be somewhat shorter, but there would be no important difference in the estimates.

The estimated cost of artesian wells upon the Llano Estacado is very large, and has been made with a view to every possible contingency which may arise. I consider it in all respects sufficient, and with such an amount I would feel certain of success.

The construction of these wells on the Staked Plain is alone necessary for the establishment of a route of travel across the plains in all respects favorable, and one which, with great advantage to our Indian relations, can be occupied by a chain of military posts, which, in their locations, will fulfil every condition necessary or desirable in selecting sites for military posts in the Indian country. The establishment of such a route, and one thus protected, will open to settlement and cultivation an immense region of fertile country which is now alone occupied by bands of wild Indians. It seems but proper, therefore, that I should invite the attention of the department to the great importance of considering favorably the estimates which I have presented; and I do so with the full conviction that the sum asked for will insure complete success.

CHAPTER VII.

Construction of a railroad along the route, and its estimated cost.

The construction of a railroad across the plains necessarily presumes the establishment of a wagon road along the route, and of a chain of military posts for its protection.

For the first, certain facilities of ground, and the supply of wood, water, and grass, are absolutely requisite.

In the establishment of military posts, the agricultural capacities of the country, and the effects of the posts upon Indian relations, are matters to be carefully examined.

Before approaching the question of the railroad, therefore, it has seemed to me desirable to enter fully into the examination of these subjects, and I have exhibited in the previous chapters a few of the most important advantages presented by the route near the 32d parallel, and have explained as clearly as possible the means for obviating certain

natural obstacles which interpose to modify them. A determination of the bare question of practicable grades is by no means sufficient, since easy grades may be obtained over immense districts of barren country, unfit for human habitation, and in which it would be next to impossible to keep up the military stations which, for all time, would be necessary for the security of the road. There are a few important requisites absolutely indispensable, and I have thought it proper to give in detail the capacity of the route I have examined for supplying them.

It appears from the preceding part of this report that a large proportion of the facilities which may be considered as desirable are found along the route near the 32d parallel, and that the few natural obstacles which present themselves are obviated with little labor and expense.

Three of the most important elements which enter into the construction of a railroad are—

1. The possibility of obtaining practicable grades.
2. The capacity of the country to supply material for construction and for daily use.
3. The facilities for delivering the iron for the road, and supplies for the working parties at points along the line.

In considering these questions, the same natural divisions of the country, to which I have already referred, may be properly used, and will be examined in detail.

FIRST SECTION, 352 MILES—*From Red river to eastern base of Llano Estacado.*—It is to be borne in mind that the ascents and descents referred to in this chapter are along surface lines, and are in every case steeper than it would be either necessary or desirable to establish the grades. For convenient reference, I have appended to this chapter a table exhibiting more in detail the ascents and descents for each section, and the distances between the stations.

The eastern terminus of the line surveyed was at Preston, on the south side of Red river, and in latitude about $33^{\circ} 45'$. As I do not consider this point well-selected, either for passing the river or in view of a continuation of the railroad eastward, I shall omit any reference to the cost or plan of a bridge to cross Red river.

In ascending from the immediate banks of the river to the "Divide" between its waters and those of the Trinity, the route for the first six miles pursues, through heavy timber, a gentle ridge, dividing the waters of two small streams which flow into Red river above and below Preston. The surface line of ascent in this distance is quite regular, and amounts to 66.3 feet to the mile, which could be reduced, by gaining more distance, to almost any desired grade.

From this point to the eastern edge of the Upper Cross Timbers, the ascent is 676 feet in a distance of 59.6 miles, or 9.8 feet to the mile. The country, about equally divided between prairie and timber, is gently undulating in surface, and no abrupt ascents or descents occur. A grade of fifteen feet to the mile could be readily maintained over the entire distance. There are three streams to cross, each of which is about twenty yards in width, and approachable nearly on a level. All the materials for constructing the wooden bridges required are at hand at each point. These streams are, first, Big Mineral, tributary to Red river, and the Clear and Elm forks of the Trinity.

The Upper Cross Timbers—65.5 miles west of Preston—are about ten miles through from east to west, and are bounded on the east by a bluff or table-land 256.5 feet above their lowest line. The country is rough and broken in the timbers, and the embankments and excavations would be comparatively heavy.

Descending from their eastern edge, we pass for the first five miles through a descent of 256.5 feet, or a surface line of fifty-two feet to the mile.

From the lowest line of these Cross Timbers to the bluff banks of the Brazos, a distance of 85.2 miles, we ascend 304.9 feet, or an average ascent of 2.7 feet to the mile. The country continues gently undulating along the line of survey, and contains a rather larger proportion of timber. There are many small streams, or rather threads of water, which descend each way into the Trinity and Brazos on the south, and the Red river on the north. The excavations and embankments would be very slight. The only stream to be crossed is the west fork of the Trinity, about twenty yards in width, and with gentle approaches.

The Brazos is bordered on both sides by bluff banks of the same general level of the country, and from which it would not be necessary to descend in order to pass the river. At the point of crossing, the banks approach to within 1,600 feet of each other, and leave a waterway of 738 feet, occupied by the immediate bed of the river. All the materials for constructing a bridge, both wood and stone, are found upon the spot. Along these bluff banks large coal-fields crop out, and from them bituminous coal of good quality can be readily procured.

From the Brazos to the crossing of Clear fork the country is more undulating, and in this distance of 32.4 miles we ascend 402.1 feet at the rate of 12.6 feet to the mile. The Clear fork is about forty feet wide, and presents no obstacles to approach. Timber of large size is found on its banks.

In passing from the Clear fork to the Double Mountain fork of the Brazos, an ascent is made of 1,755.8 feet in a distance of ninety miles, or at the rate of 19.5 feet to the mile. It would be difficult to reduce this grade much, as the whole surface of the country is so uniform that the ascent is barely perceptible at any point. From thence to the "Divide" of the waters of the Brazos and Colorado, an ascent is made over a distance of eight miles at the rate of forty-five feet to the mile. This rate could be reduced as much as would be considered advantageous.

At the crossing of the Clear fork of the Brazos the oak timber disappears, and is replaced by extensive forests of mezquite. This timber is hard and durable, and covers at least one-half of the country between the Brazos and the dividing ridge between its waters and those of the Colorado.

There are no streams of importance to cross, although many small tributaries of the Clear fork and Double Mountain fork of the Brazos intersect the route at short intervals.

From this divide we descend to the Colorado 308.1 feet, in a distance of 22.8 miles; an average descent along the surface of 12.1 feet to the mile. The timber (mezquite) is not so plenty west of this divide as east of it; but abundance is found for construction and use.

The Colorado is about forty feet wide, and can be readily approached; its banks being but little below the general level of the country.

Water is abundant, although the water of the river itself is slightly brackish. From the Colorado to the Sulphur springs, at the east base of the Llano Estacado, the ascent is 319 feet in a distance of 44 miles, or 6.3 feet to the mile. The mezquite becomes much scarcer until, about 10 miles east of the springs, it disappears. Water is abundant in the small streams tributary to the Colorado.

Timber for building.—From the Red river to the Clear fork of the Brazos, 187.5 miles, the timber is very abundant and of the same character as that found along the streams and ridges of Arkansas and Missouri—oak, elm, ash, pecan, &c. The most valuable for use in construction is the post-oak, which is entirely convenient at all points between the Brazos and Red rivers. This oak is from eight to fourteen inches in diameter, and about thirty feet in the clear or from the ground to the first branches. It is perfectly straight and without knots, and each tree would furnish at least three ties.

The mezquite, which replaces the oak west of the Clear fork, although more durable, is not so well adapted for ties. It is about thirty feet high, but more crooked and much more interrupted by branches, which grow out nearly horizontally. It is from eight to twelve inches in diameter, and, although not so well adapted for ties as the oak would, nevertheless, furnish them immediately on the line at any point.

Of the stone.—For the facilities in this respect, I quote from the report of the geologist: "From the Red river to the Elm fork of Trinity, 57 miles, the route is upon the cretaceous rocks, which are very useful in the construction of a railroad; lying in horizontal strata, they form excellent embankments, contain numerous springs of water, and the limestone especially furnishes excellent lime for building.

"From the Elm fork of the Trinity to the Clear fork of the Brazos, 131 miles, the route lies upon the lower carboniferous strata. The carboniferous rocks present excellent sandstone for the construction of bridges and embankments; iron in abundance and black slate.

"The route from Clear fork of the Brazos to the eastern base of the Llano Estacado, 165 miles, was upon the rocks of the Trias.

"The Trias is composed of red friable sandstone, with red and gray clay: in a word, it is variegated with interposition of beds of gray sandstone, of dolomite or magnesian limestone; and, finally, it contains an immense mass of white gypsum, amorphous or crystallized. Salt springs and saline efflorescences are found in this formation. For the construction of a railroad the rocks of the Trias present great facilities. They furnish sandstone, plaster or gypsum, and lime from the magnesian limestone; and, finally, they are very easy to work, and, at the same time, firm enough to form excavations and embankments. Numerous springs issue from the beds of red clay, and give water in abundance."

It seems, therefore, that this section abounds in every desirable material for construction and use of the railroad, and that grades are readily attainable which are in all respects favorable.

The head of navigation of the Red river is far to the north of the eastern terminus. At fifty miles west, the head of steamboat navigation of the Trinity approaches to within 40 miles; at 170 miles west, the head of navigation of the Brazos approaches to within 85 miles; and at the eastern base of the Llano Estacado, 354 miles, the head of navigation of the Colorado is within 175 miles.

For this section, therefore, we find every combination of advantages which exist along any railroad route in the United States; and in estimating the cost of the road, it should not be found to differ much from the most favored locations of railroads within the old States.

Estimated cost of first section.—The survey of this route was not, of course, sufficiently in detail to enable any accurate computation for excavations and embankments, or plans or estimates for bridges to be made; and therefore, in estimating the cost, a comparison must be made with roads in the United States which have been constructed in a region nearly similar to that in question.

It would be next to impossible to find a railroad in the United States, without going to the prairies of northern Illinois, which can compare in facility of ground or other advantages with this section of the route, near the 32d parallel; but it will answer the present purpose to make the comparison with the New York and Erie railroad.

The total cost of this road per mile was \$45,652. Assuming this amount, therefore, as a basis, and adding ten per cent. for contingencies, we have \$50,000 per mile, (nearly,) and for the whole distance of 352 miles, \$17,600,000.

This estimate I regard as very large, and one which will fully cover every possible contingency.

SECOND SECTION, 125 MILES—Llano Estacado.—From the Sulphur springs of the Colorado the ascent to the Staked Plain is so gentle and uniform as to be barely perceptible, and no bluff nor unusual swell of ground marks its existence.

To the summit-level of the plain the ascent is 423.6 feet in a distance of 89.1 miles, or an average ascent to the mile of 4.8 feet. Neither excavation nor embankment would be required in this whole distance, as the ascent is both gradual and uniform, and uninterrupted by hill or ravine.

The descent to the Pecos, although more rapid, is in all respects similar; and so well adapted is this section to the construction of a railroad, that, with the exception of transporting the ties, no work is required. The surface line from the summit-level to the Pecos descends at the rate of 18.3 feet to the mile, over a distance of 35 miles.

There is neither timber nor water upon this section, and for the supply of the latter requisite boring would be necessary. As I have explained, in a previous chapter, the process and cost of the boring required, it is unnecessary to refer to it in this place.

Timber for ties and for fuel is found very near the east side of this section, and within fifty miles of its western limit. It would therefore be requisite to transport the ties over an extreme distance of eighty-seven miles, to the summit of the plain.

Rocks.—Building-material of limestone and sandstone is very abundant, and can be procured at any point. The Pecos river, at its in-

tersection with the 32d parallel, is about forty yards in width, and descends through many rapids over a bed of compact silicious limestone. A stone bridge could be constructed at little cost from material found on the spot.

Cost of construction—In estimating the cost of a railroad over this section, it would be necessary to reduce very much the estimate which has been made for the section east of it, in consequence of the very great and very unusual facilities of ground. Instead, therefore, of adding to, it will be in all respects advisable to reduce, the assumed basis.

Assuming, therefore, the cost of the road used in estimating for the first section, and reducing it by ten per cent., we have for the cost per mile of the road over this section, \$40,000, (about,) and for the total cost, \$5,000,000.

Although the additional expense of boring for water and transporting the ties will be necessary on this section, yet the work for grading is in all respects so much lighter as to compensate certainly for double the expense required for these purposes.

THIRD SECTION, 169 MILES—*From the Pecos to the Rio Grande, at El Paso.*—This section is in all respects different in natural features from those which precede. It consists of elevated table-lands, whose highest lines are occupied by three ranges of lofty mountains—the Guadalupe, the Waco, and the Organ ranges. The latter is completely turned by the line at its southern extremity, and need not, therefore, enter into the consideration. The controlling points of this section are the Guadalupe Pass and the pass through the Waco mountains.

In approaching the Guadalupe Pass from the Pecos, the line is nearly straight, and to the head of Delaware creek ascends 102.6 feet in a distance of thirty miles, or 3.5 feet to the mile.

The country along Delaware creek is uniform, and the ascent is not abrupt at any point. Water in abundance is found along the creek, which is a constantly running stream.

From the head of Delaware creek to the summit of the Guadalupe Pass the ascent, though rapid, is quite uniform, and the line straight. It might probably be considered advisable to reduce the grade on this part of the line; but as it could easily be overcome on the direct line, it would be questionable whether any change would be advantageous. The pass is elevated 1,545 feet above the head of the Delaware creek, which gives, for a distance of 24.4 miles, an average ascent of 61.8 feet to the mile. The eastern side of the mountains immediately contiguous to the line is faced with pine timber of large size, and abundant springs of water break out at several points. All the rocks of the "Trias," before referred to, are found along the line from the Pecos to the mountains, and furnish abundantly the building-material described for the first section.

In descending from the Guadalupe Pass to the table-lands west of this range, the first serious difficulty in the construction of a railroad was presented.

The summit of the pass is at the east base of the mountains, and from thence to the Ojo del Cuerdo a descent of 1,824.8 feet is made in a distance of seventeen miles. The present wagon-road descends ab-

ruptly from the summit of the pass to the bed of a rocky ravine, and at a distance of 3.8 miles is 1,227.8 feet below it. The road then turns abruptly to the northwest, and, crossing several spurs which project in a southerly direction from the high peak, descends to the plain.

I at first thought it might be possible to descend more gradually into this dry bed, and to pursue it to the plains on the west side of the mountains, but I found the bed of the stream so much inclined as to make the grades impracticable. This ravine leads from the south point of the mountain in a southerly direction, and reaches the plain at a distance of eight miles—having accomplished a descent of 1,800 feet in that distance. Its eastern side is an abrupt rocky precipice 1,000 feet above its bed, and on the west it is bounded by a narrow spur of the mountains, which descends to the plain with a slope even greater than that of the ravine. The west face of the mountains is perfectly uniform, and interrupted neither by spur nor ravine, and has a gentle slope to the plain of the salt lakes, along which, descending diagonally, any grade could be obtained. It became very important, therefore, to find some method of passing, with practical grades, from the east to the west face of the mountains. This, after some examination, was accomplished, by passing round the south point of the range, and close under the high peak. This, however, would require some heavy work, principally the filling up or bridging over of two narrow and deep rocky ravines, which penetrate to the very face of the precipice which terminates, at the south, the high summits of the Guadalupe mountains. Two short curves and a deep cut at the point of entrance to the pass from the east would also be required.

By these means we reach the western face of the mountains at a distance of three miles from the summit of the pass, and with a grade of 108 feet to the mile. From thence, descending diagonally along the face of the mountains, the plain of the Salt Lake is reached by any grade which may be considered advantageous. The work over the short distance of three miles along the south face of the mountain would be heavy, but all materials for embankments or bridges are at hand.

A map and profile, on a large scale, exhibit the position of the line and of the wagon road, with the descents along each.

It is proper to remark that the line of survey was not carried over this immediate line further than the determination of the relative heights of the points on the east and west faces of the mountains, and the distance between them was computed. A reconnaissance was made, however, sufficiently close to be convincing of its practicability.

From the Ojo del Cuerbo, along the table-lands, we reach the "Cornudas," at a distance of twenty-four miles, and with a gradual and uniform ascent to the mile of 23.8 feet. At the Cornudas are the immense natural tanks which I have already described, and which by enlargement would supply abundance of water.

From the Cornudas to the "Alamos," near the springs, the line still continues along the table-lands, and over a distance of 8.2 miles ascends at the rate of 26 feet to the mile. The springs of the Alamos supply water in abundance. From thence to the east base of the Waco mountains, a distance of 20.4 miles, the ascent is 0.9 foot to

the mile. The ascent is quite uniform, and no grading would be required.

From the east base of the Waco mountains an ascent of 227.1 feet, over a distance of 1.7 mile along the wagon road, is presented, to the summit of the pass. No difficulty, however, in obtaining any desirable grade occurs at this point. The faces of the hills are very uniform, and descend gently to the plain, and are approachable from the east at any point. I have therefore increased the length of ascent to 3.7 miles, which gives a grade of 57 feet to the mile. From the summit of the pass the wagon road descends rapidly into the dry bed of a ravine, which conducts to the table-land west of the mountains, at a distance of 3.8 miles, and through a descent of 219.3 feet to the mile. The hills, however, which border the ravine on each side, descend into it gently and with a slope quite uniform, and the line passes diagonally along their face, with a grade of 79.8 feet to the mile, and a gain of seven miles of distance. The descent to the plain is made at a point four miles north of the low, isolated range of hills in which are found the Waco Tanks. Water and building-material of stone are readily obtained. The cuttings along the face of the hill present little difficulty, and no lateral ravines interrupt the uniformity of the slopes.

From the point at which the descent to the plain is made, the line is straight to the highest line of the table-land near El Paso, passing close along the north face of the isolated hills which contain the Waco Tanks. An ascent is made of 56.5 feet over a distance of 27 miles, or 2.1 feet to the mile. The distance between the Waco and the Organ ranges is twenty miles, and along the east face of the latter an abundance of large pine timber is found. From the summit of the table-land the line descends along the plateau to the Rio Grande, at Molino, passing close under the south base of the Organ mountains. No descent is made to the bottom-lands of the river; as at Molino, the elevated table-lands extend down to the very banks. The descent from the summit of the Mesa to Molino is 161 feet in a distance of three miles, or a descent of 53.7 feet to the mile. At this point the Rio Grande is closely bordered on both sides by table-lands, and descends over rapids for the space of half a mile. The bed and banks of the river are rocky, and there is no doubt but that this place presents greater facilities for bridging than any point to the north within 300 miles.

The table-lands appear to extend uninterruptedly to the west, but my instructions did not authorize any examination west of the river. Major Emory, the present boundary commissioner, is of opinion that it would be impossible, from difficulties of ground, to connect this point immediately with the table-lands, which extend as far to the west as the Rio Mimbres, and that it will be better to continue the line up the immediate valley of the river, to a point three miles above; and there cross. In either case the best and only easily practicable approach to the river is made at the town of Molino. By this means the whole range of the Organ mountains is avoided, and the profile which accompanies the map will exhibit the impracticability of reaching Dona Ana, with allowable grades, through this range.

Timber.—Timber is found in this section on the east side of the Gua-

dalupe mountains, upon the immediate line of the road, and along the east face of the Organ mountains, about thirty miles north of it.

The valley of the river Sacramento, which is at an average distance of thirty miles north of the line, between the Guadalupe and the Waco and Sacramento mountains, is said to contain fine timber of almost every description, but my orders did not justify me in attempting the examination of it.

Stone.—Building-material of this kind is very abundant along the line throughout this section, and for its character I again quote from the report of the geologist: "In descending the west side of the Sierra Guadalupe, and traversing the Waco and Organ mountains, which intervene before reaching El Paso, the carboniferous rocks are found strongly upheaved and in contact with the eruptive rocks, which are granite, red sienite, black sienite with the hornblende, trap forming a part of the Organ mountains, and finally white horizontal sandstone, extending into the valleys between the sierras. As regards the construction of a railroad, the rocks between the Guadalupe mountains and El Paso are very favorable.

"There are sandstone, limestone, and granite; and it is probable that in choosing the points, artesian wells could be bored with success."

Cost.—In estimating the probable cost of this section, it will be necessary to compare the country with a region as nearly similar in character as possible, through which railroads have been built.

The route of the Baltimore and Ohio road seems best to fulfil this condition, and it is therefore adopted for the comparison.

It is to be remarked, however, that although the country along both routes is mountainous in some places, yet the mountains are quite distinct in their topographical features, and the intervening valleys are wholly different.

The Alleghany mountains, through which the Baltimore and Ohio road has been constructed, are approached over a very rough country, and numerous lofty spurs of the mountains project far into the uneven valleys along which the road has been located. These spurs prevent the location of the road along the faces of the mountains, and must be cut through or turned. In either case the work is heavy, and the route very much lengthened. The mountains of New Mexico, on the contrary, rise abruptly from a table-land comparatively level, and have few spurs projecting from their faces. In the case of the Guadalupe and Waco Passes there are absolutely none. The descent along the lower faces of the mountains is very gradual and very uniform, and conducts to table-lands nearly level, which separate the ranges of mountains. Any heavy work in grading is therefore confined to the short lines through the passes. When practicable passes through these mountains can be found, they present facilities for constructing a railroad altogether superior to those attainable in the mountains east of the Mississippi.

The cost of the Baltimore and Ohio road was \$56,000 to the mile, (about.) Assuming this as a basis, and adding ten per cent. for transportation of material for building, and we have for the cost of the road through this section \$61,600 per mile, and a total cost of \$10,400,000 (nearly.)

Labor can be procured on this section much cheaper than it can in any part of the United States, the wages in New Mexico for common laborers being very much below the charges in this country.

RECAPITULATION.

For the First Section.—1st. An air-line; 2d. All requisites for construction; 3d. A maximum grade of 66.2 feet for six miles; 4th. An average grade of 20 feet to the mile for the remainder.

For the Second Section.—1st. An air-line; 2d. Maximum grade of 18 feet to the mile; 3d. The whole line perfectly uniform; 4th. No wood nor water.

For the Third Section.—1st. A maximum grade of 108 feet to the mile for three miles; 2d. A grade of 79 feet (about) for 32 miles; 3d. An average grade of 20 feet for the remainder; 4th. Water sufficient, and timber not remote from the line.

Cost.

Section.	Length in miles.	Cost to the mile.	Total cost.
First.....	352	\$50,000	\$17,600,000
Second.....	125	40,000	5,000,000
Third.....	169	61,600	10,400,000
Total cost.....			33,000,000
To which add cost of line along Red river to Fulton (making total distance from Fulton 779 miles).....			7,000,000
Total cost.....			\$40,000,000

I have preferred, in making these estimates of the probable cost of the road, to err on the side of excess rather than deficiency, and I am fully satisfied that the estimated amount will entirely cover every possible contingency which may arise under proper management.

The question of the time necessary for the construction of a railroad over this route is surrounded with so many uncertainties, and embarrassed with so many considerations which it was impossible to estimate, that it cannot be expected that I can give even an approximation to the probable period required for the completion of the road.

It will suffice to say that the work can be prosecuted during the whole year, as the seasons are not severe enough to offer any impediment.

I cannot properly dismiss this portion of my report without inviting the attention of the department to two points, which seem to me of much consequence.

I would suggest, in the first place, an early examination of two additional lines from the Pecos, at the 32d parallel, to the Rio Grande, at

El Paso. One route diverges to the north, and passing the Guadalupe mountains by the valley of the Sacramento, about thirty miles north of the 32d parallel, unites with the line already surveyed in the vicinity of the Cornudas. It is altogether probable that easier grades could be obtained through the Guadalupe mountains, and the road, although lengthened at least forty miles, would for a portion of the distance traverse the timbered valley of the Sacramento river.

The other line is much more advantageous. It diverges to the south, and turning the Guadalupe and Waco mountains at their southern extremities, conducts to the Rio Grande, at Molino.

I was informed at El Paso that a route had been hastily examined by intelligent persons in this direction, and that it was more practicable than the present travelled road. The only difficulty that was encountered was the want of water, but it is altogether probable that it could be found by careful examination of the country. This proposed line would probably be shorter than the one surveyed; and if the ranges of the Guadalupe and Waco mountains can be avoided, the route would unquestionably be in all respects more favorable.

These routes I consider it of consequence to explore, and I respectfully invite the attention of the department to the propriety of doing so as early as possible in the spring.

It is also, as it seems to me, desirable to make a reconnaissance of the route from the crossing of the Brazos in a direct line to the Red river in the vicinity of Fulton. There are many reasons for this change from the route already surveyed, among which may be stated that the heavy work in the Upper Cross Timbers would probably be avoided, and that a more practicable crossing of Red river could be found.

With a view to the continuation of the line to the eastward, the survey of this route would be in all respects advantageous.

The country in the direct line from Preston to the Mississippi is very much broken, and very rough through the range of the Ozark mountains, which would be completely turned at the south by the route to Fulton. At this place, also, many lines of railroad, from different points on the Mississippi, are rapidly concentrating, and would perfect the connexion with the eastward without the heavy work and enormous expense of continuing in a direct line the route already surveyed.

It would probably be only necessary to make a rapid reconnaissance of this line for the purpose of fixing the positions and determining the character of the crossing places of the Trinity and its tributaries. It is well known that the country would offer no serious obstacle to the construction of a railroad.

To the tables which accompany this chapter I refer for a condensed statement in detail of the ascents and descents to the mile along this route. These are in all cases steeper than it would be either necessary or advisable to establish grades of the railroad. The routes suggested for examination are marked on the map with a dotted blue line.

Table of ascents and descents to the mile from Red river to the Rio Grande.

From Preston, on Red river—	Distance from point to point.	Total distance from Red river.	Ascent, in feet.	Descent, in feet.	Rate of ascent or descent to the mile along the surface line, in feet.
To Mrs. Steel's.....	5.7	.....	398.2	.....	66.2
Big Mineral.....	9.2	14.9	40.9	.....	4.5
Lower Cross Timbers.....	9.3	24.2	135	.....	15
Gainsville.....	12.5	36.7	96.8	.....	8
Clear fork of Trinity.....	9.5	46.2	.....	91.2	10.1
Elm fork of Trinity.....	10.5	56.7	232.6	.....	23.2
East edge of Upper Cross Timbers.....	8.8	65.5	170.7	.....	19
Lower line of same.....	4.6	70.1	.....	256.5	51.4
West fork of Trinity.....	61.3	131.4	.....	12.3	0.3
Brazos river.....	23.7	153.1	191.9	.....	8
Clear fork of Brazos.....	32.4	187.5	402.1	.....	12.6
Double Mountain fork of Brazos.....	90	277.5	1,755.8	.....	19.5
Divide of Brazos and Colorado.....	7.8	285.3	361.3	.....	45.2
Colorado river.....	22.8	308.1	.....	278.6	13.3
Sulphur springs of Colorado.....	44	352.1	319.3	.....	6.3
Summit of Llano Estacado.....	89.1	441.2	423.6	.....	4.8
Pecos river.....	35.6	476.8	.....	659.1	18.3
Head of Delaware creek.....	30	506.8	102.6	.....	3.5
Summit of Guadalupe Pass.....	24.4	531.2	1,545	.....	61.8
Ojo del Cuerdo.....	23	554.2	.....	1,824.3	79.3
Las Cornudas.....	24.1	578.3	478.6	.....	23.8
Los Alamos.....	8.2	586.5	207.4	.....	26
East edge of Waco Pass.....	20.4	606.9	16.7	.....	0.9
Summit of Waco Pass.....	1.7	608.6	227.1	.....	57
West edge of Waco Pass.....	3.8	612.4	.....	876.6	79.8
Waco Tanks.....	2.7	615.1	.....	.....	.....
Summit of Mesa.....	22.2	637.3	56.5	.....	2.3
Molino del Norte.....	3	639.3	.....	161	53.6

CHAPTER VIII.

General Summary.—Business of the road, &c.

I have set forth at some length, though, I fear, imperfectly, in the preceding chapters, the advantages presented by the route I have surveyed for the location and construction of a railroad, and which may be summed up as follows, viz :

- 1st. That easy grades can be obtained along the whole route.
- 2d. That the cost of construction is reasonable.
- 3d. That over more than half the distance timber and building-material of every description can be procured on the ground.
- 4th. That several points are presented on the line not far distant from the heads of navigation of the streams of Texas.
- 5th. That the only obstacle to an abundant supply of water is easily removed.
- 6th. That over the most unfavorable portion of the route the grades

are not difficult, and timber for the ties is to be transported but short distances.

7th. That the agricultural and mineral resources of the route are in all respects good.

8th. That the chain of military posts to be established for its protection would, both individually and collectively, combine all the necessary requisites to be considered in the establishment of military posts in the Indian country.

9th. That the country traversed is of mild and genial temperature, and but little subject to the changes of the seasons; and, finally, that the route presents every combination of advantages and facilities, both for railroad and wagon-road, for military purposes or for emigration, that can reasonably be expected west of the valley of the Mississippi.

There is, however, another element which enters into the consideration; and although of little consequence should the government undertake the building of the road, has, nevertheless, been the basis upon which all railroads heretofore constructed in the United States have been projected. I refer to its prospective business.

I do not propose to speculate upon the trade of China and the East Indies, nor even upon the exchange of commodities between the Atlantic and Pacific coasts. I presume such matters are better understood by the entire business community of this country than by myself, and I shall therefore confine my remarks upon the subject to a rapid sketch of the local trade at present existing along the route, and of its prospective increase from the construction of a communication with the markets of which the information is not so general.

I had proposed to furnish with this report statistics exhibiting all the facts connected with this subject for a succession of years, but my time is so limited that it will be impossible to arrange such information in an intelligible form. The brief sketch of the subject which I shall give will, however, serve to attract the attention of those interested, and full information concerning all matters relating to it can be easily obtained.

By far the most important commercial feature of the country west of the frontiers of our settled States is undoubtedly what is known as the "Santa Fe trade"—so called for the reason that until very late years Santa Fe was the only port of entry for all goods coming from the United States, whether sold in New Mexico, or in the States of Chihuahua, Sonora, and Durango.

It has not been many years since the Santa Fe trail was regarded as something mysterious and wonderful; and the wild and reckless trader who wandered across the immense plains of the far west with his small stock of goods, was looked upon in our cities as a creature little less savage and ferocious than the grizzly bear of the Rocky mountains. This strange overland traffic across the trackless prairies, and through hordes of hostile Indians, was prosecuted under difficulties and obstacles which have never before surrounded a trading enterprise; and although neither encouraged nor protected by the authorities of the United States or Mexico, it has increased in value with each successive year.

Up to the period of the occupation of New Mexico by the American

forces in 1846, the duties collected upon the goods brought across the plains by these hardy adventurers were exactly what the fancy or the interest of the governor of the Territory might dictate; and his simple dictum was sufficient to increase or depreciate the price of any foreign article brought to the markets of New Mexico.

During the dominion of the famous General Armijo, the tariff upon the Santa Fe trade was greatly simplified by the rule which he adopted of collecting \$500 for every wagon-load of goods, no matter of what value were the goods or what size the wagon; and during his memorable reign, the traders were accustomed to halt on the borders of the settlements of New Mexico, and concentrating all their property into as few large wagons as would hold it, they abandoned the remainder until their return. As a matter of course, while the extortion of the governor was so unrestricted, and the cost of transporting cheap as enormous as costly goods, the Santa Fe trade was confined to an exchange of expensive articles of luxury for the gold and silver of the mines, and but few of the inhabitants of the country had either the means or the inclination to avail themselves of the opportunity of engaging in so expensive a traffic.

The purchase of the country by the United States, and the protection extended to the traders, have wonderfully increased the value of this trade, and at this time it will not fall short of \$6,000,000 annually.

The expense of transportation is still enormous, amounting to \$8 per hundred for goods delivered at Santa Fe, and probably as much more for distributing them to points at which they find a market; and the trade of the United States with New Mexico, Chihuahua, Sonora, and Durango is still confined to articles of luxury, exchanged for gold and silver. It is plain that a trade so restricted, which amounts in annual value to \$6,000,000, would be amazingly increased could such facilities for transportation and communication be presented as would enable the trader to throw into the country the most common and cheap of our fabrics, and, of consequence, those most useful to the Mexican, and best adapted to his means of purchase.

It cannot be expected that the valuable agricultural features of these territories can be even partially developed when no market for agricultural products is presented, and where nothing but a resort to the mountains for gold or silver will enable the Mexican to purchase articles which he both covets and requires.

So soon as an exchange of the products peculiar to the country, for the fabrics of the United States, can be established by opening rapid and cheap communication by railroad, the Santa Fe and Chihuahua trade will make a commerce which will contribute largely to the support of the road. This trade is now carried on by two routes—one through Texas, and the other from the Missouri river—which unite at El Paso, where the great highway leaves the Rio Grande and conducts south into the northern States of Mexico.

Another element which would enter largely into the consideration of the business of the road, would be the vast impulse given by its construction to the settlement of the fertile region of northern Texas. This vast extent of country is so amazingly fertile and well-watered, and so well adapted in climate and character to the culture of cotton, that it is

doubtful whether the crops of this region will not, by the construction of a railroad, be the most important element in the wealth of Texas. That a population would assemble along the road more rapidly than it could be built, is rendered more than certain by the very remarkable agricultural resources of the country; and as the line of this road would monopolize the trade of the fertile valleys of the rivers of Texas, both above and below, it seems not unreasonable to anticipate from this source a very large increase to the business of the railroad.

The emigration to California and New Mexico would not only concentrate necessarily upon the route, and contribute largely to its profits, but would tend, in a remarkable degree, to develop the stock-raising advantages of New Mexico and western Texas. By pursuing this route the emigrant would overcome eight hundred miles of distance, over the worst portion of his route to California, and a journey of two months would be reduced in time to as many days. He would find himself in the valley of the Rio Grande, where stock of all kinds is cheaper than at the points from which he started, and where wagons, provisions, and every necessary, could be readily and cheaply supplied, should the demand be sufficient to encourage the production of such articles. From thence he would have a journey to California with wagons of only eight hundred miles, and through a country where severity of climate is unknown. It seems proper to consider this source of profit also as an important element in the business of the road.

These sources of business would undoubtedly build up, at the point at which the railroad terminated on the Rio Grande, a populous town, which would be the depot of the immense merchandise to be distributed over New Mexico and the States of Chihuahua, Sonora, and Durango; and as nature has marked unmistakably the point at which the road must approach and cross the river at Molino, this point will undoubtedly add another instance to the rapid growth of cities in the west.

The government annually expends very large sums for transporting troops and supplies to the frontier posts of Texas, and to the military department of New Mexico, which expenditures, although considerably reduced by the less expensive charges on a railroad, could also be fairly exhibited as a prospective source of profit.

I have neither the time nor the means at present to enter into detailed estimates of the value of the business accumulated from the sources to which I have referred; but I am of opinion that examination of the subject will fully justify the belief of which I am fully possessed, that a railroad across northern Texas will be profitable, even if not continued beyond El Paso.

It seems proper also that I should refer in this place to the eastern terminus of this survey, to which there are some objections as a terminus to a railroad which looks to a connexion with the East.

The Red river from Preston to Fulton, in Arkansas, has a direction very nearly east, and I would suggest as forcibly as possible the continuation of this line in the direction of the latter point. The dividing ridge between the waters of the Trinity and Red rivers is in all respects of extreme practicability for the construction of a railroad, and the eastern terminus would be thrown forward to a point to which a series of rail-

roads from every direction is rapidly concentrating. By this extension, also, the range of the Ozark mountains, which interpose in the direct line between Preston and Little Rock, or Memphis, is completely turned at its southern extremity, and the surveys of the route from Little Rock to Fulton, which had just been completed when I reached the frontier of Arkansas, exhibited a route entirely favorable. It would not be necessary to continue the examination of the route from Preston to Fulton, as the character of the country and its practicability are well known.

In the consideration of a proposed eastern terminus of the Pacific railroad it has been urged, as a point of much consequence, that it should be so placed as to insure the earliest and most favorable connexion with the lines of railroad at present built, or in process of construction; and it therefore seems proper that I should exhibit what advantages of the kind are offered by the route now in question. Fulton, in Arkansas, its proposed eastern terminus, is the centre to which many lines of railroad are now concentrating, and which will undoubtedly be finished as soon as the terminus of the Pacific Railroad shall be established, and long before the road can be built.

From Cairo, at the mouth of the Ohio, where it connects with the great Central road of Illinois, a railroad is now in process of location and construction through Little Rock to Fulton. At Little Rock it is met by a branch from Memphis. A road from Vicksburg and the New Orleans and Shreveport road, along Red river, unite at Fulton; and these various lines connect at their eastern termini with the great chains of railroad which traverse nearly all the States of the Union. In this respect, therefore, this route seems to combine all the requisites or recommendations which seem desirable.

But there is one element of a consequence not to be overlooked in estimating the advantages of this route; and that is, the means now at hand without the aid of the government for building it.

The State of Texas has granted something more than 10,000,000 of acres of land to any company which will undertake, under sufficient guarantees, to build a railroad along this route as far as the Rio Grande. The company have the privilege of selecting the lands thus granted from any unoccupied lands in the State; and to one who understands the value of the arable lands in Texas this grant seems altogether sufficient for the construction of the railroad. There can be no doubt, if the company which undertakes its construction can, upon this basis of real estate, borrow the funds necessary to complete the road before they are compelled to offer the lands for sale, that the grant will not only be sufficient to pay the cost of the road, but will make this company the richest corporation in America.

By this munificent contribution of Texas in aid of a great national enterprise, the question of the Pacific railroad is reduced from the consideration of a line of 2,000 miles to one of 800 miles; and to dwell upon the importance of this fact seems altogether superfluous.

I am, sir, respectfully, your obedient servant,

JNO. POPE,

Brevet Captain Top. Engs., in charge of Exploration.

HON. JEFF. DAVIS, *Secretary of War.*

APPENDIX.

DIARY OF THE EXPEDITION.

BY J. H. BYRNE, ASSISTANT COMPUTER.

CHAPTER IX.—*From the Rio Grande, at El Paso, to the Pecos, at the 32d parallel.*

The surveying party arrived at Doña Ana from Albuquerque, on the 16th January, 1854. In consequence of the judicious measures taken, the journey across the "Jornada del Muerto" was accomplished without any suffering either to men or animals. The latter were in good condition when they reached Doña Ana.

It had been anticipated that a delay of not more than ten or twelve days would be necessary to complete the arrangements requisite for the movement of the expedition. These anticipations, however, proved fallacious. Orders had been issued that the transportation for the escort should be supplied from El Paso; the wagons and teams to be taken from the train that had transported the four companies of the 8th infantry from Texas.

On making application to Brevet Lieut. Col. Alexander, who had the control of these wagons, &c., an unlooked for difficulty arose, which caused an embarrassing and *expensive* delay of four weeks. Col. Alexander declined to supply the transportation, stating that he had no authority to turn it over on the requisition made upon him. After many fruitless efforts to change this opinion of the Colonel's, it was determined to send a *special express* to the headquarters of the department, at Albuquerque, for such orders as would set the matter at rest. The express was accordingly despatched, with directions to make the trip to headquarters and back in eight days: it returned within the time agreed upon. The orders brought by it were immediately forwarded to Col. Alexander, who at once furnished the transportation.

During this detention, the valley of the Mesilla was surveyed and sketched; and every information of a scientific character, tending to illustrate the natural productions of this section of country, was obtained. It is not necessary in this place to describe Doña Ana or its neighborhood; it has been so often and so well depicted, that it renders any notice of it totally superfluous.

Every obstacle being now happily removed, the transportation for the escort arrived from El Paso on Friday, the 10th of February, 1854. It comprised eight wagons with six mules each, and one extra team of six mules, under the direction of wagonmaster W. B. Baylor. This party brought with them from Fort Fillmore sixteen beeves and

seventy head of sheep. The most energetic exertions were *at once* made to forward the final preparations. The next day, the 11th, was devoted to loading the wagons, repairs, &c., &c.

While remaining here, all the animals were turned out to graze from sunrise to sunset. We hauled our wood from the vicinity with our own wagons.

Starting.—All being in readiness, the expedition left Doña Ana at 9 o'clock a. m. on Sunday, 12th February, 1854. The party consisted of Captain John Pope, topographical engineers United States army, commanding; Lieutenant K. Garrard, 1st dragoons, assistant engineer; ———, quartermaster and commissary of subsistence; Lieutenant L. H. Marshall, 3d infantry, commanding escort; Captain C. S. Taplin, acting mineralogist; Dr. W. S. Diffendorfer, surgeon and acting naturalist; John H. Byrne, computer; Thomas Mitchell, wagon-master; escort (twenty-five rank and file,) teamsters, herders—numbering in all seventy-five persons. The party found it impossible to obtain a guide, or to collect any information in reference to our route, not one of the persons spoken to on the subject having ever traversed it. Neither could a forge be obtained. The want of this indispensable article was severely felt.

Camp No. 1—Sunday, February 12, 1854.—The command moved east from Doña Ana over a road of about six miles deep sand; the remaining portion of it, seven miles, was good, with a gradual ascent of about ten miles before we reached the pass in the mountains. The road at this point is rocky, with an abrupt rise. The cold was here intense, although in the valley beneath it was comparatively warm. Descended the mountain for about five miles, having the Organ peaks on our right hand, and encamped at San Augustin springs at 5 p. m. Water plenty; wood scarce; grama-grass good, and in abundance. The mules were here hobbled and turned out to graze during the night, having been previously fed with corn. Captain Pope accompanied the command four miles from Doña Ana, and then took the road to El Paso, "to transact some business, and make some necessary surveys." General direction, north 81° east; miles, $18\frac{9}{16}$.

Camp No. 2—Monday, February 13, 1854.—Animals driven in to the wagons and fed with corn at daylight. Command started at sunrise; road good. Arrived at the Ojo de la Soledad about noon. The wagons were here unhitched and the animals watered. The water is one and a half mile to the right of the road. In consequence of the uneven and rocky nature of the ground, wagons cannot reach it. The water is situated in a rocky ravine. The command halted here for the remainder of the day. In anticipation of crossing the Jornada to the Waco mountains, the water-barrels were filled. This consumed much time, and cost a great deal of labor, the water being at so great a distance, and so difficult of access. The animals were hobbled and turned out to graze until sundown, when they were driven in and fed with corn, after which they were herded and grazed during the night. Grama-grass good and plenty. General direction, south 53° east; miles, $8\frac{1}{2}$.

Camp No. 3—Tuesday, February 14, 1854.—Animals driven in at daybreak and fed. Command moved about sunrise. The road for upwards of seven miles was rocky and uneven; the remainder through

pretty deep sand. One wagon broke down during the day: it had to be brought along on a slide. This accident occasioned a considerable delay. Two white mules strayed away—supposed they went after water. Two of the Mexican herders were sent in search of them. Encamped at sundown on the Jornada. No water nor wood; grass plenty. Cooked with the brush that lay around upon the plain, sufficient for the purpose. As the animals evinced signs of fatigue, they received an additional allowance of corn; afterwards they were hobbled, turned out to graze, and herded, as usual, during the night, which was very cold, with a high wind. General direction, south 49° east; miles, $13\frac{9}{10}$.

Camp No. 4—Wednesday, February 15, 1854.—Animals driven in and fed before daybreak. Command started a little before sunrise. It was hoped we would be able to reach the Waco Tanks before night. Lieutenant Marshall and Captain Taplin left the party in the early part of the forenoon to find the trail. The road was over heavy sand; several ridges of sand had to be crossed. Having followed the road for about eight miles, we turned off to the left in the direction of the Tanks. Nooned for two hours; animals turned out to graze. As we had now to make our own road through deep sand and brush, our advance was slow. Having made about twelve miles, the animals showed such symptoms of exhaustion that it was deemed advisable to lighten the wagons. One hundred and twenty-five fanegas of corn were accordingly taken out and left on the prairie. This was about 4 o'clock p. m. We travelled until nearly 11 o'clock p. m.; but, in the darkness, getting entangled in some sand-hills, we were obliged to halt for the night. The animals were here fed with corn; but as they had been for *sixty hours* without water, they did not eat. All eyes were turned in the *supposed* direction of the Waco Tanks, hoping to discern a light to serve as a guide, but in vain. Neither Lieutenant Marshall nor Captain Taplin had joined the command up to this hour. Wagonmaster Beylor started on horseback to find the Tanks. He returned long after midnight unsuccessful. Animals turned out to graze as usual. No wood; no water; grass plenty. General direction same as yesterday; miles, $17\frac{4}{10}$.

Same Camp—Thursday, February 16, 1854.—At sunrise principal wagonmaster Mitchell, accompanied by a soldier, (who stated he knew where the Tanks were situated,) left camp to find them. During their absence, Lieutenant Marshall and Captain Taplin came into camp about 9 o'clock a. m. They had found a trail, and reached the Waco Tanks on the previous night, but had no means of communicating with us. We found we had camped upwards of six miles to the west of them. All the animals were immediately driven to water. As they had now been seventy-two hours without it, they quickly exhausted the tanks on the west side of the mountain. That upon the east, however, afforded an ample supply. It was intended to have moved the camp this day, but the unavoidable delay in watering the mules and stock prevented this intention from being carried into effect. An ambulance with six kegs brought sufficient water back to camp for cooking until the next day. The animals were fed, hobbled, and turned out to graze during the night.

Camp No. 5—Friday, February 17, 1854.—Left camp about 8 o'clock a. m., and moved to the Waco mountains, which we reached about 11 o'clock a. m. These mountains are composed of a dark gray sandstone, scattered about in high masses in the most grotesque disorder and confusion. The tanks containing the water are immense reservoirs, hollowed out by the hand of nature. That upon the west side is capable of holding about five hundred gallons; the other, upon the east side, would contain, when full, perhaps fifteen hundred gallons. The animals were watered, hobbled, and turned out to graze. General direction, south 62° east; miles, 6 $\frac{8}{10}$.

Same Camp.—Saturday, February 18, 1854.—On examination many of the wagon-wheels were found to require repairs; they were taken off the wagons and sent to El Paso to have the necessary repairs made. The want of a forge, already alluded to, was now sensibly felt. Lieut. Garrard left for the same place on business. Wagonmaster Beylor, with seven wagons, returned for the corn that had been left on the Jornada, (see Wednesday, 15th instant;) he arrived in camp with all the corn about 8 o'clock p. m. same day, having made twenty-eight miles. About the same hour the Mexicans, who had been sent after the stray mules, (see Tuesday, 14th,) came into camp, bringing the animals with them. They say that, with the exception of a small quantity of bread, they have subsisted for four days upon a hawk which they shot; they had to follow the mules to Camp No. 2, "Ojo de la Soledad," where they had to rest the animals, which were in a very weak condition. One mule missing; it has gone towards the "Pass," as it can be tracked by the lariat. A Mexican herder sent in pursuit. The animals fed, hobbled, and grazed, as usual. At this camp there is abundance of wood and grama-grass.

Same Camp—Sunday, February 19, 1854.—The mule which strayed from camp (see Saturday, 18th) returned by itself. Besides the water contained in the Tanks, there are numerous holes and crevices in the mountains, which contain sufficient for every purpose to last for a considerable time. It is proper to remark that animals cannot drink from the Tanks; the water is taken out in buckets, and thrown down the rocks until all have been supplied: thus, watering is a matter of time and labor. The peculiar formation of these mountains, their innumerable caverns and hiding-places, seem to have been intended for a refuge for the Indian; nor have they neglected to avail themselves of its advantages. In one instance, however, they "reckoned without their host." About fourteen years ago these Arabs of New Mexico, the Apaches, having made a desperate foray upon the Mexicans, retreated with their plunder to these mountains. The Mexicans surprised and surrounded them, hemming them up in the rocky ravine forming the eastern Tank. Here an engagement took place, in which the Indians were totally defeated and nearly exterminated, only two or three escaping. It is said that upwards of one hundred of them were killed. The water in the Tank is rapidly diminishing. At the present rate of consumption, it cannot be calculated on longer than three or four days more; but there is a sufficient quantity of it in the numerous holes in the mountains to supply the command for cooking purposes for

a considerable time longer. The animals fed, hobbled, and grazed, as usual.

Although the command has traversed through the very centre of the Indian country, we have not up to this time seen an Indian. It is a matter worthy of remark that not one animal has been lost. This happy result proceeds, no doubt, from the unceasing vigilance and care with which the animals have been watched. A strong guard is posted every night from sundown to sunrise. To prevent any loss by a "stampede," the precaution has been taken to hobble the animals whilst out grazing.

Same Camp—Monday, February 20, 1854.—The Mexican sent in pursuit of the stray mule (see Saturday, 18th) arrived in camp. The men in camp were this day occupied in repairing harness, wagons, &c., &c. The animals since our arrival at this camp have not been turned out to graze at night. They are herded all day until sundown; then driven in, fed with corn, and tied to the wagons. This arrangement is considered a matter of necessity, and is adopted to prevent any loss. The weather continues warm and pleasant in the daytime; the nights are a little frosty; indeed, the only inconvenience felt in this respect is from the wind, which frequently sweeps through the cañon with great violence. Water nearly exhausted.

Same Camp—Tuesday, February 21, 1854.—The teamsters still occupied in making repairs, &c. On examination it was found that the water will not hold out longer than to-morrow. The wagons which carried the wheels requiring repairs to El Paso returned. Captain Pope, Lieutenant Garrard, and the party which accompanied them, joined the command about 9 o'clock p. m. A man named Cutting, who had been sick for some time at Fort Fillmore, returned with them. He had been attacked at Doña Ana with pleurisy, and sent to the above post for medical treatment. All the water-kegs filled, and carried to the next camp.

Camp No. 6—Wednesday, February 22, 1854.—Left camp at 2 o'clock p. m., and moved in the direction of the Sierra Alto. The road winds through a deep ravine; it is a good gravelly road. Reached the Sierra Alto at 5 o'clock p. m., where we camped. No water; grama-grass good and abundant. No wood; a sufficient quantity of brush was found for cooking purposes. Observations made at night for the latitude. On our arrival in camp the animals were turned out to graze for a short time; then brought in, fed with corn, hobbled, and grazed during the night. A strong guard was posted. It froze pretty hard during the night, with a strong wind. General direction, north 30° east; miles, $4\frac{2}{3}$.

Camp No. 7—Thursday, February 23, 1854.—Left camp about sunrise, and moved in the direction of the Sierra de los Alamos. From this camp there are two roads leading to them. One runs south of the Sierra Alto, and is much shorter than the road we took. It is formed by the dry bed of a creek, and is tolerably good; but at one point it has a descent so steep and abrupt, that it was deemed more safe and prudent to take the longer and more beaten track. The latter (surveyed by Colonel Johnson) runs, for about two miles from our last camp, through a deep and tortuous cañon; the road here is rocky. By doubling teams on some of the wagons we surmounted three very steep hills,

at the first of which one of our wagons broke down. It was broken up, and such portions as were thought useful, in view of future accidents, were put in the other wagons and carried along; the remainder was abandoned, as we had no means at our disposal for repairing it. On leaving the cañon we came upon a good gravel road, nearly level, with the exception of some gentle undulations of the ground. Our camp for the approaching night (Los Alamos) could be seen during the whole day. We reached it, and encamped at 5½ p. m. The Sierra de los Alamos consists of three mountains, directly to the east of the Sierra Alto. The water is situated on the north face of the mountain, about half a mile from the road. There is a trail leading to it. Indeed, it cannot be mistaken, as there are a few cotton-wood trees near the springs, and nowhere else in the vicinity. The water is difficult of access. It issues from seven holes, and is supplied from springs in the rocks; there was sufficient for every purpose. Good grass; no wood; brush around camp for cooking. The animals having been watered, were fed with corn, and tied to the wagons until 2 o'clock a. m., when they were hobbled and turned out to graze until after sunrise. Observations for the time were made during the day. A strong guard posted as usual. General direction, north 70° east; miles, 20⁸/₁₀.

Camp No. 8—Friday, February 24, 1854.—Left camp at 9 o'clock a. m., and moving in the direction of the Cornudas mountain. There is a fine gravelly road from our last camp to this mountain; there are some hills in the course of it, but they do not present any difficulty. We reached our camp, the Cornudas, about 2 o'clock p. m. This mountain is about five hundred feet high, and consists of huge masses of rock, scattered in the utmost disorder and confusion. The water (as at the Waco Tanks) is contained in reservoirs in the rock, and is very difficult to reach. There was sufficient for all purposes. Grass good; wood plenty. On the east of the mountain there is a cavern, entered by an arched doorway, receiving light from an opening in the roof, in which there was a well (now filled with sand) which, it is said, at one time contained twelve feet of water. There are also many other places here equally curious and interesting. The geological formation of these rocks differs from those of the Waco Tanks, as they consist of a kind of granite or gneiss. The weather was colder this day than we had experienced since we left Doña Ana. The animals, immediately on our arrival in camp, were watered, hobbled, and turned out to graze, having been first fed with corn. As usual, a strong guard was posted during the night. Observations for the time were made during the day, and also at night for the latitude, but without satisfactory results, as the night clouded up. As we could not reach water on the next day's march, the casks were all filled. Although a great quantity had been used from the reservoirs, there did not appear to be any diminution of the water in them. A little rain came down about 4 o'clock p. m. General direction, north 45° east; miles, 9.

Camp No. 9—Saturday, February 25, 1854.—Left camp at 11 o'clock a. m. The mules and stock were allowed to graze until 10 o'clock a. m., when they were all watered. Before leaving camp some requisite repairs were done to the wagons. The road for this day was good,

over a gravelly mesa. Reached camp, open prairie, at 3¼ p. m. No water; no wood; brush enough for cooking purposes; grama-grass good and abundant. The animals were hobbled and turned out to graze till sundown, when they were driven in and fed with corn, then turned out to graze for the night; a strong guard posted as usual. Up to this time we had not seen an Indian; still, every precaution that prudence can dictate is taken to prevent surprise. We have not lost a single animal as yet. General direction, south 85° east; miles, 12.

Camp No. 10—Sunday, February 26, 1854.—Left last camp at twenty minutes after 7 o'clock a. m., and moved to our next camp, the Ojo del Cuerdo. Our road for this day was good; for about six miles it was gravel; the remainder a firm red soil, until we approached within a mile and a half of camp, when it became somewhat sandy. At about eight miles from camp we came to a gradual descent, which continued until we reached the bed of the Salt Lakes, about one and a half mile west of the Ojo del Cuerdo. Encamped ten minutes past 2 o'clock p. m. The mules travelled very well to-day, and are in very good condition. The Ojo del Cuerdo consists of two sulphurous lakes. The surface of this valley is covered with a salty and sulphurous efflorescence, which continues in a southerly direction until it reaches the Pecos, at a point where it is joined by the Lymphia, a distance of nearly two hundred miles. The valley around our camp, as far as the eye can reach, is dotted with patches, of considerable magnitude, of a brilliant whiteness; they are deposits of pure salt, formed by the evaporation of the water. Many holes had been dug near our camp, the water in which does not taste very salty; it loses much of the salt while filtering through the sand from the lakes. The grass is strongly impregnated with salt, and cannot be nutritious. No wood; brush very scarce. Found here, for the first time, *bois de vache*. On our arrival at camp the animals were watered, hobbled, and turned out to graze; they were afterwards (at sunset) driven in, fed with corn, and tied to the wagons until daybreak, when they were turned out to graze until 9 o'clock a. m., when they were well watered. As we did not anticipate reaching water the next day's march, the kegs were filled, for the use of the command, from the holes already mentioned. Observations for the time were made during the day. As the Ojo del Cuerdo is considered a dangerous camping-ground, all were upon the *qui vive*; and, as a precaution against a stampede, the mules were tied during the night to the wagons. A strong guard posted. General direction, north 82° east; miles, 17½.

Camp No. 11—Monday, February 27, 1854.—Left last camp at half-past 9 o'clock a. m. Our course for this day was, for about seven miles, through deep and heavy sand, along the base of a range of low and very white sand-hills; the remainder of the march was over a good gravelly road. From many of the heights in the road we could see the Salt valley stretching away to the southward, as far as the eye could reach. The left side of the road, for some distance from camp, was dotted with small sand-hills of dazzling whiteness. Reached our encampment on the prairie at ten minutes to 3 o'clock p. m. The animals were immediately hobbled and turned out to graze until sundown, when they were driven in, fed with corn, and grazed until sunrise. No

water, nor wood; brush sufficient for cooking purposes. Grama-grass good and abundant. As we approached nearer to the Guadalupe mountains, (supposed to be the most dangerous part of the road,) our vigilance is redoubled. General direction, south 60° east; miles, $12\frac{4}{10}$.

Camp No. 12—Tuesday, February 28, 1854.—Left last camp at half-past 7 o'clock a. m., and moved for the pass of the Guadalupe mountains. Our road for to day was bad and rocky. We had to pass over some steep hills of the same character. Our course lay south fifty degrees east for about seven miles, then turned north sixty-eight degrees east for upwards of three miles, then for about one mile north forty-eight degrees east. Before entering the cañon we avoided a steep and difficult hill, by making a detour to the left of the road, striking at a short distance the beaten track. We now entered the cañon, and encamped about half way up it, on a small and rocky plateau, at twenty minutes after 4 o'clock p. m. The passage through the cañon is along the dry bed of a stream, which has its source near the high peak of the Guadalupe mountains, and is very rough and difficult to travel. One wagon broke down here, which we abandoned, having no means of repairing it. Springs are found at the head of the ravine under the highest peak, and about five hundred yards from the point at which the road ascends the face of the bluff. We found plenty of wood (mezquite and brush) to answer all purposes. The south peak rises in a bold outline, towering to the enormous height of two thousand feet; it is composed of gray sandstone. The animals were watered, fed with corn, and turned out to graze during the night. Grama-grass poor, and very scanty. Observations for the time were made during the day, and also at night for the latitude: the latter were not very satisfactory, as the northern stars clouded up. Miles, $18\frac{8}{10}$.

Camp No. 13—Wednesday, March 1, 1854.—Left camp at $8\frac{1}{2}$ a. m. We moved up the cañon, breasting a steep and rocky ascent; there is an abrupt turn to the right, which we were obliged to take, which led us up a continuation of this hill for about a quarter of a mile before we reached the summit. This task consumed a considerable time, but it was accomplished without doubling teams, or any accident occurring. From the summit the view over the surrounding country was at once grand and picturesque—the southern peak of the Guadalupe towering majestically above all.

Our march, until we reached the "Pinery," (our camp,) was over a good gravelly road. We arrived here at half-past 11 o'clock a. m. There is an abundance of every requisite for camping at this place. The water (springs) is situated at the distance of five hundred yards from the road, at the base of the mountain; timber and good grama-grass are plenty. We were fortunate in obtaining a fine specimen of the "maguey" plant, the first we had yet seen; it was earthed in a box and carried along. This encampment is by far the best we have yet come to. On our arrival the animals were hobbled and turned out to graze until sundown, when they were driven in, fed with corn, and tied to the wagons till sunrise, when they were grazed a couple of hours before starting. As we are now in a dangerous locality, the animals are tied to the wagons as a prudent precaution. Observations for the time taken during the day, and for the latitude at night: the latter had

to be discontinued, as it blew a perfect hurricane from about 4 o'clock p. m. until we left camp next morning. The night was excessively cold and severe. A strong guard posted; while the cattle are grazing (although hobbled) there is a guard placed over them. General direction, south 84° east; north 45° west; miles, $4\frac{1}{10}$.

Camp No. 14—Thursday, March 2, 1854.—Left camp at $8\frac{1}{2}$ a. m., and moved in the direction of Independence spring. Our road was a good gravelly one, with a gentle descent from camp to camp. A black-tailed deer was shot, skinned, and stuffed; we were also fortunate in finding some curious specimens of cactus. We reached camp—the above spring—at twenty minutes to 11 o'clock a. m. This is a spring of clear and pure water; it issues from a deep and large hole, through a quicksand bottom, in a rapid stream. Means were taken to sound the depth of this hole, but without effect—a pole of considerable length going down without meeting any obstruction. This spring is no doubt supplied from the mountains in its vicinity. Grama-grass good and abundant. There is here a sufficient quantity of mezquite and brush to answer for cooking purposes. On reaching camp the animals were watered and turned out to graze, being hobbled as usual; brought in at sundown, fed with corn, and tied to the wagons during the night. No observations taken. General direction, 89° east; miles, $6\frac{3}{10}$.

Camp No. 15—Friday, March 3, 1854.—Left last camp at ten minutes past 7 a. m. Our road for this day was over a rolling prairie, and, with the exception of one steep and rocky hill, was, on the whole, pretty good. There are, however, some deep and rocky gullies, worn from the rain descending from the higher ground, which caused some little difficulty. At about twelve miles from last camp we halted for a short interval to rest. The mules travelled well to-day, taking all things into consideration, they are in good condition. Reached our camp, head of Delaware creek, at fourteen minutes to 3 o'clock p. m. About one and a half mile from this camp we crossed the dry bed of a creek. The wagons were halted here, and wood placed in them for the use of the command. There is at this point an abundance of dry and good wood.

Along our line of march to-day we perceived several graves, over which were placed flat stones. No inscription told the names of those who "slept beneath," nor recorded the manner of their death. There is something so melancholy about these resting-places, removed as they are from the habitations of civilized man, that reflections of a serious nature are called up in the minds of the most volatile.

On our arrival at camp the animals were watered, hobbled, and turned out to graze. As it is contemplated to remain here for a couple of days, they were not fed with corn, but were turned out to graze under a strong guard. The grama-grass is good and plenty. Observations for time and latitude taken this day. General direction, 84° east; miles, $16\frac{1}{10}$.

Same Camp—Saturday, March 4, 1854.—Lieutenant Garrard left camp this morning with one wagon, escorted by five soldiers and five men of the train; the former rode in the wagon, the latter were mounted. All were well-armed. Lieutenant Garrard's object is to find a more direct route south of the Guadalupe range, and to proceed until he

could see the Alamos, one of our former encampments. (See No. 7, Thursday, February 23, 1854.) It was decided that the command would await his return at our present camp. The assistant wagon-master was sent to hunt up wood at a nearer point than the place we had taken it from the previous day; but he was not successful. On his return, two wagons, under a guard, were ordered to bring wood from the dry creek we passed yesterday.

Our present camp is twenty-six and five-tenths miles from the peak of the Guadalupe mountains, opposite to it and directly east. This camp presents some interesting features. On examination we have found upwards of eight springs, located in a space of about two hundred yards. One of these rushes out in a bold and rapid stream, over a limestone bottom. The water is pure and good. There are also three more, nearly as good, at a short distance up the creek. Several of them are clustered together at the head of the creek, within the space of a few yards; four of them are strongly impregnated with sulphur, each of them differing in strength; the whole of them (both sulphurous and pure) flow into the creek, forming a most detestable compound. It is not presumptuous to suppose that a careful analysis of these sulphuretted springs would develop medicinal properties of a highly important character. A keg of this water is carried along for the use of one of the command, who is afflicted with a painful eruption on the face; its effect will be noted in due time.

We cooked to-day a maguey plant. This plant is extensively cultivated in old Mexico, and a wine called "pulque" extracted from it by tapping. It is said that one plant will yield four quarts of juice a day for four or five months. The Apache—who has not arrived at the degree of civilization necessary to manufacture intoxicating liquors—cooks and eats it; decidedly the most sensible plan. The following is the *modus operandi*: The lower and sound portion of the plant (not the root) is divested of all the leaves, stock, &c., then placed in a hole dug in the ground, then covered completely with earth to the depth of an inch, and over all there is built a good but slow fire. It requires from twelve to eighteen hours to cook it thoroughly; when cooked thus it is extremely pleasant to the taste, and is a capital substitute in the absence of all other vegetables; indeed, it is the only diet of this nature that these Indians possess. The other way of cooking it is to pound or mash it up, and boil it until it becomes thick. This is also very palatable and nutritious.

At a short distance from camp (down the creek) there are large quantities of gypsum in a state of decomposition. We found here a species of pepper-grass, having a sharp and pungent taste. Since our arrival here we have added largely to our collection in natural history, mineralogy, and botany.

The mules have been grazed since our arrival. The principal spring is called the "Ojo de San Martin." Observations for the time taken to-day, and at night for the latitude and longitude. The day warm and pleasant; the night clear and frosty; no wind.

Same Camp—Sunday, March 5, 1854.—The wagon which accompanied Lieutenant Garrard returned with the five soldiers who formed part of the escort. Lieutenant Garrard, with the remaining part of his es-

cort, came into camp at sunset. In pursuance of the arrangement, (already mentioned,) he proceeded south of the Guadalupe range of mountains to find a pass which, it is said, runs in the direction towards the Pecos. This country is a succession of bluffs, rising from the mountains in a gentle ascent, to a point twenty miles below them. Here this description of country terminates, and it becomes totally impassable—the descent as far as the Salt lake being rocky and precipitous. There is no such pass as that stated by Captain Marcy and Colonel Grey. The wagon had to be sent back, as it was found it could not proceed further than the point above indicated. Through the negligence of the man who carried the theodolite, it was seriously injured. This man's pay was stopped, and he was ordered to work with the teams for his rations. In consequence of this serious accident, the whole command was cautioned, and told that a similar punishment would be inflicted upon any who would perform the duties assigned them in a careless or heedless manner. The soil around our camp is deeply impregnated with sulphur. No observations taken; the sky clouded during the day and night. The animals turned in at sunset, and fed with corn; afterwards grazed during the night, being, as usual, under a strong guard, and hobbled.

Camp No. 16—Monday, March 6, 1854.—Left last camp at half-past 8 o'clock a. m. Our road for this day was a good gravelly one, with a gentle descent for the whole way. We had some few hills, but they presented little difficulty. The principal wagonmaster, with three men, started at daylight this morning to follow the course of the Delaware creek, and find a practicable road for a wagon to the Pecos. The soil we passed over to-day is composed of sand and gravel, mixed with gypsum. Many curious botanic specimens were this day obtained.

Our camp, which we reached at 3 o'clock p. m., is about half a mile to the right of the road, on the Delaware creek. There is much difficulty in watering animals at this stream, the greatest care being required to prevent them from miring. The water flows through a deep basin about six hundred yards from camp, which is deeply strewn over with gypsum.

The day was remarkably warm, sultry, and cloudy, giving some indications of rain. At night it rained heavily for a short time, with flashes of very vivid lightning, accompanied by loud thunder, which could be heard reverberating through the mountains we had left behind us.

The grama-grass is good; wood, consisting of mezquite, cedar, and brush, is plenty. The animals were brought in from grazing and fed with corn; then turned out to graze for the night. Reached camp at 3 o'clock p. m.; general direction north, 38° east; miles, $12\frac{2}{10}$.

Camp No. 17.—Tuesday, March 7, 1854.—Left last camp at twenty minutes after 9 o'clock a. m. At a short distance from camp we met the wagonmaster and party, who reported, "that by following the creek on its left bank we would have a good road to the Pecos." Reached the "crossing of the Delaware creek" at 2 o'clock p. m., where we halted; the animals were watered and allowed to graze for a short time. We did not cross the creek, but continued down the

left bank; in this we did not experience any difficulty. The country is an open and nearly level prairie, having a slight descent (nearly the whole way) towards the Pecos. We have now to make our own road. At about ten miles from last camp, the nature of the soil changes; the gypsum disappears. From this point to the river the soil is light sand mixed with gravel, producing an abundance of excellent grama-grass. From the crossing of the Delaware to the Pecos there is no growth of wood of any description whatever; we found, however, along our line of march, plenty of mezquite root, dry and good.

About a mile from our halting place, (the crossing,) and on the opposite or right bank of the creek, there is a valley of about eight hundred acres of good soil, which could be irrigated from the creek at no very great cost of labor or money. The want of timber, and the difficulty of irrigating the land, will no doubt prevent this section of country from being cultivated to any great extent. The last obstacle might be surmounted, but the former appears irremediable.

Along our road to-day we discovered several caves. On examination they proved to be highly interesting, their interior being composed of gypsum, the roofs and sides highly polished, and of the purest white: they well repay the trouble (no easy matter) of entering them.

We reached our camp at half-past three o'clock p. m., situated on the creek. Here there is an abundance of good grama-grass. The mezquite wood is plenty, and can be obtained without much labor. We killed a rattlesnake (the first we have yet seen) on a hill near camp. It was put in spirits and carried along.

The wagonmaster, on his return, (as above mentioned,) reports that at the Pecos he discovered a fire—still burning—at which some Indians had been cooking. From their tracks they were on foot, and appeared to have crossed the river. This was near the mouth of the Delaware creek, our proposed camp for to-morrow night. There is a plenty of wild ducks and hens on the creek. On arriving at camp the animals were turned out to graze, hobbled as usual; brought in at sunset, and fed with corn; then turned out to graze during the night under a strong guard. No observations made. General direction, north 50° east; miles, 13 $\frac{9}{10}$.

CHAPTER X.—*From the valley of the Pecos to the Sulphur Springs of the Rio Colorado of Texas.*

Camp No. 18—Falls of the Rio Pecos, mouth of Delaware creek, Wednesday, March 8, 1854.—Left last camp at twenty minutes after 7 o'clock a. m. Our road to-day was through an open and nearly level prairie, similar to that we travelled yesterday. The soil is good; gravel and sand. In all directions on our line of march there is an abundance of mezquite root, but, as before mentioned, no growth of wood. We reached our camp, Falls of the Rio Pecos, mouth of Delaware creek, at five minutes to 10 o'clock a. m. We were fortunate enough at this

point to discover an excellent crossing, about one hundred yards from the mouth of the Delaware creek. The water rushes over "falls," in a bold and rapid current, at a rate of nine knots per hour. The river at this point has a good rocky bottom, is about eighty feet wide, and two and a half feet deep. There are here seven little islands, through which the stream flows with great force. This crossing presents no difficulties whatever, only requiring a few hours' labor to cut down the banks on either side, to permit wagons *heavily loaded* to cross over without trouble. Those who are well acquainted with the several crossings of the Pecos below this, say that it is by far the best along the river. The animals were hobbled and turned out to graze. The grama-grass is good and abundant. Sufficient mezquite around camp for cooking purposes. The water is brackish, but not to such a degree as to affect the health. General direction, north 42° east; miles, 6.

Same Camp—Thursday, March 9, 1854.—The soil of the valley, on examination, proves to be fertile and of easy cultivation. It can be irrigated from many points of the river. All the way up it, as far as we have gone, it is rapid, and varies from five to twenty feet in depth. Its waters are discolored, and abound in catfish of a very large size. There are also, though not plenty, some wild duck and water-hen along the banks.

The valley of the Pecos is about two and a half miles in width, enclosed by gently receding table-lands, and although nearly destitute of timber, yet supplies an abundance of mezquite root for fuel. The surface of the table-lands and ridges present only the dwarf mezquite brush, but beneath the whole earth is a net-work of the root, in some instances as large round as a man's leg, and furnishing the best fuel known to the country. The town of El Paso and its vicinity are supplied entirely in this way. The Pecos traverses its valley in a very tortuous course, and with a current of about two and a half miles to the hour, and from five to twenty feet depth of water. In many places bluff banks of diluvium and gypsum, about fifty feet high, impinge upon its banks. The river below the 32d parallel changes its character from a rocky bed, with occasional rapids, to soft mud bottom and banks. Fording places below this parallel are very rare, and present in all cases a depth of water which, at any other than the dry season, absolutely prevents the passage of wagons or wheeled vehicles. From the 32d parallel to its mouth, the Pecos is always navigable for small stern-wheeled boats, the difficulties consisting merely in its extreme crookedness and narrowness. The banks are perpendicular, about ten feet high, and falling into the stream constantly—the deep water being uniform from one shore to the other. The average width would not exceed one hundred feet.

It is not deemed advisable to encounter that *terra incognita*, the Llano Estacado, with the whole command, until the practicability of such a measure shall have been tested by a previous examination. Our very limited information respecting it points out the necessity of such an examination, to avoid the danger to which so large a party would be exposed by encountering this Jornada. Captain Taplin was intrusted with this important duty. The following is a copy of his instructions:

FALLS OF THE PECOS RIVER, MOUTH OF DELAWARE CREEK,
 March 9, 1854.

SIR: You will please proceed to examine the "Llano Estacado," from this point to the headwaters of the Colorado or Brazos river, on a line 20° east of north, noting particularly the practicability of the country for wagons; and the intervals, as exactly as possible, between the permanent watering-places. You will continue your examination eastward until you strike some stream flowing to the east or south.

Should you be successful in finding water at reasonably convenient intervals along your route, from this point, you will, after resting your animals one day, return by the same route; but if not, you will please, after reaching any stream flowing eastward, and at a distance of more than sixty miles from this place, to make twenty-five miles of southing, and from thence return in a direct line to this camp.

Your party will consist of five mounted men of the topographical party, and five infantry soldiers of the escort. You had better keep the mounted men scouring the country for a mile or two on each side of the route you pursue, that no chance of finding water be lost.

The quartermaster and commissary of the expedition will supply you with two light wagons, with eight mules each, and provisions for ten days, for the use of your party. Six water-kegs will be filled here and carried with the party, and I cannot too strongly impress upon you the necessity of economizing this supply of water. Two kegs will be amply sufficient to supply all the absolute necessities of the party for five days at least; and in case of being three days without water, or the failure of your mules for the want of it, the remaining four kegs can be distributed among them. The other precautions for preserving the strength and efficiency of your animals are as well known to you as myself.

Upon your return to this camp, you will please furnish me with a written report of your expedition.

I am, sir, respectfully, your obedient servant,

JNO. POPE,

Brevet Capt. T. E., commanding Exploring Expedition.

Capt. C. L. TAPLIN,

Assistant on Survey.

This day we (for the first time since starting) became aware of the vicinity of the Indians. About sundown we perceived the prairie on fire about two miles from camp, up the river—the wind blowing from the northeast, and directly towards us. As the grass and weeds were dry, and the wind strong, the flames rushed onward with great rapidity. Instant and prompt measures were taken against this appalling danger. The prairie was fired round the camp, from the river to the creek. We were thus in a triangle, the *Pecos* and *Delaware* being the sides—the belt of prairie we had burned, the base. There can be no doubt whatever that this was an act of the Indians, as we could clearly see the plain fired in many and different directions at the same time. The fire swept on round the camp, and crossing the creek some hundred yards above us, and seizing the dry grass on the right

bank, illuminated the whole plain during the night. Happily, our energetic proceedings defeated the designs of the Apaches. On the first intimation of danger, the animals and stock were driven into camp—the former tied to the wagons, the latter well guarded. It is intended to adopt this precaution every night while we remain here, and also to increase the guard over them while they are grazing in the daytime.

No observations made this night; the sky cloudy and hazy. They were taken for the time during the day.

Same Camp—Friday, March 10, 1854.—Lieut. Garrard, accompanied by a party of five mounted men, left camp at half-past 7 o'clock a. m., in pursuance of the following instructions:

CAMP AT FALLS OF RIO PECOS, MOUTH OF DELAWARE CREEK,
March 9, 1854.

SIR: You will please proceed from this place, by the route we have just traversed, to the spring in the cañon near the high peak of the Guadalupe mountains; and having descended to the valley of the Salt lakes, you will examine the western and southern faces of the low range of hills which extend to the south and east from the high point of the Guadalupe range. It is generally believed that a practicable and nearly level pass can be found to the head of Delaware creek by passing to the south of these hills; and should you be successful in finding such a pass, you will please return by it to this camp.

Should you prove unsuccessful in finding a pass better than the one at present in use, you will please examine the valley of the Salt lakes towards the southeast, to ascertain whether a good route cannot thus be found to the Pecos, which shall strike the river at a distance south of this point, not to exceed sixty miles.

You will please take, as accurately as possible, your compass courses and distances for the entire survey, both going and returning, and will note every peculiarity of country, (timber, grass, water, &c., &c.) When you arrive at a point from which you can see the peaks of the Alamos mountains, please take accurate bearings to them and to the high peak of the Guadalupe mountains. It is absolutely necessary that a compass course and estimated distance be observed for each marked change of direction; as without a continuous set of courses and distances it will be impossible to make a sketch of your route.

A party of five mounted men, with rations for six days, will be detailed to accompany you.

Upon your return to this camp, you will please furnish me with a written report of your expedition.

I am, sir, respectfully, your obedient servant,

JNO. POPE,

Brevet Capt. T. E., commanding Exploring Party.

Lieut. K. GARRARD, 1st Dragoons,

Assistant on Survey.

The prairie fires still continue to burn over the surrounding plain, but all fear of injury from them has disappeared. Neither have we had any further Indian demonstration. The command has abundance of fish to eat, and we have caught some weighing upwards of thirty pounds. We saw some turtle floating down the stream, but were unable to catch them.

The animals and stock were driven in at sunset; the former got some corn, and were tied to the wagons during the night, strongly guarded.

Observations for time taken this day, and at night for latitude and longitude.

Same Camp—Saturday, March 11, 1854.—Observations for time made in the forenoon; heavens clouded up at night.

Same Camp—Sunday, March 12, 1854.—Heavens clouded during the day and night.

Same Camp—Monday, March 13, 1854.—Heavens clouded during the day and night.

Same Camp—Tuesday, March 14, 1854.—Heavens clouded in the forenoon and afternoon. Observations for longitude and latitude taken at night. Lieutenant Garrard and party arrived in camp at 3 o'clock p. m.

Same Camp—Wednesday, March 15, 1854.—Lieutenant Marshall, with seven men, rationed for four days, proceeded up the Pecos with instructions to examine it as far as the Sacramento river, which is supposed to be within two days' travel of this point. The main object of this expedition is to ascertain the correctness of the report that there is an abundance of large timber of all descriptions on the banks of the Sacramento, and also (if such is the fact) to ascertain, if it be possible, to raft this timber down to the Pecos. Lieutenant Garrard, according to instructions, presented a report of his expedition, of which the following is a copy:

CAMP ON FALLS OF RIO PECOS, MOUTH OF DELAWARE CREEK,
March 15, 1854.

CAPTAIN: In obedience to instructions conveyed to me in your letter of the 9th instant, on the morning of the 10th I left this camp at 8 o'clock a. m., and reached the spring in the cañon near the high peak of the Guadalupe mountains, at 10½ a. m. the following morning, a distance of about sixty miles. Leaving the spring at 11 a. m., I proceeded in a direction east of south along the base of the western slope of the Guadalupe mountains, and encamped about eighteen miles from the spring. During the whole distance the mountain range presented a rocky and almost perpendicular side, intersected now and then by cañons opening into the plain, which proved, on examination, to narrow as you ascended them; terminating in steep ravines, and practicable only for horse or mule trails, being used as such by the Indians.

On the morning of the 12th instant I left camp at 6 o'clock a. m., and, continuing on the same course I travelled yesterday, I crossed over a ridge near where this range of mountains appears from the road to

terminate; and descending again into the valley of the Salt Plain, I found that what has been considered the terminus of the Guadalupe mountains is merely a spur running out from the main range in a south-westerly direction into the Salt Plain; the main range itself continuing uninterruptedly in the same course as it has north of the spur for many miles. I proceeded on for about fifteen miles on a southeast course, and found the mountains became higher and more rugged as I advanced along their base, retaining this character for about thirty miles to the south, where they appeared to terminate against the northeastern slopes of a range of mountains which extends from the northwest across their course. Being now more than a day without water, and having travelled over a hundred miles from our camp at the mouth of Delaware creek, and the object of the expedition having been accomplished, I at this point turned back, and following my trail for about ten miles, bore off northeast across the mountains, direct for Delaware springs. Ascending cañons, and leading our animals up the almost perpendicular sides of the mountains, I encamped towards evening near three beautiful natural tanks of water, which I discovered by following an Indian trail.

The next morning, (March 13th,) starting a few moments before 6, and crossing the dividing ridge of the Delaware valley and the Salt Plain, I followed, in a northeast direction for about fifteen miles, a ravine which afterwards became a cañon; then bearing more to the north, and crossing a succession of low hills, I struck the road near the head springs of Delaware creek, and encamped at the springs at 2½ o'clock p. m.

In conclusion, I have to report that there is not, within forty miles of the high peak of the Guadalupe mountains, a pass through them more practicable than the one which the road now traverses; that which appears from the road to be the terminus of these mountains, and has been generally considered as such, is a spur running out into the Salt Plain, the main range itself continuing without interruption for seventy or eighty miles east of south from the high peak, becoming more impracticable as you proceed to the southward; that the chain of Salt lakes which lie along the western base of the Guadalupe mountains, and which have been supposed to have their outlet into the Pecos around the southern and eastern bases of the range of bluffs extending south and east from the high peak of the Guadalupe range, have no such outlet.

I found grama-grass of good quality in great abundance along the entire route both going and returning, and water in the following places, viz: in natural tanks about thirty-five miles southwest from the head springs of Delaware creek, and about twenty miles east of south from the high peak of Guadalupe mountains; and again in water-holes for three miles along the course of a ravine in a direction north, and about five miles from the tanks. The water in all these places was rain-water, collected in natural cisterns; but from their appearance, and the quantity of water in them, it is likely it can be found there at all seasons of the year. These points are no doubt the habitual resorts of the Apache Indians, as there were numerous well-beaten trails leading to them from all directions, signs of frequent encampments in the neigh-

borhood, and figures drawn by the Indians upon the rocks, sketches of which are to be found in my note-book. We saw also at the tanks fresh tracks of a party of Indians who had evidently passed only a few hours before us.

There was no large timber of any kind along the routes, but in many places along the ridges there is a considerable growth of scrub-pine and cedar.

I transmit herewith a sketch of the route pursued by the party.

I am, Captain, respectfully, your obedient servant,

KENNER GARRARD,

Lieutenant First Dragoons, Assistant on Survey.

Brevet Captain J. POPE,

Top. Engineers, commanding Exploring Party.

Observations for the time made during the day. The heavens cloudy at night. The mules and stock driven across the creek, and allowed to graze during the night; they, as usual, were hobbled, and placed under a strong guard. This course was adopted for the purpose of economizing the corn. It is not anticipated that any injurious result will follow from this arrangement, (during our stay here,) as every precaution that prudence can dictate is taken to prevent surprise.

Observations for the time made during the day. The heavens cloudy during the night.

Same Camp—Thursday, March 16, 1854.—The following is a copy of Lieutenant Marshall's instructions:

FALLS OF THE PECOS RIVER, MOUTH OF DELAWARE CREEK,

March 14, 1854.

SIR: You will please proceed to examine the Pecos river as high up as the Sacramento, provided that point be not more than seventy miles distant from this place. It is reported in New Mexico, by those who profess to know, that the valley of the Sacramento river is abundantly supplied with large timber of every description, and you will investigate the truth of these statements. Should such prove to be the fact, you will please examine the Pecos carefully from the mouth of the Sacramento to this point, with a view to ascertain if the timber can be conveniently floated or rafted down that stream. You will also note every peculiarity of country along your routes as to timber, grass, water, &c., &c., and will keep a set of accurate compass courses, and estimated distances for the entire expedition. A party of seven mounted men, with rations for four days, will be detailed to accompany you. Upon your return to this camp, you will please furnish me with a written report of your expedition.

I am, sir, respectfully, your obedient servant,

JOHN POPE,

Brevet Captain Top Engs., commanding Ex. Party.

Lieut. L. H. MARSHALL, 3d Infantry,

Commanding Escort.

Lieutenant Marshall and party returned to camp at sundown. (For his report see Friday, 17th instant.) The weather for the last few days has been intensely warm—this day particularly so, the mercury rising to 97° Far. in the shade. Many of the men have bathed in the creek; the temperature of the water pleasant and refreshing. The young grass is springing up on the ground that was fired a few nights ago. The prairie still continues to burn; the light can be seen at a distance of 45 miles from camp, near the Sacramento river. The mules and stock, (the former hobbled) under a strong guard, grazed during the night. The animals which returned with Lieutenant Marshall were the only ones fed with corn.

Although the water of the Pecos is somewhat salty, and that of the Delaware creek considerably impregnated (from the springs above) with sulphur, yet the use of it has not been followed by any injurious consequences to the health, of a serious character. Some few of the party have been attacked, but not seriously, with diarrhœa, which disappeared in two or three days on applying simple remedies. It is observed that the animals prefer the sulphurous water.

Lieutenant Garrard made some surveys in the vicinity of camp, which will be duly noticed. We have added largely to our collection in natural history, &c. All repairs to wagons, harness, &c., are being made; indeed all hands are usefully employed. Observations for the time made during the day, and at night for latitude and longitude.

Same Camp—Friday, March 17, 1854.—Lieutenant Marshall presented the following report, in compliance with the concluding paragraph of instructions dated 14th instant:

CAMP NEAR FALLS OF PECOS,

March 17, 1854.

CAPTAIN: In obedience to instructions received from you on the 14th instant, I have the honor to report the result of the expedition under my charge.

I left camp on the morning of the 15th instant at 9 o'clock, and travelled in a northeast direction, for the greater part of the time along the right or west bank of the river, until 6 o'clock p. m., when I camped, having marched thirty-seven miles. About three miles from camp I met a party of Apache Indians, under their head chief, Negrite, who had a paper from the commanding officer of Fort Fillmore, giving him a good character; * * * * *. They approached me with a white flag, and said they were good Apaches, who wished to be at peace with the whites; they informed me that the Sacramento was near.

The country over which I passed was a rolling prairie, similar in all respects to that traversed between the head of Delaware creek and the Pecos. The soil, a mixture of clay and decomposed gypsum, evidently rests on a bed of limestone and a conglomerate of limestone and clay, which outcrops at several points along the river. On the left or east bank of the river is the broad plain of Llano Estacado, which evidently has for its basis the same conglomerate rock mentioned above.

On the morning of the 16th I left camp at 6 o'clock, and travel-

led for about a mile along the bank of the Pecos—passing through a grove of young ash-trees, the first and only timber I have seen on the river. I then ascended to the plain, and at the distance of half a mile came suddenly upon a stream, which I concluded to be the Sacramento. This river is about fifty feet wide, and six feet deep at the mouth—a slight bar forming on the right bank; the bottom is gravelly and hard; in some few places there are quicksands. The river varies from two to fifty feet in width, and in depth from one to fifteen feet. Its course is in some places zigzag, and there are three or four hackberry trees on the right bank, near its mouth. The water is clear and good, having a slight metallic taste. There is plenty of cat-fish and suckers of a large size near the mouth of the river. Trout can be caught higher up the stream.

I went up this river five and a half miles due west; it then turned to the northeast. At the bend of the river I found an Indian town, consisting of five or six wigwams.

I now determined to retrace my steps—not having found timber, nor seeing any probability of finding it within a few miles. I went back along the bank of the river to a point half a mile east of the bend, and crossing the river, there I rode over an ascending plain directly north of the ford until I reached a round mound, about three miles from the ford, from the top of which I could see the Guadalupe range sink into the valley of the Pecos. I could also perceive the Sacramento enter the chain of high hills which rises out of the plain about ten miles on the south side of, and continue until it connected with the Guadalupe range; also the depression in the Guadalupe chain, through which I supposed the Sacramento must pass. The country on the right bank of the river is of precisely the same nature as that described above. On the left the soil is a red clay, resting upon a stratum of gypsum. I passed some caverns on my way to and from the hill. There are several falls in the Sacramento—one of them a fall of six feet.

In the Pecos there are six or eight rapids; I refer you, for their locality, to the accompanying sketch of the route. I made a collection of such minerals and flowers as I thought would exhibit the character of the country. I reached camp at sundown.

In conclusion, as far as I could see from the hill before mentioned, the timber (if there be any on the Sacramento) must be north of the Guadalupe chain; and, in my opinion, it would be impossible to float even a small log down the Sacramento, although a very large one could be very easily rafted down the Pecos.

I have the honor to be, respectfully, your obedient servant,
 L. H. MARSHALL,
Second Lieutenant Third Infantry.

Brevet Captain JOHN POPE,
Commanding Exploring Party.

Lieutenant Marshall further reported having seen a considerable quantity of deer, antelope, and partridges along the route.

A stone monument was erected on the summit of a hill on the right bank of the Delaware creek, for reference on the survey across the Llano Estacado.

The mules and stock grazed during the day and night, under a strong guard, on the south side of the creek.

No observations taken this day; the heavens cloudy at night.

Same Camp—Saturday, March 18, 1854.—Some surveys made to find the levels of the river; the result is a fall of three feet one inch in three hundred feet. The mules and stock grazed as usual; were brought in at sunset, fed with corn, and then turned out to graze during the night.

The principal wagonmaster, (Mitchell,) accompanied by a Mexican, came into camp, with a letter from Captain Taplin. As this letter gives a mere outline of his expedition, it is not copied in this place. (The full report of this expedition is given at page 96 of this journal.) The following is a general statement of the route of the party over the "Llano Estacado," as given by the wagonmaster. He says: "For about eighteen miles after leaving our camp the road is good. At this point it becomes heavy sand, which continues the whole way across the Staked Plain until about the same distance from water on the opposite side. The intermediate plain is entirely destitute of water. The party accomplished the distance (say one hundred and forty-two miles) from water to water in five days. In consequence of the exhausted condition of the animals, the wagons were abandoned on the fourth day, about forty miles from water. After reaching the springs (which Captain Taplin supposed to be one of the sources of the Colorado) the mules were rested a day and a half, but were too much broken down to justify Captain Taplin in attempting to rejoin the command. He therefore sent wagonmaster Mitchell to report the fact, and his intention of attempting to rejoin us by the emigrant trail. Mitchell brought a Mexican and three mules, one packed. Two kegs of water were carried along, half a keg of which was left at the wagons for the use of those persons who would come for them. He (Mitchell) left Captain Taplin on the 16th instant at 3 o'clock a. m., travelled until 4½ o'clock p. m.; camped and started on the 17th at 4 o'clock a. m., travelled until 4 o'clock p. m., resting during that time for half an hour, then proceeded until 8 o'clock p. m.; camped, and started on the 18th at 3 o'clock a. m., travelled until 10 o'clock a. m., resting an hour, then proceeded to camp on Pecos, reaching it at sundown: thus making the whole distance (one hundred and forty-two miles) in forty hours' travelling. There is game, grass, and wood in abundance on these plains, but not the slightest trace of water."

The total impracticability of crossing the "Llano" with our wagons being now obvious, and the command so much divided, it was decided to move down the east side of the Pecos to intersect the emigrant trail and meet Captain Taplin. Immediate preparations were made for this movement.

Camp 19—Sunday, March 19, 1854.—Left camp at daylight and crossed the river. As the banks had been cut down to facilitate the crossing of the wagons, they passed over without any accident, with the exception of one, which had its hounds broken, the repairing of which occasioned some delay. The bottom of the river at this point is rocky, and no difficulty whatever is presented if proper care is taken.

About half our route to-day was over a rolling prairie, which was easy to travel; the remainder was level. The road was good, being composed of sand and gravel. For the second time during the expedition we had a slight fall of rain, which commenced before we left camp and continued until noon, when it cleared up, the weather becoming excessively hot.

At four miles from camp we came upon a deep-red soil, (sandy,) which continued until we struck the level plains.

The greater portion of the soil passed over to-day is capable of extensive culture; it can be irrigated from the river. Along our route there was a considerable quantity of mezquite root and brush mezquite; also the grama-grass was good and abundant.

Reached our camp on the "Rio Pecos" at 3 o'clock p. m. The banks of the river are here steep and precipitous, rendering it impossible to water animals at it without cutting them down. This was done with a little labor. We had an abundance of mezquite root; the grass was good and plentiful. Immediately on our arrival in camp the animals were watered and turned out to graze, the mules being hobbled, as usual. At sundown they were brought in, fed with corn, and turned out for the night, strongly guarded.

No observations taken; heavens cloudy during the day and night; general direction, south 40° east; miles, $12\frac{4}{5}$.

Camp No. 20—Monday, March 20, 1854.—Left last camp at 7 o'clock a. m. With the exception of a short distance of rolling prairie, our route to-day was over a level and rich bottom, which widens as we descend the river. This valley can be easily irrigated, and would, no doubt, amply repay the outlay and labor. The grass in the bottom is not so good as it has been; it is only tolerable prairie-grass; but on the bluffs the buffalo-grass and grama-grass are excellent. The underground and bush mezquite is abundant. On one of the bluffs, composed of a deep-red sandstone, we found the sulphuret of lead rich in silver.

We camped at 4 o'clock p. m. near a sloping bank of the river, where the animals could be watered without the use of buckets. It is to be observed that the banks of the river are so steep that animals must, speaking generally, be watered by hand. At this camp we for the first time met with an accident. One of the mules, getting into deep water and quicksand, was drowned. The current was so swift and strong that it was impossible to save the animal. The mules and stock, having been watered, were fed with corn, afterwards hobbled, and turned out to graze during the night, strongly guarded. Mezquite and brush plenty; grass (prairie) only tolerable.

During the day we saw several Indian trails, which had been travelled very recently.

No observations taken; heavens cloudy during the day and at night. General direction, south 35° east; miles, $19\frac{6}{10}$.

Camp No. 21—Tuesday, March 21, 1854.—Left camp at half-past 6 o'clock a. m. Our route during this day's march was over a slightly rolling prairie. We saw an abundance of underground mezquite. The grass has changed from grama to prairie grass of an inferior quality. As on the previous day, we found excellent buffalo-grass on the bluffs. The flowers, before so profuse, have entirely disappeared in the valley;

they, however, grew abundantly on the bluffs and high gravelly ground. The soil to-day was good, and can be cultivated by irrigation from the river. The bluffs gradually recede as we proceed down the river. The last one we saw before reaching camp is about three miles from it. We saw several Indian trails, which became more defined as we approached camp, which we reached at twenty minutes after 2 o'clock p. m. This camp is evidently a favorite resort of the Indians, as the deep trails leading to it sufficiently prove. Animals can be watered here with great facility, as the bank slopes gently down to the water. The mezquite root is not very plenty in the *immediate* vicinity of camp, We, however, found enough of it and brush to answer all purposes. The prairie-grass is tolerable.

On one of the bluffs (above mentioned) a gold-bearing quartz was found.

From evidences brought under our notice to-day and yesterday, there can be no doubt that this section of country is rich in the precious metal. It remains for our more fortunate successors to reap the benefit of this opinion.

We are now, it is believed, about twelve miles above "Marcy's crossing."

The animals and stock were watered and turned out to graze—the former hobbled.

As we are now in a dangerous country, the following precaution is taken against surprise: Six of the best animals are kept in the corral, so that, in the event of a *stampede*, they can be made available to recover the other animals. For the future, except under peculiar circumstances, the riding-mules will not be fed with corn.

No observations taken during the day or at night. General direction, south 80° east; miles, 17 $\frac{2}{10}$.

Camp No. 22—Wednesday, March 22, 1854.—Left last camp at half-past 6 o'clock a. m. Our route for about six miles was over a tolerably good prairie, the soil being good—sand, mixed with gravel. It then changed to a yellow, soft sand, covered thickly with chaparral. The ground is much cut up by mole and prairie-dog holes, which render the travelling fatiguing to the animals, as they are constantly sinking into them.

We could distinguish an immense salt lake in our front for many miles before we arrived at it, in which there appeared to be a large body of water. However, on crossing it, we found it perfectly dry. It is upwards of two and three-quarter miles across, and is covered over with a salty efflorescence. As the sun shone fiercely upon its dazzling surface, the effect upon our eyes was most painful. On digging, the soil became moist. At the depth of two and a half feet we came to water, the taste of which was intolerable.

We had here an interesting instance of the powers of refraction. As the mounted party arrived at the lake before the wagons, the men behind supposed we were standing in water. When they reached the lake, they also appeared to be wading through water. We saw some antelopes here, but did not succeed in killing any; they were shy.

On leaving the lake, we proceeded to the river over a soft and heavy red sand. It was very bad travelling for the wagons. The grass be-

came scanty and bad. We reached camp at ten minutes after 4 o'clock p. m. The most convenient place was selected for watering the animals, yet we had to use buckets—it being dangerous to allow them to drink from the bank, which was steep and miry. Mezquite-root scarce in the neighborhood of camp. We found some drift-wood on the banks of the river. The grass being of an inferior quality, the mules were fed with corn, hobbled, and grazed during the night, under a strong guard.

Until the last two or three miles, the mezquite and grass were abundant. Altogether, the country to-day was far inferior to that we have traversed for some time past.

No observations taken during the day; the night cloudy, with a slight rain. General direction, south 50° east; miles, $20\frac{4}{10}$.

Camp No. 23—Thursday, March 23, 1854.—Left last camp at twenty minutes to 7 o'clock. At a short distance from it we found a long stake driven firmly in the ground on the bank of the river, evidently intended as a mark or guide, but by what party put there we could not ascertain. We now struck a wagon-trail, which we supposed to be Marcy's. However, on following it up for some miles, it terminated abruptly. After considerable search for it, without success, the command halted and turned back, and, at a mile and a half distant, encamped near the river. Two parties were sent out to hunt up the trails; one of them struck it about three miles from where we halted.

Our road to-day was good; the soil gravelly, and mixed with sand. The bluffs approach nearly to the river's edge. Indeed, at one point the road was barely broad enough to permit a wagon to pass along the stream. This portion of our route was thickly covered with gypsum and shells; the former in larger masses than we had yet seen. Selenite was also abundant. On cutting off a piece of it with a penknife, it was found to be as clear and transparent as glass. Indeed, the poorer classes of the Mexicans, and all the pueblos in New Mexico, use selenite of a much inferior quality as a substitute for this necessary article.

The soil to-day consisted of a firm red sand, mingled with clay; the bluffs are red sand. The grass assumed a completely different hue, becoming quite green; the effect was pleasing to the eye. There was prairie-grass in the bottom, grama and buffalo on the bluffs—all excellent and abundant. We reached camp at 11 o'clock a. m., on the bank of the river. The animals and stock were driven about a mile from camp to an old camping-place, where they could be watered without using buckets. On their return the mules were hobbled and turned out to graze; the wagon mules, and those retained in camp for the purpose already mentioned, only fed with corn. Animals grazed at night, guarded as usual. Mezquite-root and brush plenty along our whole route to-day.

For the last few days the rattlesnakes are becoming numerous. The weather is oppressively sultry, the thermometer ranging from 84° to 88° in the shade.

Our botanical collection is increasing, every day disclosing some new and beautiful varieties of flowers.

It is deeply to be regretted that our limited means of transportation

does not permit us to increase our geological and mineralogical collection to the extent we desire; as the country affords us abundant opportunities of extending our researches in these valuable branches of science. We continue to be fortunate in our collection of natural history. Observations for the time taken in the afternoon. Heavens cloudy at night, with a slight rain. General direction, north 82° east; miles, $7\frac{2}{10}$.

Camp No. 24.—Friday, March 24, 1854.—Left last camp at twenty minutes past 6 o'clock a. m., and moved in the direction of the trail discovered yesterday. We struck the road at the "Emigrant Crossing," about 9 o'clock a. m., distance from camp upwards of four miles: This is an extremely bad crossing; our oxen swam for upwards of thirty feet to the opposite bank. It would be utterly impossible for wagons to cross without rafting. It cannot for a moment compare with the "Crossing of the Pecos," (mouth of Delaware creek,) the former presenting many difficulties—soft bottom, deep stream, and on the east side miry banks. The latter affords many facilities, and is strongly recommended to emigrants. We halted here to water, which had to be done with buckets. As we will not reach water until we strike the "Sand Hills," our kegs were filled. We are now upon the long-desired trail.

Our route was over a rolling prairie; the soil is gravel, mixed with clay. Grama-grass good and abundant. On both sides of the road there was plenty of mezquite-root and brush:

We reached camp at half-past 3 o'clock p. m. No water. Mules and stock turned out to graze. The arrangement of the previous night continued.

Observations for the time taken during the afternoon; also, for the latitude at night. The latter had to be discontinued, as the heavens suddenly clouded up, with every indication of a coming storm.

During the day we espied a mule grazing at some distance to the right of the road. We approached him, but he evinced an evident dislike to our further acquaintance, taking to his heels in gallant style, affording quite a hunt to the mounted party, which he certainly "distanced." However, we accomplished by stratagem what we failed to do by speed. After some difficulty he was driven into the herd and "lariat" by the Mexicans. He was at once put in harness, and worked well, taking this sudden change in his condition most philosophically. On examination we found him branded with the "U. S." mark. Being in good order, the animal was a valuable accession to our teams. General direction, north 16° east from river; miles, $19\frac{8}{10}$.

Camp No. 25.—Saturday, March 25, 1854.—Left last camp at twenty minutes after 6 o'clock a. m., and moved in the direction of the "Sand Hills." Our route to-day, for nine miles, was over a level prairie; the road for this distance was excellent. Before reaching the "Hills" we had nearly seven miles of bad sandy road. We could perceive them at a distance of twelve miles, stretching away as far as the eye could reach. For two miles, before camping we passed round their western base. We arrived in camp at twenty minutes after two o'clock p. m.

These "Hills" present a curious and interesting geological formation. They extend about fifty miles from north to south, and fifteen miles east to west. They consist of white drift-sand, thrown up into innumerable

conical mounds, totally destitute of all vegetation. One would suppose that this region of sand is the last place where water could be found; yet, however incredible it appears, there is an abundance of water in these hills, contained in basins of the finest sand. When amongst the "Hills," one would suppose there had been a heavy fall of snow. Our camp was about a quarter of a mile from the water. The animals were driven up to water, sinking to their knees in the sand. The team-mules were fed with corn; six animals picketed in camp for the purpose previously mentioned.

The soil for ten miles from the Pecos was good, with plenty of prairie-grass and mezquite-root. As we near the "Hills," these become scarce. At camp we had some brush. The grass was very poor and scanty.

The weather changed suddenly to cold, with a high wind. A slight rain fell during the night.

Our camp is thirty-one and two-tenths miles from the "Emigrant Crossing" of the Rio Pecos. No observations taken during the day. Heavens cloudy at night. General direction, north $7^{\circ} 30'$ east; miles, $16\frac{4}{10}$.

Camp No. 26.—Sunday, March 26, 1854.—Left camp twenty minutes to 7 o'clock a. m., and proceeded in the direction of the next watering-place in the "Sand Hills," five miles distant from camp. There is a well-marked trail here leading to the water, which can be obtained, however, at any point in the "Hills," by driving the animals about half a mile from the road. The mules and stock were watered and turned loose to graze some time. We passed from last camp from northeast to southwest in arriving at this point, over a deep sandy road, which was very trying to the animals. From the great quantity of fragments of abandoned wagons, this place has been evidently a general camping-ground.

Having halted about an hour and a half, the command started. The remainder of our route for this day was over a fine and deep sand; we encountered many steep hills of the same nature. There could not, indeed, be a worse road, as was sufficiently evident from the exhausted condition of our animals. We fortunately overcame all the difficulties of this miserable road without doubling teams or meeting with any accident. As we did not expect to reach water until the following day, all the casks were filled at the above halting-place. The grass is poor and scarce; there is no wood, although we found enough of brush and weeds for cooking. In short, there is no vegetation on this arid and sandy plain.

We reached camp, after a laborious and fatiguing march, at $3\frac{1}{2}$ o'clock p. m., and camped without water. The same arrangement as last night respecting the mules.

The weather continues cold; had it been as hot to-day as it has been for some time past, it is doubtful if we could have succeeded so well.

A party under assistant wagonmaster Baylor was sent out at daylight to go ahead and find water. By some inconceivable mistake they took the trail (at which we watered,) instead of the road; and having wandered about for a number of hours, completely bewildered, they accidentally came upon our track.

No observations taken during the day or at night. General direction

for five miles to watering-place, northeast to southwest; remainder of the day, north 20° east; miles, $12\frac{6}{10}$.

Camp No. 27—Monday, March 27, 1854.—Left last camp at twenty-five minutes after 6 o'clock a. m. For about five miles we encountered the same deep sand we had yesterday. The remaining portion of our route to-day was over a good gravelly road. Lieut. Marshall and four of the party left the command early in the morning to find water. He met us near our camping-place in the evening, having gone thirty miles without discovering any. The grass along our route is tolerably good; the mezquite-root is not so abundant as it was before we struck the "Sand Hills." We reached camp ten minutes after 5 o'clock p. m. No water; grass (prairie) tolerable; the mezquite-root requires some trouble to collect. We had sufficient water in kegs for cooking purposes, but it was used with economy, as we do not know if we will strike water to-morrow. We saw a large number of antelopes to-day; but they were so shy, we did not succeed in killing any of them.

The soil, after leaving the sand, was composed of a fine sand mixed with clay; decomposed gypsum was lying pretty thick in some places. The day was not so hot as usual—a fortunate matter for the animals, which, as yet, do not exhibit any particular sign of wanting water; they were halted at 10 o'clock a. m., and allowed to graze for a short time.

The arrangement of the preceding night in respect to the mules is continued.

Observations for the time taken in the forenoon; afternoon and night cloudy. General direction, north 50° east; miles, $18\frac{9}{10}$.

Camp No. 28—Tuesday, March 28, 1854.—Left last camp at 7 o'clock a. m. From various accounts, we anticipated meeting with water to-day in more than one pool on our route. In these hopes we were sadly disappointed. Parties were sent out in every direction to look for it, and our anxiety was increased as each of them returned with an unsuccessful report. The animals were now showing symptoms of wanting it. The heavy dews of the last two nights have, in some slight measure, relieved their thirst, and this, together with the fact that the days have been cool, has enabled us to travel the frightful road we have traversed since Sunday last.

Every gully and pond, where water was likely to be found, were visited, but in vain. Our only alternative to prevent the loss of our animals was to push on briskly for the "Mustang springs." We halted once during the day to rest our animals, and then proceeded at a steady pace. The grass was good until within six miles of our camping-place, when it changed, becoming poor and full of weeds.

We saw a number of antelope and deer to-day; one of the party shot two deer. On a ridge near camp we perceived a mustang, the only one we had yet met with.

The soil is much the same as yesterday; our road is an excellent one.

Reached camp at half-past 5 o'clock a. m. No water, the animals evincing signs of fatigue, having been two days and nights without water; grass very poor; mezquite and brush plenty.

There was not sufficient water left in the kegs for cooking, through the injudicious conduct of some of the command in drinking it during

the day. The matter was investigated and some of the party punished, to prevent a repetition of so serious an offence. Our good spirits do not, however, fail us, as we hope to strike water to-morrow about 10 a. m. Same arrangement as usual with regard to the animals.

No observations taken; day cloudy; it blew hard at night. General direction, north, 52° east; miles, $25\frac{8}{16}$.

Camp No. 29—Wednesday, March 29, 1854.—Left last camp at 6 o'clock a. m., and moved for the Mustang springs, over a rolling prairie. About three miles from camp we met Captain Taplin and party, all well and in good spirits. His report, and a detailed account of his proceedings, will be given in the subsequent pages. We arrived at the Mustang springs at half-past 10 o'clock a. m. Last night all our sheep (thirty-two in number) were stampeded by the wolves, and our exertions for their recovery were in vain. This is deemed an appropriate place to take a retrospective glance at our road for the last few days.

From the point where we first struck the Sand Hills, we proceeded along their western base and crossed the main ridge of sand at the lowest apparent point. At five miles across, we came to the last known watering-place to the eastward. In this direction we passed over many ridges of deep sand, separated by valleys of the same character. They are in reality impassable for heavy-laden wagons. From the above point to the hard prairie east of the Sand Hills, a distance of thirteen miles, we continued to cross deep sandy ridges, with intervening bottoms of a similar description, totally destitute of vegetation. From the Pecos river to the level prairie east of the Sand Hills, the road passes through about thirty miles of the heaviest sand. It is the worst road to be found in New Mexico, on the Rio Grande, or, indeed, anywhere else. It cannot be too strongly urged upon emigrant parties never to attempt travelling by this route, except in the rainy season, from August to the middle of October, as the distance without water from the Sand Hills to the first permanent water to the eastward, is sixty-seven miles, thirteen of which (immediately to the eastward of the hills) are through sand so deep and heavy as to be absolutely impassable for heavy laden teams. With animals perfectly fresh, and lightly loaded wagons, it requires all our exertions to overcome the difficulties of this dreadful road. It is also to be observed that our animals were in fine order, with eight and ten mules to each wagon.

The Mustang springs form several lakes or large pools, which are highly saline; the one on which we camped, the most easterly, is less salty than the others, and is by far the best for use. It is slightly sulphurous, but not very unpalatable. There are some holes dug around, in which the water is somewhat better than in the bottom. These lakes are about three miles in length, and run north 20° west, and south 20° east. They are enclosed by gentle eminences, on which the grass is better than in the bottom.

We met a party of Kiowas, who had a large number of horses and ponies, and were returning with them to their own country from Mexico. It is needless to say these animals had been stolen. The chief met us near our halting-place, and showed a friendly spirit. The

Indians encamped at a short distance from us. With the exception of a few words with the chief, no further intercourse was held with them. They did come into our camp, but departed hastily towards the north.

The soil during this day's march is generally good clay, mingled with sand, with occasional gravelly places. The hills at the "Springs" are formed of decomposed limestone. There was no growth of wood or even brush along our route. The mezquite root is plenty, but difficult to get at. The grass is improving.

The animals were watered and driven up on the hills to graze. They were all fed with corn, and herded, under a strong guard, during the night, except six mules, which were picketed in camp, to be used in case of emergency.

Observations for the time taken during the day, and for the latitude at night. General directions, north 52° east; miles, 13.

Camp No. 30—Thursday, March 30, 1854.—Left last camp at 10½ o'clock a. m. Our route was over a rolling prairie; the road excellent. The animals, being now recruited, looked and travelled well. As we do not expect to reach water this evening, our kegs were filled, and the animals all watered before we started. On our whole route to-day we did not see any wood; the mezquite-root is plenty, but more difficult to obtain than usual. As we proceed, the grass improves. To the right of the road the plain was covered with young green grass, which the animals ate with great avidity. This green grass is the result of firing the prairie, which is done by the Indians on the grounds they most frequent. Occasionally the grass is fired accidentally; a fresh and excellent crop replacing the dry grass.

We reached camp at 15 minutes past 2 o'clock p. m. We found good grass and mezquite-trees in considerable quantities.

The same arrangement in respect to the animals as on the previous evening.

No observations taken in the day; the wind blew a perfect gale at night from the north.

The soil during this day's march was a good clay and sand; we met with several places covered with decomposed limestone. This land could, no doubt, be cultivated successfully if there was either natural or artificial irrigation. Stock to an incredible extent could be raised on these plains near the watering-places. This result will perhaps be accomplished at a future day.

Camp No. 31—Friday, March 31, 1854.—Left last camp at five minutes to 7 o'clock a. m., and moved in the direction of the Big Springs, over a rolling prairie. About four miles from camp we descended into a fine valley, having a rich soil, covered with a fresh growth of grass. As we proceed the country assumes a different and more fertile appearance. On our route to-day there is a great quantity of mezquite, which becomes particularly abundant as we approach the "Springs." We reached our camp, Big Springs of Colorado, at 20 minutes after 12 o'clock p. m.

These springs are surrounded by immense masses of limestone rock, and are situated in a basin or reservoir of the same geological character, about 60 feet wide, and to all appearances about 30 feet deep. The water is excellent. On exploring the rocky eminences in the vicinity,

we found large quantities of shell of the muscle species imbedded in the rock.

We had everything here requisite for camping—water, wood, and grass in abundance. It is one of the best camps we have yet stopped at.

The animals were turned out to graze; they were not fed with corn, except the few retained in camp. Corn was not necessary, as the grass is good, and the mules in capital order.

Observations for the time taken in the day, and also at night for the latitude. General direction, north 52° east; miles, $10\frac{8}{10}$.

Camp No. 32—Saturday, April 1, 1854.—Left last camp at $9\frac{1}{2}$ o'clock a. m. Before starting all our kegs were filled, and the animals watered, as we do not expect to reach water this evening. Immediately on leaving camp we crossed the beaten road which we had traversed from the Rio Pecos, and moved in a southwest direction. We at first encountered a succession of ravines and gullies, composed of lime and sandstone; but from these we did not experience any difficulty. By following a ravine we came upon a fine hard bottom, over which the wagons travelled well. It is to be borne in mind that we are now making our own road. Along our route we perceived many salt lakes without water; they were, with one exception, on the left. To the right of the bottom there is a table-land, which extended the whole way for this day's march. The wagons did not ascend, as the valley is the best road for travelling.

The soil is clay and sand, with gravel at intervals. In the immediate vicinity of the Lagunas the surface is covered with a saline efflorescence; the grass also is tinged with salt.

We reached camp at ten minutes to 2 o'clock p. m., where we had plenty of wood and grass; no water.

The same arrangements as last night in respect to the mules.

No observations taken in the day or at night. General directions, south 70° west; miles, $10\frac{6}{10}$.

Camp No. 33—Sunday, April 2, 1854.—Left last camp at five minutes to 7 o'clock a. m., and moved in the direction of the Sulphur Springs of the Colorado, the first water reached by Captain Taplin's party; our road being over a hard and slightly rolling prairie.

The soil is a fine sand, gravelly in some places. The mezquite continues abundant. The grass is generally good, with some exceptions, when it becomes dry and weedy.

We have seen a considerable quantity of antelope, deer, and pheasants for the last few days; the former are so shy, it is difficult to get near them.

Reached camp—Sulphur Springs of the Colorado—at 3 o'clock p. m. In the neighborhood of the springs the mezquite root is scarce; but wagons can be sent about two miles from them where there is an abundance.

The usual arrangement respecting the mules continued.

No observations taken during the day or at night; general direction, north 70° west; miles, about 16.

CHAPTER XI.—*From the Sulphur Springs of the Colorado to the Clear fork of the Brazos.*

The following, which is the first portion of Captain Taplin's report of his exploration of the Llano Estacado, was received at the Pecos, March 18, 1854:

SULPHUR SPRINGS OF THE COLORADO,
March 15, 1854.

SIR: In obedience to your instructions, dated March 9, 1854, to examine the Llano Estacado from the falls of the Pecos river, mouth of Delaware creek, to the headwaters of the Colorado or Brazos river, I have the honor to submit the following report.

On Thursday, March 9th, I crossed the Pecos at 11 o'clock a. m., in a direction north 70° east. My command consisted of wagonmaster Mitchell, six of the topographical party, and five men of the infantry escort—in all, thirteen persons—having two light wagons, with eight mules each, rations for ten days, six kegs of water, and eight sacks of corn; the number of mules was twenty-two, six of the party being mounted. This day we made eighteen miles, and encamped at 7½ o'clock p. m.

About four miles from the Pecos we crossed a ravine with a grove of wild china trees upon it; some of these were twenty feet high. Our road was hard and gravelly, with the exception of the last three miles, which were sandy. This sand is red, and covered over with prairie-mole holes, into which the mules sunk above the fetlock every few steps. Along our route saw antelope, deer, and rabbits; there is an abundance of grass, dwarf mezquite, palmetto, and cactus. No signs of water.

Friday, March 11.—Left camp at 6 a. m.; our road continued sandy; mezquite-brush thick in some places. At half-past 12 p. m. we stopped twenty minutes to rest the mules. We then proceeded until 7 o'clock p. m., and encamped. An antelope and a rabbit were killed. The mules evinced signs of fatigue. No signs of water; distance this day, twenty-four miles.

Saturday, March 11.—Left camp at half-past 5 a. m. Having travelled about three miles, we struck a ravine leading to the south, in the bed of which were large boulders of sandstone; bluffs on each side. Two of the party were sent up and down this ravine to look for water, but without success; the wagons in the mean time continuing their course. From this point the face of the country changed to a hard and gravelly soil, with a rolling prairie, covered with grama-grass. Antelope, deer, rabbits, owls, crows, prairie-hens, and small birds, were quite numerous. At half-past 1 p. m. the animals received one gallon of water each, and rested for an hour and a half. We moved forward at half-past 3 p. m., and again struck the sand, which is red and covered over with a coarse bunch-grass about two feet in height, and patches of dwarf-oak about six inches high, loaded with acorns.

About 9 o'clock a. m. perceived a high bluff, bearing southeast, evidently fifteen or twenty miles distant, facing to the west, and sloping gradually to the east; it serves as a landmark for miles around. From the abundance of game, there is no doubt water in that direction. We had plenty of dwarf mezquite, wild china, and brush along our route to-day. The mounted men are kept on the flanks, riding at a considerable distance, looking for water. Encamped at half-past 7 p. m. on the plain. No sign of water. The weather is cool, with frost at night; a cold wind blowing from the north nearly all the time. A fallow deer was killed to-day. Distance, twenty-five miles.

Sunday, March 12.—Left camp at half-past 5 a. m., and resumed our course through the sand-hills. The mules are much fatigued by the innumerable mole-holes. Stopped at half-past 12 p. m., and gave the mules the remainder of the water, except three gallons reserved for the men. The country, as far as can be seen, is a perfect sea of tall, reddish grass, interspersed with hillocks of sand. The mules are very much jaded; the water we brought from the Pecos being somewhat saline, does not seem to benefit them. Encamped at half-past 6 p. m. We have made but twenty miles in twelve hours; no sign of water.

As the country ahead of us does not appear to improve, it was determined, for the safety of men and animals, to leave the wagons and push on, being uncertain how far it may be to water. An antelope killed to-day.

Monday, March 13.—The men were called at 3 a. m. to arrange their packs; the escort were mounted, blankets serving for saddles. They had one pack-mule to carry their rations. We took two along, leaving the corn in the wagons. Started at 4 a. m.; the road continued sandy for about six miles. At this point we struck a hard, firm prairie, and again found grama-grass. Proceeded until half-past 11 a. m., and rested the mules for twenty minutes. The country is more rolling, with basins which evidently contain water in the rainy season. At half-past 2 p. m. we came to a small pond of muddy water, where our mules had a little water each, but the men could not drink it. Saw fresh mustang signs and two mustangs. Encamped at 6 o'clock p. m., without any sign of water. As usual, some of the party kept on our flanks, on the lookout for water; plenty of mezquite-root for fuel.

Tuesday, March 14.—Camp stirring at half-past 3 a. m. We started at 4 a. m. Although our mules were counted at midnight, and found correct, yet, through the carelessness of the escort, (who were on guard,) two of the mules got loose and strayed off. Every precaution was taken against such a contingency; there was rope sufficient, and these men had been cautioned to be particular in picketing their animals. Our mules were suffering so much for water, we could not delay to hunt up these animals.

The country is becoming rolling. After travelling for six miles we came upon a high ridge, and saw to the north of our road a large ravine leading to the east; along its banks were stony bluffs. Still further to the northeast was another high ridge, having about the same course; to the southeast high hills, apparently twenty-five or thirty.

miles distant. The whole face of the country slopes to the eastward. We struck a fresh trail leading down to springs in the ravine, which we reached at 9 a. m. Some of these are highly tinged with sulphur and saltpetre—others perfectly fresh and pure. They issue out from under a bed of limestone rocks. These springs are no doubt one of the sources of the Colorado. About a hundred yards below the head spring there is a large pond, at which animals can be watered with great facility. There had been recently a large party of Indians at this place; it is their regular camp-ground. The scarcity of grass and fuel in the vicinity is thus accounted for. They can, however, be found in abundance at the distance of a couple of miles. We will remain here until night, when we will move out for grass. At 4 p. m. moved out one and a half mile to good grama-grass, keeping a good look-out for our mules.

Wednesday, March 15, 1854.—Last night was cloudy and warm; towards day-light a heavy dew fell. At 11 a. m. moved back to the springs, unpacked and watered our mules; we will remain here till evening. The animals are so much broken down, it would be impossible for them to return to the Pecos without resting for two or three weeks. Mitchell and a Mexican will be sent back on express to the Pecos; they will start early to-morrow morning, taking a pack, with as much water as they can carry. Mitchell thinks he will reach the river on the third day, which will be about the twelfth since we started. In a couple of days the whole party will return for the wagons, and bring them to this place. The corn (about five sacks) will be issued as rations to the party; as the grass is good, the animals will not feel the want of it. If the party remain together we shall be on Captain Marcy's trail, which is not more than twenty miles from this point. It will require all our exertions to get the almost empty wagons here, (from the weak condition of the mules;) the distance going and returning is eighty-eight miles. On our return the animals will remain here for rest. When we move, it will be for grass or game, and then slowly. With the corn and the game we shall get, we will not, it is to be hoped, be driven to extremities; if so, we shall kill a mule. Our animals will be recruited as much as possible. In the event of not hearing from you soon, you will meet us on Marcy's trail. All have behaved well, with the exception of losing the two mules; the particulars of which are given above.

In concluding this portion of my report, I beg to state, that I make the distance from the Pecos to these "Springs" one hundred and thirty miles. This I consider a low estimate. Throughout this whole distance there are no permanent watering-places. It is very doubtful whether water can be depended upon at any time, except immediately after heavy rains. This Llano presents many advantages for a railway; it would (an important consideration) require very little grading. I regret, exceedingly, that I cannot comply with your orders to return to the Pecos; the exhausted state of my mules rendering it utterly impossible for me to do so. I have, except in this unavoidable deviation from your wishes, endeavored to carry out the instructions conveyed to

me. I hope sincerely the course I have pursued will meet your approbation.

I am, sir, very respectfully, your obedient servant,
 CHAS. L. TAPLIN,
Assistant on Survey.

Captain JOHN POPE,
*Topographical Engineers, U. S. A.,
 commanding Exploring Party.*

The above received at camp, mouth of Delaware creek, March 18, 1854. For particulars of Mitchell's return across the Llano Estacado, see page 86. The following is the concluding portion of this report:

SULPHUR SPRINGS OF THE COLORADO,
April 2, 1854.

SIR: I have the honor to submit the continuation of my report from the 16th to the 29th ultimo:

Thursday, March 16.—This morning Mitchell and the Mexican started. My party now consists of ten men, with seventeen mules. At 11 a. m. went back to the springs and watered our mules; encamped there until 4 p. m., the mules again watered; filled our canteens and started for the wagons. We followed our own trail for six miles and camped for the night. This is a trail evidently used by the Indians, which we followed out, in hunting, ten miles; it no doubt leads to water.

Friday, March 17.—Started at 5 a. m., keeping our old trail. At 10 a. m. we discovered our two lost mules, about one mile south of the trail; they were soon caught. We reached the wagons at half-past 5 p. m., and found everything safe. Mitchell left a note stating that he arrived here last night at 5 p. m., and started on this morning; he left us half a keg of water. We have over four sacks of corn, which will be issued to the men as rations. Game wild; nothing killed but a prairie-chicken.

Saturday, March 18.—Started with the wagons at half-past 5 a. m. for the springs. The distance I estimate at forty-five miles. Game scarce; antelope and rabbit killed. Camped at 6 p. m. on prairie; saw a large band of mustangs.

Sunday, March 19.—Dark and cloudy, with thunder and lightning; every appearance of a storm. Could not see the trail until 6 a. m., when we started for the springs; which we reached at 10 a. m., and camped half a mile below several ponds, with water running between them. The day misty and rainy; an antelope killed.

Monday, March 20.—Cloudy, with misty rain all night. As yet we have no recent signs of Indians. We, however, keep a vigilant look-out; our mules well guarded. Started at 11 a. m., and followed the ravine down two miles and camped; grass good; scattering mezquite. Here the bed of the ravine widens, and forms a saline bottom of salty grass; the water, which is brackish, stands in holes.

Tuesday, March 21.—This morning it cleared off, the wind changing to the westward. At 11 a. m. moved up to the vicinity of the springs, as the water is brackish here. In expectation of a party from

the Pecos, we do not wish to move to any distance from this place for three or four days. Nothing killed; game wild and hard to get at.

Wednesday, March 22.—Watered the mules; filled our kegs and moved out to where there was good grass. One pint of corn issued to the men: this they boil or parch; it is ground in a coffee-mill. No game killed to-day.

Thursday, March 23.—At 11 a. m. moved to the springs. Since the 19th we have lived upon a pint of corn per day, with the game we have killed. The men behave well; no grumbling. Rain and thunder at 10 p. m.

Friday, March 24.—It being the tenth day since Mitchell left for the Pecos, all idea of a party coming across has been given up. We will start to-day for the road, keeping an east course from this place. The mules are well-rested and in good condition.

Travelled ten miles due west, and camped in a mezquite bottom; plenty of large, dry mezquite for fuel; no water. We passed two salt lakes to the south of our course; rolling prairie. The oak and mezquite are becoming larger; plenty of grass. Crossed the ravine about five miles below the springs; no water in the bed of it.

Saturday, March 25.—Morning cloudy; misty rain; wind north; not very cold. A high range of hills in sight, a little south of east, about fifteen miles distant. I altered my course towards, and struck, Marcy's trail about six miles from last camp. This trail runs nearly north and south; followed it for four miles to the south, and encamped between the hills or bluffs for the night. The water is in ponds; plenty of mezquite on the hills; large brush; wild china in the bed of the ravine; also plum and currant bushes.

Sunday and Monday, March 26 and 27.—We lay by in camp to rest the mules. It may be of importance to have them in good condition when we meet the command.

The Sulphur springs are about twenty miles distant from this point, in a northwest direction; we crossed the ravine leading from them at the base of the hills running off to the east, about two miles from this camp. There are large banks of red clay and dirt a short distance down the ravine. About half a mile above this point is the deep chasm spoken of by Captain Marcy, as the "Big springs of the Colorado." Near them are whole ledges of petrified oyster-shells; the rock is principally lime and sandstone. The spring is at least fifteen or twenty feet deep, and about twenty yards wide. Plenty of wild plum-trees in full bloom; the grass is springing up; trees budding. We have not lately come upon any Indian tracks. Two antelopes and one rabbit killed. Rattlesnakes begin to show themselves in great numbers. Heavy frost last night.

Tuesday, March 28.—Left camp at 8 a. m. for the Laguna, twenty-three miles distant. Passed over a rolling prairie. Saw several dry ponds in low places, where there is evidently water in the rainy season; also some large mezquite and hackberry.

I and Cloud (the hunter) being in advance of the wagons, saw, as we supposed, some mustangs, but on a nearer approach they proved to be Indians. We stopped until the wagons came up. All looked to their arms, and started to meet them. From the brush and breaks

in the hills, we knew it must be the Laguna at which the Indians were encamped. Upon coming to the top of the hill we saw them driving off their horses in a northwest direction. Two of the Indians came towards us. Their interpreter, a Mexican, who said he was taken captive when a boy, stated that they were a stealing party of Kioways, returning from Mexico with a large band of horses, colts, and mares. We saw but fifteen of this party. The interpreter said there was a larger one coming up to-night, principally on foot. As they were hungry, we gave them a few pints of corn.

Moved on to the Laguna. Having watered our animals and filled our kegs and canteens, we proceeded further, and encamped on the open prairie. The Indians fired the plain as they went off. This signal was immediately answered by a fire about three miles distant to the south.

In an hour we perceived the party spoken of by the Mexican. Some of them were driving their loose animals off towards the lake; but the principal part (twenty-three in number) came to us. There were three of them mounted, and these on miserable animals. One of the Indians rode ahead displaying an old white shirt, intended as a flag; it certainly was not a white flag. Our mules were tied to the wagons, the men standing to their arms. The Indians having been told not to come near the wagons, sat down in a circle and commenced begging, as usual. We gave them a little corn. They started for the lake, where their animals were driven. As soon as it was dark we geared up and moved about four miles, and encamped. The wagons were driven close together, the animals tied to them. Kept a good look-out.

Wednesday, March 29.—At day-light turned our mules out to graze; geared up at 8 a. m. and started on. At 10 p. m. perceived a party ahead of us, which proved to be the command. Three kegs of water which we had along were of great service to them. It gave me much pleasure to report the recovery of the missing mules.

I cannot conclude without bringing under your notice the excellent conduct of the men under my charge. It was highly praiseworthy; each man aiming to assist and aid his comrade. All bore the hardships which we unavoidably encountered with cheerfulness and good temper.

It now only remains for me to reiterate my hopes that the course I have pursued, in the execution of your orders, will receive your approval.

I am, sir, very respectfully,

CHAS. L. TAPLIN,

Assistant on Survey.

Captain JNO. POPE,

Top. Eng. U. S. A., commanding Exp. Party.

Same Camp—Monday, April 3, 1854.—The following is a topographical outline of the country from the Mustang springs to the present camp. For about eight miles after leaving the Mustang springs, we continued to travel a road of the same character as we had previously; at this distance we descended a bluff of fifty feet, to a level valley about seven miles across. The valley, at its northwest extremity, con-

tains a chain of salt lakes, which have a course a little south of east, their outlet passing only a mile and a half east of the Big Springs of the Colorado, which are tributary to it. At the northern extremity of this valley, also, the outlet to the Sulphur Springs of the Colorado joins this chain of salt lakes.

The Big Springs of the Colorado issue from a ravine on the northeast slope of a range of hills, 200 or 250 feet high, whose general direction is south 45° east; at a distance of one and a half mile the outlet of the springs joins the valley of the salt lakes, and becomes, at this point, dry. Many of these lakes contain water, the beds, when we passed, being moist, the water totally unfit for use.

An Indian trail leads from the Sulphur Springs of the Colorado, in a southwest direction, to the Mustang springs, and from them to the Horse Head crossing of the Pecos. It also extends in a northeast direction from this point to the head of the Brazos. This trail is a very broad and deep one, and is evidently in constant use by the Indians in their forays into Mexico. It leads, undoubtedly, along the eastern base of the Llano Estacado, and connects the extreme western permanent watering-places. From the position of this trail, and the character of the country to the northwest of the Sulphur springs, there can be no question that this is the nearest water to the Pecos in the direction of Delaware creek. The Kioways whom we met, as already mentioned, came by a trail from the Horse Head crossing to the Mustang springs, and continued their journey homeward to the Arkansas by the same trail, passing the Sulphur springs.

The Sulphur Springs of the Colorado, five in number, issue from one side of a ravine, the water of one spring tinged slightly with sulphur; the remainder contain pure and fresh water, which holds a small portion of lime in solution. Below the springs there is a large pond, where animals can be watered with much ease. The east side of this ravine is composed of layers of limestone, which is found to be mixed (in a decomposed state) with the surrounding soil. The grass is young and good; it is eaten with much avidity by the animals. Our wood (mezquite-root) is obtained in abundance by sending wagons a couple of miles from camp for it.

Our animals are out grazing all the time—loose during the day, but hobbled at night. Two horses and two mules are held in hand all day, so as to be in readiness in the event of a stampede, or other emergency requiring their use. There is a strong guard placed over them day and night; they are constantly moved about to fresh grass.

Rattlesnakes are abundant; we have killed several, some of them of a monstrous size.

The soil is good clay mixed with gravel. The country on all sides around us presents a nearly unbroken level, covered with a young growth of short and nutritious grass.

No observations taken during the day or at night.

Same Camp—Tuesday, April 4, 1854.—Lieutenant Garrard left camp this morning at 6 o'clock to survey and take the levels of the Llano Estacado from the falls of the Pecos (our former camping-place) to this point. His party consists of three mounted men and an ambulance driver, one ambulance with four mules, three riding and six

pack-mules, supplied with nine days' rations, and two sacks of corn; the six mules were packed with two kegs of water each.

The lieutenant was accompanied as far as his first camp, thirty-five miles from this place, by three men, and six mules packed with two kegs of water each; six of these kegs were used at the point last mentioned, in watering the mules destined to cross the jornada, and six left there to be used (for the same purpose) on their return from the Pecos. This last party are to start for this camp on the morning of the 5th. It was not deemed judicious to send a large party across, the difficulty of providing a sufficiency of water for a larger number being very great. It is hoped that this arrangement will prevent much suffering to either men or animals.

We anticipate that the lieutenant will join the command in about nine days. The animals herded, &c., the same as usual. No observations taken to-day.

Same Camp—April 5, 6, and 7, 1854.—The weather is very changeable, the days being exceedingly warm, the mercury rising as high as —, the nights and mornings cold. One day the thermometer rose —° in a few hours. There is, however, always a good breeze. For nearly the first time since we left Doña Ana, we are free from dust and sand. No one can truly appreciate this luxury but those who have encountered the clouds of sand by which the traveller is blinded, choked, and literally overwhelmed, on the banks of the Rio Grande, and throughout nearly every portion of this country. We appear to be getting rid of this frightful nuisance.

The same arrangement continued respecting the animals.

Extensive astronomical observations taken during these days. The party that accompanied Lieutenant Garrard to his first camp returned on the 5th, at sundown.

Same Camp—Saturday, April 8, 1854.—Captain Taplin left the command this morning at 7 o'clock, with instructions to examine the country in advance of the train for about sixty miles. He was accompanied by four men of the escort and six of the topographical party, all mounted, with one pack-mule carrying four days' rations.

The command in camp employed in repairing wagon, herding, &c.

Same Camp—April 9 and 10, 1854.—The weather still continues warm in the day, cold nights and mornings, with occasionally strong winds. The absence of a large body of water prevents the atmosphere from becoming damp and humid; if it were otherwise, it would be insupportable.

All are wishing for the word to start on our way, though the camp is good and supplied with every requisite. All are more or less anxious to move forward. The level plain with which we are surrounded as far as the eye can reach, without a single brush or tree to break the monotony of the scene, is truly wearisome.

Animals grazed and herded as usual. Extensive astronomical observations taken these days.

Same Camp—April 11, 1854.—Captain Taplin and party returned to camp at 1 p. m. His report of the country ahead of us is highly favorable. He found, first day's march, water in holes twenty miles from camp; next water fourteen miles further; from this point

until the termination of the second day's march, it is about four miles from one watering-place to another. The whole distance travelled by this party was sixty-one miles. Mezquite and hackberry plenty at, or convenient to, all the watering-places. Grass generally good. Most of the ravines on this route lead to the southeast. Lieutenant Garrard and party arrived in camp at 5 p. m. He reports the distance from the Fall of the Pecos, mouth of Delaware springs, to this camp, to be one hundred and twenty-five and one-tenth miles, and north 70° east. His report of the Llano Estacado varies so little from the statement of Captain Taplin, that a reference to the latter will answer every purpose as to the character of the country, vegetation, &c. Neither the party nor the animals showed much sign of suffering; the one being in good spirits, the other (taking all things into consideration) in very good condition; the arrangements for their comfort and convenience proving successful.

The surveying of this dreaded Llano is now accomplished; its reputed horrors, by no means exaggerated, have been overcome; it has been crossed safely by two of our parties without loss or suffering. This jornada is no longer a sealed book; we have now a thorough and practical knowledge of it in every respect. Everything considered, we have reason to congratulate ourselves upon the successful termination of this important portion of our survey.

Lieutenant Garrard and Captain Taplin having arrived, orders were issued to the command to start on the following morning.

The animals that crossed the Llano fed with corn. The same arrangement regarding the mules continued. Observations taken during the day and at night.

Camp No. 34—Wednesday, April 12, 1854.—Left camp twenty minutes to 11 a. m., and followed the Indian trail, (already mentioned;) but as it bore too much to the north, we turned off it at two miles from camp, and proceeded more to the eastward. We also left the route pursued by Captain Taplin for a similar reason, taking a direct course for our destination, Preston. For the first three miles our route was sandy and heavy; the country considerably broken by ravines and gullies. On advancing, our road was over a hard and firm ground. The prairie is directly eastward of the Llano Estacado; it is level and well defined, and covered over with a short thick grass, which the animals eat with much avidity. The mezquite-tree is most abundant. There can be little doubt that during, or immediately after, the rainy season, water can be obtained in the numerous holes along this road.

The soil is good clay mixed (slightly) with gravel, producing a variety of flowers. This, with the fresh and green appearance of the landscape, forms a pleasing contrast to the parched and arid prairie that we have generally been traversing. Antelopes and rabbits plenty; the former are so shy, they are hard to get at.

The day was warm, but tempered by a pleasant breeze. We encamped at fifteen minutes to 3 p. m. without water. This was not felt, as our mules had been watered before starting and our kegs filled. Mezquite abundant; grass good.

The mules were turned loose (unhobbled) until sundown; then

driven in, hobbled, and turned out to graze during the night. Four animals kept picketed in camp, in case of emergency. A strong guard over them, as usual.

No observations taken during the day or at night. General direction, north 55° east; miles, $11\frac{1}{4}$.

Camp No. 35—Thursday, April 13, 1854.—Left camp five minutes to 7 a. m. Our route for about three miles continued over a level and excellent prairie. We then began to descend into a wide and pleasant valley. Our road was diversified by numerous gentle undulations. Having proceeded about eight miles, we came to a deep ravine, in which we found water. At this place we nooned for nearly two hours; the animals were plentifully watered, and turned loose to graze; our kegs were filled. There is excellent grass here, besides a description of wild Timothy grass, which the mules ate greedily. The water is neither good nor pure, except in one or two holes, tasting strongly of weeds. The mules being hitched up, we proceeded upon a nearly level prairie. We now perceived to the north of our course, about eighteen miles distant, a high mound and some bluffs, where we suppose the Colorado takes its rise. The prairie is slightly rolling, and covered over with white and yellow flowers, emitting a fragrant perfume. The mezquite is green and grows in the utmost profusion; indeed, one is cheated into the belief that he is passing through an orchard. This is the only growing timber we have seen since we left the Pinery. The sloping banks are clothed with violets, adding to the variety and pleasure of the scene. The soil changes its color, and becomes a deep red; it is good firm clay, mixed with sand. Saw plenty of antelope and deer, but did not succeed in getting any. The Doctor shot a "bird of paradise;" its plumage is of the most exquisite delicacy and color.

The day was not so warm as usual, but pleasant for travelling. We had an excellent road the whole day, and reached camp at fifteen minutes to 4 p. m. No water; mezquite-wood in abundance; grass good.

The usual arrangements in respect to the animals continued.

No observations taken during the day or at night. General direction, north 70° east; miles, $15\frac{1}{8}$.

Camp No. 36—Friday, April 14, 1854.—Left last camp ten minutes after 6 a. m., and resumed our course over a rolling prairie. The mules were fresh, and travelled well, our road being firm and good. We nooned for about two hours, at eleven miles from last camp, on the banks of an arroyo, where we watered the animals and filled our kegs. During this day's route we passed five arroyos: two of them contained water; the remainder were dry, but had every appearance of having lately contained water. These ravines are generally rugged and steep; we did not experience, however, much difficulty in crossing them. They run off in a northeast direction towards the mound and bluffs already mentioned, and eventually fall into the stream, on the banks of which we camped, supposed to be one of the forks of the Colorado.

The soil passed over to-day is good red clay and sand; we came upon two or three gravelly places. There is an abundance of mezquite

trees and roots; the former growing same as yesterday. The grass is green and abundant. Wild flowers are scattered profusely over the plain. Saw a number of antelope; killed one. Reached our camp on the Colorado fifteen minutes after 4 p. m. Its banks are very steep; the water is running, and not deep. This encampment is about fourteen miles south of a mound and bluffs we saw yesterday, and which continue in sight throughout to-day. There is plenty of mezquite and some hackberry; water brackish. In the neighborhood of camp there are many mounds of red sand; the tops and sides covered with red sandstone in great profusion. On the summit of these hills we found fossil sea-shells and portions of petrified trees: these hills stand apart from each other; one of them assumes the form of a pyramid. There is plenty of game here.

Animals grazed loose till sundown; then driven in, hobbled, and turned out for the night, as usual—under a strong guard.

No observations during the day; observations for time and latitude taken at night. General direction, north 70° east; miles, $18\frac{2}{3}$.

Camp No. 37—Saturday, April 15, 1854.—Left last camp fifteen minutes after 7 a. m., and crossed the Colorado about four miles from camp, at the base of a red sandstone bluff. The banks were steep and rocky. After some labor, a very good crossing was made. The banks were cut down on both sides, and the rocks being thrown along the bottom, made it firm. The stream was narrow and shallow; the sides of it are of good firm clay.

Having effected a safe crossing, we ascended a high rolling prairie, passing over two deep arroyos—one dry, the other with a stream of clear running water, which empties itself into the Colorado. The sides of these arroyos are steep, but we succeeded in crossing them without much difficulty. We encountered several ravines on our route, but none of them of a formidable character. A portion of our road (about three miles) was heavy sand; with these exceptions it was excellent.

The soil is good clay, of a red color, mixed with gravel. The mezquite-tree still continues abundant. Scrub-oak is beginning to appear in considerable quantities. The grass is generally good, except in the vicinity of the sand, where it becomes coarse and scanty.

We nooned for two hours at the arroyo mentioned above as having the running water. Our animals were watered here, and as we were uncertain of finding water at night, our casks were filled.

When within a couple of miles of camp for the night, we met a party of Camanches. We halted, and two of them approached us with a white flag. Immediately after the whole party came up, headed by a most *outré* looking figure. This was Sanchoz, one of their chiefs, dressed in an infantry captain's uniform coat, silver epaulets, red sash tied over his shoulder, nondescript pantaloons, and moccasins: add to this a military cap with an enormous red pompon, and some idea may be formed of an exhibition at once ridiculous and humiliating. This man, who is rather old, has an intelligent countenance and piercing eye. The party consisted of about seventeen in number; five of them were squaws, whose appearance was not very fascinating. One of them had a "muchecho" on the saddle before her. Through their in-

terpreter (a Mexican captive boy) we learned that they had been to Fort Chadbourne, and were going to hunt wild horses. The women rode *à la mode des hommes*. They all had good horses; indeed some of their animals were beautiful and in high condition. After the usual embracing, and the customary vows of eternal friendship, the chief, though so well-dressed, commenced begging. We gave them an ox. They then departed, as we devoutly hoped; but some of them came afterwards to our camp *in time for supper*. They were told not to come near camp after night-fall.

Reached camp at half-past 4 p. m., near a ravine, with water, running southeast. Water not good; grass excellent; wood abundant. Same arrangement continued regarding the animals. The vicinity of the Indians put all hands on the *qui vive*. No observations taken during the day or at night. General direction, north 70° east; miles, $12\frac{1}{8}$.

Camp No. 38—Sunday, April 16, 1854.—Lieutenant Marshall, accompanied by five of the topographical party and five soldiers, all mounted, with two pack-mules and four days' rations, started at half-past 6 a. m. for Fort Chadbourne, to get some articles necessary for the expedition; and also to explore the rivers, &c., in that direction. He will join us in four days on the Brazos river.

Left camp and crossed the ravine, and proceeded over a good rolling prairie. We crossed also, in a short distance, two dry ravines. At about six miles distance we passed over the most eastern tributary of the Colorado. The banks of this stream are thickly covered with timber—mezquite, hackberry, wild china, plum, willow, and scrub-oak. It contains an abundance of fish—trout, buffalo, catfish, sunfish, perch, and bass. We caught a great many of them. The stream is deep; the water beautifully fresh and clear.

We had to cut down the trees on both banks, and level them a little, to allow our wagons to pass. This, however, did not cause much delay or trouble. We nooned here for two hours on excellent grass. We then moved forward over a firm prairie, and camped at half-past 5 p. m. on the "dividing ridge between the Colorado and Brazos rivers," on a dry bed of a stream which runs into the latter. No water; wood and grass in abundance.

The country still continues to improve. The trees assume a greater variety, and are of a larger growth. The grass is good and short; speaking generally, it is of an excellent quality. The scenery is varied and pleasing. The plain, clothed profusely in many places with flowers, looks quite fresh and gay. Our animals travelled well, and looked in excellent condition; same arrangement in respect to them as usual. Observations for time taken in the day; none at night. General direction, north 71° east; miles, $16\frac{2}{8}$.

Camp No. 39—Monday, April 17, 1854.—Left camp at half-past 6 a. m., crossing the dry bed of the creek on which we camped. After proceeding about five miles over a very rolling country, we struck Marcy's trail; crossed and left it to the north of our route. One mile further we came to a stream of running water; this is a tributary of the Brazos, and a continuation of the ravine we passed in the morning. This stream has an abundance of trout, bass, sunfish, and catfish. We caught some

of them. A moccasin snake was killed on the bank. This reptile is as poisonous as the rattlesnake, and more dangerous, as it gives no warning before attacking.

All of our animals were plentifully watered, and our kegs filled. We nooned about two miles from this water for a couple of hours, on a dry bed of a ravine, which, though somewhat steep, we crossed without difficulty. From the summit of a ridge the country to the eastward appeared much broken, and difficult to travel; we found, however, that it was not so bad as it appeared. Reached camp on a tributary of the Brazos at 15 minutes after 4 p. m.: there was water here, but it was brackish and bad; the mules drank it freely; wood and grass in abundance. The soil passed over to-day is excellent; mezquite, hackberry, and scrub-oak abundant: the former attains a large growth. The grass is also excellent, particularly along the sides and bottoms of the ravines. Vegetation is very forward; the face of the country improves as we proceed. We have lately obtained some curious petrifications—particularly some petrified teeth of an enormous size, belonging to an animal unknown to us. Mules grazed, &c., as usual. No observations taken during the day; some at night, for time and latitude. General direction, north 70° east; miles, 16.

Camp No. 40—Tuesday, April 18, 1854.—Left last camp at 20 minutes after 6 a. m., and proceeded over a fine rolling prairie; passing many dry ravines. At about six miles from camp we came to a tributary of Brazos—it had good water. The banks on both sides had to be cut down; the wagons passed over safely. All the ravines we crossed yesterday afternoon run into this stream. The gypsum formation here is somewhat analogous to that of Delaware creek. Our animals were watered, and our kegs filled. We resumed our route over an undulating plain, and three miles further came to another tributary of the Brazos; the banks here had also to be cut down. The water in this ravine is intolerably saline. We nooned here for about two hours; turning the animals out to graze. Having proceeded about fifteen miles, we intersected a wagon trail, running north and south; this is supposed to be a trail from some of the upper posts or towns in the northern part of Texas to Marcy's trail. We saw a trail which had evidently been traversed by a large party of Indians. Our route to-day was over a fine country in every respect. We had timber of a great variety, and tolerably large growth; in fact, if the timber in this section of the country was not stunted in its growth by the constant firing of the prairie, there could not be a better timbered country. We found mezquite, oak, china, cotton-wood, &c., of a pretty large size. Reached camp at half-past 4 p. m., on the dry bed of a ravine; wood abundant; grass not so good as it has been. Immediately before coming into camp we encountered some heavy sand. No water at camp. Animals grazed, &c., as usual. No observations taken. General direction north, 60° east; miles, 17 $\frac{6}{10}$.

Camp No. 41—Wednesday, April 19, 1854.—Left last camp at 15 minutes after 6 a. m.; continued our course over an excellent road, and through a fine country. We did not encounter so many ravines as we had for some days previous; crossed two having a northerly direction. After proceeding twelve miles, we descended about thirty feet from the pla-

teau to a level plain. The face of this descent is composed of limestone and red sandstone—the former in horizontal strata; decomposed gypsum was pretty thickly scattered around. A little to the south of where we descended the bluff is nearly 100 feet high, and nearly perpendicular. The country continues well wooded, with grass in abundance. It is to be observed that the mezquite-tree is the principal growth—oak, cotton-wood, &c., scarce. Our road to-day was good and firm; one or two places, some little sand. Found no water until we camped, at 15 minutes after 1 p. m., on a ravine running northeast. This water is strongly impregnated with gypsum, tasting bitter; it appears to be permanent; it is best where the rocks are thickest; it was very saline in some holes which we dug. Wood abundant; grass excellent, both prairie and grama. Animals grazed, guarded, &c., as usual. No observations taken; the day and night cloudy; with every appearance of rain. General direction, north 60° east; miles, 18 $\frac{1}{10}$.

Camp No. 42—Thursday, April 20, 1854.—Left camp at 20 minutes to 7 a. m., and crossed the ravine upon which we camped. We continued our course through a fine, well-wooded country, over a hard, firm road. The appearance and character of the country is somewhat similar to that of yesterday. Having passed a dry ravine, at 11 $\frac{6}{10}$ miles we came to a creek with tolerable water, at which we nooned; the water was rather scarce, but much better than where we stayed last night. Our animals were watered, and turned loose to graze for two hours. The bed of the creek is muddy and miry; the banks are steep. This creek must have a very rapid and deep current during the rainy seasons. Here, for the first time since we started, we found a considerable growth of elm. This tree, though it grows here tolerably large, yet does not attain the size to which it arrives in the States. Its thick foliage makes a pleasant shade from the heat of the sun. The scenery at this place is very beautiful. We saw on the bank what appeared to have been a dragoon camp; it must have been made two years since, probably by a scouting party.

Before nooning we started a wild turkey, which afforded a capital "run"—some of our best animals were immediately after him. For a little time the chances for his escape seemed highly probable; the poor fellow scampered off in great style, baffling all pursuers but one, a Mexican, named Jose, who lassoed or larriated him. The bird succeeded in slipping through the noose. This rather novel proceeding seemed to astonish him (the turkey) so much, that he lost his presence of *mind*. However that may be, he certainly lost the use of his legs, was captured, and brought into camp amidst acclamations—his beautiful plumage exciting the utmost admiration. This bird weighed 16 $\frac{3}{4}$ pounds. The mules being hitched up, we found a good crossing and passed the stream safely.

Reached our camp, on a tributary of the Brazos, at ten minutes to 4 p. m. Wood and grass good and abundant; the water is nearly the same as where we nooned; both are somewhat tingured with gypsum. Capital timber along its banks; the elm predominates. Altogether, it is a charming camping-ground. Wild turkeys abundant. For the last two days we have made a considerable descent, but it has been very gradual.

We had some hopes that Lieutenant Marshall would join us to-day, but we were disappointed.

Mules grazed and herded, &c., as usual. Day cloudy; no observations taken; observed at night for time and latitude. The streams mentioned above bear to the north. The weather continues warm, with a pleasant breeze. General direction, north 60° east; miles, $17\frac{4}{10}$.

Camp No. 43—Friday, April 21, 1854.—Left last camp fifteen minutes to 7 a. m., and proceeded on our course, parallel to the creek on which we camped, for one and a half mile, and crossed it. This is a thickly-timbered stream, with steep banks and soft bottom; water not running. We had to cut down the banks and some of the trees on both sides; filling up the bottom, we were then enabled to cross. At eight miles from camp we descended into a valley, and nooned near some permanent water. The sides of the ravine containing it are sloping and rocky. The country in the immediate vicinity is not so fertile as that we have been passing.

There is here a pond or spring of excellent water, abounding in fish, many of which we caught. Our animals were watered and turned loose to graze for two hours. Near this place we intersected a well-defined wagon trail running north and south, evidently used by traders from Texas in reaching Marcy's trail.

We resumed our course over a rather rough and rolling prairie, following the last ravine to its mouth until we struck another tributary of the Brazos. This stream runs along the base of a high bluff. We followed the valley, which is narrow, along its banks; our road was between the bluff and the stream; we were obliged to cut our way through the thick timber: this, nearly always a tedious process, did not cause us much delay. We camped on the bank of the stream at fifteen minutes after 4 p. m., in the only open place we found. The water is pure and clear; the bottom firm. Catfish, sunfish, buffalo, trout, garr, &c., abundant; grass good and plenty. This whole valley is extremely heavily timbered; brush and small trees thick. The streams passed to-day have a northeast direction.

In preparation for to-morrow, some trees were cut down on both banks, and a capital crossing made.

The country we traversed to-day is, except in the instance above mentioned, nearly similar to that we have been travelling for some days.

The weather is exceedingly warm, the mercury rising as high as ninety-eight degrees in the shade. There is, however, always a breeze, which tempers the heat, so that it is not absolutely intolerable.

Mules herded and grazed as usual. No observations taken during the day or at night. General direction, north 60° east; miles, $12\frac{8}{10}$.

Camp No. 44—Saturday, April 22, 1854.—Left last camp at fifteen minutes after 6 a. m., crossing the stream where we cut down the banks and trees the previous evening. We were obliged to cross it three times. The narrow valley on its banks is bounded on both sides by bluffs and steep ascents leading to a high table-land. The stream running in a zigzag course, required us to deviate considerably from our line, in order to avoid the many formidable obstacles presented by the numerous elevations and ravines. We had to cut our way through, with a great deal of labor. We encamped at 12 o'clock noon on its

banks. This tributary—the Clear fork of the Brazos—is here a large stream, heavily timbered, about twenty-five yards wide, and very deep; the water is excellent, and abounds in fish. Wild turkeys visit this place in great numbers to eat pecan nuts, of which they are fond. Grass excellent, particularly along the bottoms.

It was concluded to halt here for a day or two to take some astronomical observations, and also to await the arrival of Lieutenant Marshall and party.

Having been cloudy all day, the night was ushered in by a violent storm of wind and rain. It was the only rain we experienced since we started.

Animals herded, grazed, &c., as usual. No observations taken during the day or at night. General direction, north 40° east; miles, $6\frac{6}{10}$.

General remarks upon the country from the Sulphur springs to the Clear Fork of the Brazos.—Between the Sulphur springs and the dividing ridge of the Colorado and Brazos we passed over a country generally well timbered with the mezquite. The country is generally rolling for this distance. Between the Sulphur springs and the main Red fork of the Colorado it is intersected by ravines, of easy ascent and descent, tributary to the Colorado, having a course about northeast. We found an abundance of water at distances of from three to ten miles; we passed it during the dry season, and no doubt water can be always obtained. The Red fork, or main stream of the Colorado, (almost forty-four miles east of the Sulphur springs,) runs in a very zigzag course to the southeast, through a valley about one and a quarter mile in width, bordered on both sides with red sandstone bluffs, from which an easy ascent can be had to the stream at any point.

The immediate bed of the stream is about twenty feet in width, with miry bottom and perpendicular banks ten feet in height; rendering its pass up for wagons, except at particular points, very difficult. The water, which is slightly brackish, is found in pools or holes connected by a swift-running stream. From the main Colorado to the dividing ridge between it and the Brazos (a distance of $28\frac{3}{10}$ miles) we encountered two principal tributaries, both having rocky and gravelly beds, with pure water and a considerable growth of timber. The route passed over a gently-rolling country, firm and hard, having an abundance of grass, intersected with many ravines of easy ascent and descent, tributary to the main stream, and running in a southerly and southwestern direction. The country is similar in all respects, except in having a greater growth of mezquite timber, to that on the west side of the Colorado.

The dividing ridge (between the waters of the Colorado and Brazos) is elevated probably 100 feet above the Colorado, and from the head of the most easterly tributary to that stream, along the route, to the first tributary of the Brazos, is a fine high plain about $1\frac{1}{2}$ mile in width. About five miles east of this dividing ridge we crossed Marcy's trail and the first tributary of the Brazos, (supposed to be a tributary of the Double Mountain fork;) from thence to a small tributary of the Clear fork of the Brazos we passed through a country generally level, and most of the way through a thick forest of mezquite timber. The

only break in this line of country occurs between a tributary of the Clear fork and a tributary of the Brazos: a high mesa or table-land lies between them; descending from which, in the exact line of our route to the eastward, a descent of about 100 feet presents itself. This is easily avoided by passing about a mile to the north. The first tributary of the Clear fork, which we struck at a distance of — miles from the supposed Double Mountain fork, is about 20 feet wide, banks 10 feet high, having a very tortuous course to the southeastward, through a level plain bordered on the east side by a low ridge of sand about $1\frac{1}{2}$ mile across. The waters of this stream are in many places quite salty. The principal stream, which runs between this point and the Clear fork is a much larger one, and is tributary (in a north-east direction) to the main branch of the Brazos; has abundance of timber, elm, hackberry, and other trees; and traverses, in a very zig-zag course, a beautiful and fertile valley, about three miles in width, bounded by very gentle elevations, covered by forests of mezquite.

The Clear fork of the Brazos is a large stream, heavily timbered, about 20 yards in width, and in many places 10 to 15 feet deep; very pure and clear water. The stream runs in a zigzag course, through a very narrow valley or cañon, with rocky bluffs about 150 feet high, and the surface of the stream is about that distance below the general level of the country.

The country along these tributaries of the Brazos is in all respects superior to that of the Colorado, and the whole of it as fine farming and stock-raising country as can be found in the world.

The differences of level between the Sulphur Springs of the Colorado and valley of the Clear fork of the Brazos are so small as to be perceptible only to instrumental survey.

CHAPTER XII.—*From Clear Fork of the Brazos to the valley of the Red river.*

Same Camp—Sunday, April 23, 1854.—Lieutenant Marshall joined the command this morning at 9 o'clock with his party; all well. The animals were in tolerable condition, considering the journey they had made. He found Fort Chadbourne to be about seventy-five miles distant from the point where he left us; (see journal of the 16th instant.) This post was commanded by Assistant Surgeon Swift, U. S. A., all the other officers being absent on duty, and was garrisoned by two companies (F and C) second dragoons, both of which were out scouting. The lieutenant brought us some newspapers and books, from which we gleaned some items concerning the sayings and doings of the busy world. The command passed the day washing, swimming, fishing, &c., for which the stream afforded all facilities. All necessary repairs to wagons, &c., were made, and our specimens packed in a more commodious manner. For the last few days we have added considerably to our collection of birds and fishes. To-day we succeeded in catching a pole-cat, or skunk. It is a fine specimen, and required the use of only one of the senses (smelling) perfectly to inform us of his vicinity.

we also caught a garr-fish; this fish we had not seen until we struck the Clear fork. It is of a bright yellow color, and enveloped in a hard scaly covering, more like shell than cuticle. It has a long pointed head, armed with a numerous and formidable set of teeth, well adapted for seizing and holding its prey. As before remarked, this stream is very heavily timbered with mezquite, hackberry, elm, oak, pecan, cottonwood, &c.

The appearance of the country about our camp is of the most picturesque and varied character. The animals grazed in the bottoms, where the grass is excellent and abundant. The day was warm; the earlier part of it being cloudy. The night set in with a violent thunder-storm; the rain poured down heavily till about 2 a. m. In consequence of the unfavorable state of the weather, no observations could be made during our stay at this camp.

Camp No. 45—Monday, April 24, 1854.—Started at half-past 7 a. m., and ascended a high table-land, traversing a very rolling and broken country. The summits of the ridges we passed over were very rocky, with some abrupt descents. We crossed many of the heads of ravines which run into the Clear fork, but they did not present any serious obstacle. Having proceeded about eight and a half miles, we struck the military road which connects Preston, Forts Belknap, Chadbourne, Phantom Hill, and San Antonio. We nooned at a short distance from this point for about two hours; we commenced descending somewhat abruptly until we reached a most beautiful valley.

Before reaching camp we perceived a log-house and farm. It requires an absence as long as ours from all human habitations to realize the sensation this sight created. On arriving at it we ascertained that it, with about twenty-two hundred acres of the surrounding valley, had belonged to Col. Jefferson Stem, Indian agent, who was murdered by two Wichitas on the 12th of February last. The perpetrators of this outrage were seized by some friendly Camanches and killed. The Colonel was from Tippin, Seneca county, Ohio, and was a lawyer by profession. This farm, though not long under cultivation, produced last year five thousand bushels of corn.

We also encountered here a party of California emigrants, with a considerable amount of stock and animals. They received such information from us as will, no doubt, be useful to them on their journey.

Camped in the valley at 4 p. m. on a rivulet which flows into the Clear fork of the Brazos. We are now thirty-five miles from Fort Belknap, and intend following the road if it does not deviate much from our exact route. The country passed over to-day is well timbered, but not so fertile on the high-lands as that we have been traversing. At camp we had excellent grass, wood, and water; mules grazed and herded as usual. Observations at night for time and latitude.

Camp No. 46—Tuesday, April 25, 1854.—Left last camp at ten minutes after 6 a. m., and continued our route along the military road through a rolling country. The road is excellent, and, in consequence of the dryness of the season, is firm and hard. The animals being in good condition, travelled well. We were obliged to deviate slightly from our direct course, to avoid some difficult places. During this day's

march we descended considerably, but gradually. The soil all through is excellent; the mezquite, oak, and other trees abundant, and of a large growth; the grass young and nutritious. Having proceeded about eleven miles, we nooned at a spring near the road for about two hours; animals turned loose to graze. We then resumed our route over a country similar to the above, and encamped at half-past 4 p. m. near a ravine containing rain-water, of which there was an abundance for the animals, cooking and other purposes. The whole section of country is covered over with grass-hoppers, in countless myriads. They were very troublesome, and at night they completely filled our tents. They appear to be going south; and if they do so increasing in strength and numbers, an incalculable amount of injury will be inflicted on the farmer. The day was remarkably warm. Our near approach to the States, and the beauty of country through which we are passing, have the effect of increasing the good humor and high spirits of the command. Good health and temper are the order of the day. No observations made; mules hobbled, grazed, and herded as usual. General direction, north 65° east; miles, 18 $\frac{7}{10}$.

Camp No. 46—Wednesday, April 27, 1854.—Left last camp at five minutes to 6 a. m., and continued our course travelling the military road. The country is still rolling, with a good soil, and heavily timbered—mezquite, oak, hackberry, &c., of a large growth; grass excellent, and abundant. We continue to descend gently. There is rain-water along the road, at short distances, in holes and ravines. For the last two days we have added to our collection of birds and reptiles. Having travelled eleven miles, we nooned for about two hours in a delightful shade formed by large trees, near some water. We resumed our route over a country same as yesterday.

Lieutenant Marshall, with two men of the party, left the command early in the morning for Fort Belknap, to procure some necessary articles. He joined us a little after sundown, accompanied by Lieutenant McIntire, seventh infantry, and Assistant Surgeon Vollum, U. S. A. The fort is garrisoned by two companies of the second dragoons and two companies of the seventh infantry, and commanded by Major Steen, second dragoons. Reached camp at twenty minutes after 3 p. m. It is a beautiful camping-place. The rain-water is in ravines near our camp.

We are one mile from the crossing of the Brazos, and about two from Fort Belknap. The day has been excessively warm and sultry. Observations for the time and latitude made. Mules grazed, &c., as usual.

Along our line of March to-day there were perfect groves of post-oak, which is a very valuable timber for many purposes. Scrub and live-oak are also in abundance. General direction, north 34° east; miles, 16 $\frac{4}{10}$.

Camp No. 48—Thursday, April 27, 1854.—Left last camp at fifteen minutes to 6 a. m., and moved to the crossing of the Brazos. We passed over without the slightest difficulty, the water not reaching higher, in its deepest place, than the mule's knees. The river at this point is seven hundred feet from bank to bank, which are gently sloping. Its bed is gravelly and firm, and the water is very salty. From

the swiftness of the current (even with the small body of water we crossed) there must be a rapid and violent current when the river is swollen.

At a short distance from the river we came to Fort Belknap. This post is beautifully located in a finely wooded country, but is in a very unfinished and scattered state. There is here a steam saw-mill; but being out of order it is useless, the machinist not being competent to make the necessary repairs. The gardens for vegetables, &c., were in a flourishing condition.

Captain Pope and Lieutenant Garrard remained for a short time at the post, sending forward the train, which took the wrong road. When the mistake was discovered, the wagons were surrounded with brush and timber. We, however, rectified our error, and regained our correct road without much trouble.

We camped at 12 o'clock noon on a stream of good running water, over which there is a wooden bridge; grass and wood in abundance.

We travelled through a densely wooded country; post and live-oak, large mezquite, &c., in profusion. We saw several small trees of the prickly-ash, and some large cotton-woods. The grass along our route was excellent. Rain-water plenty in holes.

The day was not so warm as usual; the wind changed to the north, and (in the earlier part of the day) was very chilly.

We hoped to obtain some corn at Fort Belknap, but we could not obtain any in consequence of the extreme difficulty of supplying the post. The article is very scarce. It has to be transported from Preston, a distance of two hundred miles. The dragoon horses are allowed to twelve ears of corn per diem.

Many of the mules were shod to-day, as their feet are getting tender from travelling on the hard road.

There are extensive coal-mines in the neighborhood of Fort Belknap. This coal is used at the post. It is needless to enlarge upon the importance of this fact.

Mules herded and grazed as usual. No observations made; cloudy during the day, and very hazy at night. General direction, north 25° east; miles, 10⁹/₁₆.

Camp No. 49—Friday, April 28, 1854.—Left last camp at five minutes to 6 a. m., and resumed our route along the military road. The country is similar to that passed yesterday, but somewhat more open. It is gently rolling. There were along our course large and dense groves of oak of a very considerable size. The mezquite is also large and abundant. The soil is capable of the most extensive cultivation. There can be little doubt, from the appearance of the country, that there is sufficient rain for agricultural purposes. Though the season up to this time has been a remarkably dry one, yet the innumerable pools along our route are generally filled with water; indeed, when the earth is dug to the depth of twelve or eighteen inches, it is found to be damp and moist. Dew falls heavily. These remarks apply in general to the country we have passed since we struck the first (western) tributary of the Brazos. Nature has been prolific of her favors to this charming section of country. Having travelled about ten and two-tenths miles, we nooned for two hours in a delightful shade.

About three miles from last camp we crossed a running stream with very steep banks—the last eastern tributary of the Brazos. Six miles further we surmounted the dividing ridge between the Brazos and Trinity rivers. This ridge slopes gently on both sides. Reached camp at half-past 3 p. m., near a stream; water not running. Wood and grass abundant and good.

About four miles before reaching camp we passed the first tributary of the Trinity, which has a direction to the northeast. During the day we crossed many small ravines and gullies, containing more or less rain-water. The day has been remarkably chilly and unpleasant, the wind from the north; the night also cold. Mules grazed, herded, &c., as usual; the day-guard over them is reduced to two men, exclusive of the herders. Observations for the time and latitude made. General direction, north 36° east; miles, $17\frac{5}{8}$.

Camp No. 50—Saturday, April 29, 1854.—Left camp at ten minutes after 6 a. m., and resumed our course over the beaten road over a country similar to that of yesterday. The same remarks in reference to soil, timber, grass, and water, will apply to our route to-day. We crossed a considerable stream called the West Fork, a tributary of the Trinity. About seven miles from last camp we came upon a beautiful spring, which is covered over with rock to protect it from the sun; the water is pure and cold. Having proceeded $9\frac{1}{2}$ miles, we nooned two hours; water in holes; grass excellent. We resumed our route, and camped at ten minutes after 2 o'clock p. m. near a ravine. Our camp is in a charming locality; wood, water in ravine, and grass, all excellent and in profusion. We will remain here for three days, as it is concluded to make this place one of our principal astronomical points. Mules grazed and herded, &c., as usual. Observations made at night for time and latitude; day cloudy. General direction, north 70° east; miles, $13\frac{5}{8}$.

Same Camp—Sunday, April 30, 1854.—All hands in the command busily engaged in such work as may be requisite—repairing wagons, re-arranging the loading, shoeing and cropping the mules, &c. As usual at halting-places, the men gladly avail themselves of the opportunity for washing their clothing, &c. Our collections in mineralogy, geology, botany, and natural history, are being repacked, and placed in as small a compass as possible. Great care is taken to avoid injury to them. The collection in birds and plants is large. We have many new specimens in both, which will no doubt be interesting to men of science. Our specimens of the soils, very numerous indeed, will be found important. No opportunity has been lost, no labor spared, in collecting and increasing our contributions to these departments of science. We only regret that the limited transportation placed at our disposal prevented us from enlarging our collection to the extent we wished; the country affording inexhaustible materials. To-day we commenced an epitome of the expedition from its departure from Doña Ana to this place. Although this report was much condensed, yet it was somewhat voluminous; the great variety and importance of the matter contained in it required a considerable amount of labor to abridge without in any material manner interfering with the facts. A profile of the country was prepared; also a summary, with a table, of

the grading that may be required throughout the whole route. When finished, these documents will be sent by express to Fort Washita for transmission to Washington. Mules herded and grazed, &c., as usual. In consequence of the unfavorable state of the weather, no observations could be made.

Same Camp—Monday, May 1, 1854.—The greater part of the night was consumed in hastening the preparation of the papers referred to in yesterday's journal. At an early hour this morning we resumed our work on these documents, and finished them about 10 a. m. The express, consisting of an American and a Mexican, started immediately for Fort Washita. This express will bring our mail to us. It is presumed we will meet it near Preston. No observations made; the weather still continues cloudy. Mules herded, grazed, &c., &c., as usual.

Same Camp—Tuesday, May 2, 1854.—One of the escort having gone to hunt last evening, had not returned during the night. The fact being reported, five men were sent in different directions to find him. During their absence the man arrived in camp; he had lost himself in the thick timber, and could not extricate himself during the darkness. In the morning, after much fatigue, he reached the camp. This will be a caution to others. During the last two days we have added some beautiful specimens of birds to our collection. Rained last night, and still continues cloudy, with occasional showers; no observations can, therefore, be made. Mules herded, grazed, &c., as usual.

Same Camp—Wednesday, May 3, 1854.—It rained heavily last night; we have had some smart showers to-day, and there is every indication of another wet night. This inauspicious weather precludes the possibility of astronomical observations. The heat is very oppressive. It is intended to remain here until the weather clears up, if it does so in any reasonable time. We, however, do not remain idle; we are getting up the business of the expedition as far as it can possibly be done. Our animals look remarkably well; the rest and good grass have completely recruited them. Some of the command go out hunting. An antelope and some wild turkeys have been killed. Game of all kinds is very plenty in this locality.

It is to be observed that the streams we have passed from Fort Belknap to within five miles of this place are tributaries of the Brazos, and run in a southwesterly direction.

Same Camp—Thursday, May 4, 1854.—The weather still continues cloudy and rainy, preventing any observations from being made. We had a severe thunder-storm, with heavy rain, during the night.

Same Camp—Friday, May 5, 1854.—The weather still continues rainy and cloudy. The necessary returns and papers pertaining to the expedition are being made out, and completed as far as possible.

Same Camp—Saturday, May 6, 1854.—To-day the weather cleared. Astronomical observations for longitude and latitude made. These proving satisfactory, it is determined to resume our journey to-morrow.

During our stay we added largely to our collections of specimens.

Camp No. 51—Sunday, May 7, 1854.—We left last camp at fifteen minutes to 1 p. m., and resumed our route along the road we had previously been travelling. The animals showed that the rest and

good grass had been of service to them. They looked and worked remarkably well.

Our route to-day was through a country similar to that we had been already travelling. It is in every particular as fine an agricultural country as can be found in the world. The post-oak is in the greatest abundance, and we passed through a thick wood of it for upwards of two miles; also some hackberry and scrub-oak. Grass excellent and abundant.

We crossed several creeks and ravines, generally with water, which run in a northeasterly direction to Red river.

Encamped at twenty minutes to 5 p. m., on a ravine with running water, which was slightly brackish. Grass abundant.

Mules grazed and herded as usual. No observations made. General direction, north 80° east; miles, 11 $\frac{8}{10}$.

Camp No. 52—Monday, May 8, 1854.—Left camp at half-past 5 a. m., and resumed our course. The country still continues gently rolling and open; post-oak in abundance, with hackberry, elm, scrub-oak, &c.

We are looking for the return of our express, which is a little behind its time. The distance to Fort Washita may be, however, greater than we had imagined.

Rattlesnakes are disappearing gradually since we crossed the Colorado; but, in lieu of these dangerous reptiles, we have the moccasin-snake, equally poisonous and much more treacherous.

We encamped at five minutes to 6 p. m. on Turkey creek, a tributary of the Red river, two and a half miles west of the Upper Cross Timbers. We had capital spring-water. Two barrels had been sunk by some of our predecessors, in which the water was delightfully pure and clear.

The day and night were remarkably hot; the latter cloudy and sultry to an insufferable degree. For the first time we were annoyed by the dismal croaking of the bull-frog, which made the night hideous with its never-ending and monotonous serenade.

The mules turned loose, unhobbled; grazed and herded as usual. No observations made. General direction, north 40° east; miles, 27 $\frac{1}{2}$.

Camp No. 53—Tuesday, May 9, 1854.—Our express arrived before we left camp, bringing a number of letters, but none of an official character.

We started at half-past 6 a. m., and resumed our course. At two and a half miles from camp we struck the Upper Cross Timbers, the road through which is hilly and much cut up. In many places it is sandy, and the ascents and descents very steep; yet these do not present any serious obstacle to wagons. There is here a perfect forest of large post-oak; also elm, hackberry, and other trees in abundance. In the open spaces the soil is of the best quality; grass excellent. The Cross Timbers are eight miles from west to east—that is, from the point we entered until we left them.

Reached our camp, on the east edge of the Cross Timbers, at five minutes to 11 a. m., on a well-timbered ravine, in which there is a beautiful spring of water. Our encampment is delightfully situated. There was, however, one serious drawback to its enjoyment. The morning had been cloudy and threatening, raining slightly until

we halted, when we had a regular thunder-storm, the rain coming down in torrents, with hail-stones of an enormous size. It continued until near sundown, gradually abating in violence; then clearing off, the night was bright and pleasant.

The streams which we passed during our route to-day, together with the ravine on which we are camped, run into the Red river towards the north. The mules grazed and herded, &c., as usual. No observations made. General direction, north 85° east; miles, $14\frac{4}{10}$.

Camp No. 54—Wednesday, May 10, 1854.—The wagonmaster and a Mexican started, at half-past 5 a. m., for Fort Washita, with official and private letters for the mail; also, to select a house and encampment for the command by the time it reaches Preston, and to make some preliminary arrangements for the sale of our mules, &c., &c.

Left camp at half-past 7 a. m., and resumed our course over a rolling and open country, passing several small streams—sources of the Trinity—and encamped on the Elm fork of that river at 11 a. m.

The soil on our route to-day is of a darker color, and appears richer than any we have yet seen. The timber is not so abundant as it has been for some time past. The country is more open, with a most luxuriant growth of excellent grass.

Our camp is delightfully situated; the banks of the creek are covered with elm, post-oak, some walnut, and other trees; water and grass abundant and good.

It is a matter of some surprise that this section of country, to which nature has been so liberal of her favors, is not more settled. The soil and climate invite the farmer, assuring him a rich return. The dread of Indians is, no doubt, the principal cause; and also, perhaps, the ignorance of the advantages which are offered to the emigrant and settler, may furnish another reason. Our survey, by bringing its resources properly into notice, will remove the latter cause; the removal of the former will follow as an inevitable sequence.

Mules grazed and herded as usual, &c., &c. Observations made for longitude and latitude. General direction, north 78° east; miles, $9\frac{2}{10}$.

Camp No. 55—Thursday, May 11, 1854.—Left last camp at ten minutes after 7 a. m. There was a heavy dew last night, and there would be little necessity for rain if such dews were frequent. We resumed our course over a high ridge; the road was very muddy and heavy in many places, the result of the late rain.

The country is more open than it has been for the last few days; but the banks of the streams along our route are covered with an abundance of timber. The richness of the soil cannot be excelled; the quality of the grass cannot be equalled.

We crossed several small tributaries of the Trinity, and encamped at 11 a. m. on the Elm fork. The bank on the west side is steep, being worn away by the action of the water; that on the east side is more sloping. We passed over it without any difficulty. The bottom is rocky and firm, being composed of limestone and gravel; the water is pure and clear—very deep in some places, with plenty of perch, bass, sunfish, &c. From appearances there must be a swift and overwhelming current after heavy rains, but it quickly subsides. We found here many curious specimens of fossil. This stream is bor-

dered by a growth of large timber; elm, red, white, and post-oak predominate. There are some few trees of hickory, dogwood, and walnut.

As the day was warm and sultry, many of the command refreshed themselves by swimming, washing, &c. In anticipation of our speedy arrival at Preston, our razors were brought into active requisition; beards of the most patriarchal cut were trimmed down to ordinary dimensions, or totally demolished, and the cherished moustache disappeared beneath the ruthless hand of the barber. These operations caused much pain and many an expression of regret; but whether occasioned by the loss of these "facial developments" or by the bluntness of the razor, is a matter for conjecture.

About a mile from camp there is a farm-house, beautifully located. The owner, a person named Hewitt, settled here last fall. This farm appeared well stocked. Two families live here: there are six young children, who appeared sickly; indeed, two of them suffering from ague. Many (to us) great luxuries were purchased here, such as chickens, eggs, butter, and milk. We were not able to obtain more than five bushels of corn, at \$1 50 per bushel; the owner, as he stated, had bought this corn, not having time to raise any since he settled.

Our animals were grazed until sundown; then driven in and fed with corn, herded, &c., &c. No observations made; night cloudy. General direction, south 80° east; miles, 11.

Camp No. 56—Friday, May 12, 1854.—Left last camp at ten minutes after 6 a. m., and resumed our course. Our route was similar to that of yesterday. In respect to soil and vegetation, it was somewhat more timbered; the road was heavy, but our animals travelled capitally. It was truly pleasant to see the farms, of which there were several along our course; one particularly was on a grand scale, having a large amount of land well-fenced in and thickly planted with fruit-trees. All these farms appear well stocked.

About six miles from camp we reached Gainsville, which is beautifully located, and is no doubt the nucleus of a flourishing and important city. It consists of about fifteen houses; has two groceries, with their inseparable companion, a court-house, and a couple of dry-goods stores. We purchased ten bushels of corn, at \$1 50 per bushel; this price is as exorbitant as that charged for the same article in New Mexico. Everything else is dear in proportion. Tobacco, (very poor,) \$1; sugar, 19 cents; coffee, 24 cents; tea, \$2 per pound. This scale of prices will, after a short time, find its level.

We did not see Gainsville under the most favorable circumstances, as it rained sharply while we waited for the corn to be loaded. We noticed, however, some of the celebrities of the place, among whom the "Doctor" was the most conspicuous. He sported white inexpressibles, which contrasted strangely and strongly with the surrounding black and wet soil. It would not be charitable or humane to wish *him* success, at least, in his legitimate profession. There would appear to be some ague in this locality. Building-lots can be purchased in the town for \$50.

Bidding adieu to Gainsville, we pursued our course, and encamped at 11 a. m. near a stream of excellent water, a tributary of the Trinity. During our day's march we passed a number of small streams and

rivulets, all the sources of this river. Our encampment is situated in a dense grove of post-oak, which completely shelters us from the wind and rain. Along the margin of the stream there is plenty of fine elm and red and white oak, of a large size. The day was cloudy and rainy until near sundown, when it cleared off.

We were informed by a person who passed through our camp that some Waco Indians had stolen some horses from the neighboring settlements, and two of them killed the day previous; the Red river being very high at the time, prevented the rascals from crossing.

The mules were not fed with corn; they were grazed, herded, &c., as usual. No observations made; night cloudy. General direction, north 50° east; miles, $12\frac{6}{10}$.

Camp No. 57—Saturday, May 13, 1854.—Left last camp at ten minutes past 6 a. m., and pursued our course over a rich, well-timbered, and gently-rolling country. In our day's march we passed a number of small creeks, with running water, tributaries of the Red river. About seven miles from last camp we struck the Lower Cross Timbers, which consist of a dense growth of red, white, and post-oak, elm, and some hickory. The timber is somewhat larger than that in the Upper Cross Timbers. This place is about fifteen miles through. We encamped at half-past 11 a. m., on the banks of a heavily-timbered ravine, which contained rain-water. It is bordered with post-oak and elm of a tolerably large size. The grass is excellent, and in the utmost abundance.

Our encampment is situated at a little distance from several very fine farms. One of the most extensive belongs to a person named McCarthy. These farms, though but recently settled, present every indication of prosperity. They are well-stocked, and the horses are particularly fine. We purchased twenty bushels of corn, at one dollar and twenty-five cents per bushel. The corn had not been raised here, but was bought at Preston and hauled to this place. There is in this neighborhood an extensive coal-mine; but it was too distant from camp to obtain a specimen. Mules driven in at sundown, fed with corn, hobbled, and turned out to graze as usual. Observations made for time and latitude. General direction, ———; miles, $14\frac{4}{10}$.

Camp No. 58—Sunday, May 14, 1854.—There fell during the night a very heavy dew; indeed the heaviest we had yet experienced. This morning was cold and damp.

Left last camp at half-past 6 a. m., and resumed our course. Our road for some distance was over a fine rolling prairie, with settlements scattered along, beautifully located. About seven miles we entered a densely-timbered wood, the road through which was miserably bad. It appeared to have been recently covered over with water. At its eastern edge it is bounded by a rapid and deep stream, with high and miry banks, which must be nearly impassable after heavy rains. It occasions a considerable amount of labor to cross it. This stream is called the "Big Mincral," in consequence of its waters, when high, becoming brackish. Having crossed, we resumed our march over a capital country. Soil excellent; abundance of timber, (post-oak, elm, &c.,) water, and grass.

Mitchell, the express, met us at about 9 a. m., bringing some letters from Washita. He had selected the camp as directed. Reached camp, which is about six miles from Preston, at 12 noon, on the margin of a small running stream, evidently proceeding from a spring. The water is slightly brackish. We had no occasion to use it, as there was plenty of rain-water in the ravine round our camp. As on the previous day, we passed several small streams and rivulets, all tributary to the Red river.

We met a gentleman, (Mr. Massie,) an extensive land-owner, from whom we received considerable information about the navigation of the rivers, &c. He remained with us some time in camp.

Our encampment is situated at a short distance from an extensive farm. There is a large number of peach-trees planted here. Mules treated as on the previous evening, &c. No observations made. General direction, ———; miles, $14\frac{4}{10}$.

Camp No. 59—Monday, May 15, 1854.—Moved on to Preston, distance $5\frac{7}{10}$ miles. Spent nearly the whole day in crossing to the east side of the Red river. Preston is situated on a bluff, one hundred and fifty feet above the bed of the river, and is a small, dilapidated place, containing probably five hundred persons. Encamped near Tyson's farm.

From May 15th to May 25th, employed in discharging the men and selling the animals and wagons. Then moved forward to Fort Washita, where the field-work of the expedition was closed. On the 10th of July moved forward to Fort Smith, and from thence to Washington city.

TABLE OF CAMPING PLACES ALONG THE DIRECT LINE OF SURVEY.

Date.	Camp.	Distance from camp to camp.	Total distance from El Paso.	Remarks.
		<i>Miles.</i>	<i>Miles.</i>	
Feb. 21	Camp No. 1, Waco Tanks.....	.....	24.3	Water, in natural tanks; wood and grass.
22	Camp No. 2, in pass of the Sierra Alto.....	5.4	29.4	No water; brush for wood; good grass.
23	Camp No. 3, Sierra de los Alamos.....	23.2	52.9	Spring water; grass good; cactus for wood, not very abundant.
24	Camp No. 4, Las Cornudas.....	8.2	61.1	Water in natural rock tanks; wood, small trees; grass.
25	Camp No. 5, on the open plain.....	11	72.1	No water; cactus for wood, in abundance; fine grass.
26	Camp No. 6, Ojo del Cuerbo.....	13.1	85.2	Water in abundance; fine springs, (sulphurous;) grass poor; small brush for wood.
27	Camp No. 7, in pass of Guadalupe mountains.....	11.6	96.8	No water; cactus for wood, in great quantities; fine grama-grass.
28	Camp No. 8, near head of cañon in Guadalupe Pass....	10.7	107.5	Fine spring-water; no wood; grass, but not very good or abundant.
March 1	Camp No. 9, pinery on the east slope of Guadalupe mountains.....	4.7	112.2	Water, wood, and grass, in the greatest abundance, (fine springs;) pine groves; grama-grass.
2	Camp No. 10, near Independence springs.....	5.9	118.1	Three fine and large springs; thickets of scrub-oak and hickory; good grass.
3	Camp No. 11, head springs of Delaware creek.....	14.5	132.6	Several fine mineral and fresh-water springs; grass good; no wood near.
6	Camp No. 12, on Delaware creek.....	11.3	143.9	Water, wood, and grass; water sulphurous; dwarf cedar for wood; grass not very good.
7	Camp No. 13, on Delaware creek.....	13	156.9	Water of Delaware creek; plenty of roots for wood; good grass.
	Camp No. 14, on Pecos river, at mouth of Delaware creek.....	5.7	162.6	Water, wood, and grass abundant; roots for wood.
April 8	Camp No. 15, on the Llano Estacado.....	25	187.6	No water; grass good, and roots for wood.
9	Camp No. 16..... do.....	36.5	224.1	No water; grass not very good; roots for wood.
10	Camp No. 17..... do.....	29	253.1	No water; good grama-grass; roots for wood.
11	Camp No. 18, Sulphur springs of the Colorado.....	34.2	287.3	Water plenty and good; grass good; roots for wood.
12	Camp No. 19, on the open plain.....	11.9	299.2	No water; good grass, and mezquite groves for wood.
13	Camp No. 20..... do.....	14	313.2	No water near; grass good; mezquite groves.
14	Camp No. 21, on the Colorado.....	18.1	331.3	Water, wood, and grass.

TABLE OF CAMPING PLACES—Continued.

Date.	Camp.	Distance from camp to camp.	Total distance from El Paso.	Remarks.
		Miles.	Miles.	
April	15 Camp No. 22, on a creek with pools of water.....	11.5	342.8	Water, wood, and grass; mezquite for wood.
	16 Camp No. 23, on dry tributary of the Brazos.....	13.1	355.9	Mezquite for wood; good grass; no water, but water in abundance ten miles west, and five miles east.
	Camp No. 24, on a creek with pools of bitter water.....	15.2	371.1	Groves of heavy mezquite for wood; grass tolerably good. Passed plenty of good water during the day at convenient distances.
	18 Camp No. 25, on dry tributary of Clear fork of Brazos..	16.8	387.9	No water; abundance of mezquite; good grass.
	19 Camp No. 26, on large creek with pools of water.....	16.9	404.8	Abundance of water, wood, and grass.
	20 Camp No. 27, on tributary of the Brazos.....	16.2	421	Water, wood, and grass, (good.)
	21 Camp No. 28, on Clear fork of the Brazos.....	12.2	433.2	Water, grass, and wood, in abundance.
	22 Camp No. 29 do.....	3.2	436.4	Do do do.
	24 Camp No. 30 do.....	15.5	451.9	Do do.
	25 Camp No. 31, on a small creek.....	16.8	468.7	Do do.
	26 Camp No. 32, on west bank of Brazos river.....	15.6	484.3	Do do.
	27 Camp No. 33, on a creek of running water.....	10.1	494.4	Do do.
	28 Camp No. 34, on a creek with pools of water.....	16.2	510.6	Do do.
	29 Camp No. 35, near two creeks, with plenty of water.....	12.6	523.2	An abundance of wood; water good; grass very good.
May	7 Camp No. 36, on a creek with a rocky bed.....	11	534.2	Water, wood, and grass, all good.
	8 Camp No. 37, on a creek with standing water.....	26.1	560.3	Plenty of water, wood, and grass.
	9 Camp No. 38, on east edge of Upper Cross Timbers....	13.6	573.9	Water in springs to the north of the road, and in a ravine; wood plenty; grass good.
	10 Camp No. 39, on Elm fork of the Trinity river.....	8.8	582.7	Water, wood, and grass, (good.)
	11 Camp No. 40, on Clear fork..... do.....	10.5	593.2	Water, wood, and grass, good and abundant.
	12 Camp No. 41, on a creek of running water.....	11.8	605	Do do.
	13 Camp No. 42, near eastern edge of Lower Cross Timbers	13.6	618.6	Water, wood, and grass, (good.)
	14 Camp No. 43, on a creek flowing into Red river.....	13.5	632.1	Do do.
	15 Preston, on Red river.....	7.3	639.4	

CHAPTER XIII.—GEOLOGICAL REPORT.

Geological notes of a survey of the country comprised between Preston, Red river, and El Paso, Rio Grande del Norte.

Boston, September 21, 1854.

DEAR SIR: I have the honor to submit these geological notes in relation to the route you have surveyed from El Paso del Norte to Preston, with a view to the construction of a railroad from the Mississippi valley to the Pacific coast.

I have availed myself of the notes which you sent to me in your letter of the 12th September, and of the excellent collections of minerals, rocks, and fossils which you made during your survey. The short time allowed me to prepare this resumé must be the excuse for its brevity and imperfection. To complete the study of your collection will take several months, and then I shall be able to send you a detail report, with a map, descriptions, and drawings of the new fossils, and an analysis of the minerals you have collected in your very interesting survey. Meanwhile, I hope these notes will suffice to give you a slight sketch of the mineralogical and geological resources of the country.

Preston and its environs are formed of the cretaceous rocks that extend along the Red river and the False Washita, and as far as the Canadian river. These rocks form also the beds of several tributaries of Trinity river, especially of the Elm fork of Trinity, where your survey has found this formation very well developed with numerous fossils. The cretaceous consists, at the base, of yellowish-gray limestone, filled with broken oysters, of which the most common species is the *Gryphea pitcheri*; then pale grayish-blue clays are superposed, containing numerous fossils, such as *Exogyra Texana*, *Ostrea carnata*, *Pecten quinquecostatus*, *Toxaster Texanus*, &c. Upon these clays are sandy limestones, grayish-white, containing large *ammonites* and *baculites*: the most common are *Baculites asper*, and several other new species that you have collected, and which I will describe in the final report. The lower part, formed of limestone with *Gryphea pitcheri*, and blue clay with *Toxaster Texanus*, corresponds to what is called by geologists the neocomian formation; while the upper portion, containing *ammonites* and *baculites*, corresponds to the formation designated as *green-sand* and *marly chalk*.

These cretaceous rocks are very useful in the construction of a railroad. Lying in horizontal strata, they form excellent embankments, contain numerous springs of water, and the limestone especially yields excellent lime for building. The road is upon these rocks from Preston to the Lower Cross Timbers, where, beneath the cretaceous, is seen pinkish-gray and often violet sandstone, with an inclination south-southeast, and in discordant stratification with the cretaceous rocks. This sandstone formation belongs to the *carboniferous* rocks, whose different beds occupy the whole country of the survey between the Lower Cross Timbers and the Elm fork of Trinity river, and the sources of the Clear fork of the Rio Brazos.

On different points of the cliffs of the Rio Brazos, especially in the neighborhood of Fort Belknap, several coal-beds outcrop, and show the

richness of this coal-field of Texas. The carboniferous rocks of the Rio Brazos are connected with those of the Arkansas river, being covered only for a width of thirty miles by the cretaceous formation at Red and Trinity rivers; and as those of Arkansas continue without interruption further north than the river Des Moines, in Iowa, it is evident that the immense coal-field west of the Mississippi is fully equal to that on the east of this river, and that the population of the western prairies will have at hand large supplies of this precious mineral. Besides the coal, the presence of which upon your route is of immense advantage for the construction of a railway, the carboniferous rocks present excellent sandstone for the construction of bridges and embankments, iron in abundance, and black slate.

The upper part and the headwaters of the Rio Brazos are situated on the rocks of the Trias. This important formation remained unrecognised, (some regarding it as *carboniferous*, and others as *lower silurian*), until my exploration of the Canadian. Dr. Ferdinand Roemer, in his exploration of the part of Texas that surrounds the German settlements of Fredericksburg and New Braunfelds, had thought that he recognised the Triassic rocks; but he cites them with hesitation. Hitchcock, in his report to Capt. Marcy on the Red river exploration, thinks justly, from the sections of Dr. G. Shumard, that this formation, which he calls *gypsum formation*, is not carboniferous; but he does not know exactly to what geological epoch it belongs. My survey along the Canadian river, and yours, show clearly that the Triassic rocks rest upon the carboniferous beds in discordant stratification; and that they are below the Jurassic rocks which form the summit of the immense table-land called the Llano Estacado.

From your specimens, I perceive the Trias is composed principally of red friable sandstone, with red and gray clay; in a word, it is variegated, with interposition of beds of gray sandstone, of dolomite or magnesian limestone; and, finally, it contains an immense mass of white gypsum, amorphous or crystallized, having the same structure and texture as the Triassic gypsum of France and Germany. Salt springs and saline efflorescences are also found in this formation. The characteristics of the American Trias are very easily recognised at first sight. It has red rocks, giving a reddish aspect to the whole country, with grayish-white bands of gypsum. All the water running through or springing from this formation is red and brackish; and one may say, without hesitation, that everywhere to the east of the Rocky mountains there is a *Red river* or *Vermillion river*, or *Salt fork* or *Rio Colorado*. These rivers run through, or have their source in, the Triassic rocks.

Your road was upon the Trias from the time that you quitted the banks of the Clear Water fork of the Rio Brazos until you reached the base of the Llano Estacado, at the source of the Rio Colorado of Texas. For the construction of a railroad the rocks of the Trias present great facilities. They furnish sandstone, plaster, or gypsum; excellent hydraulic lime from the magnesian limestone; and, finally, they are very easy to work, and at the same time firm enough to form excavations or embankments. Also numerous springs issue from the beds of red clay, and give water in abundance.

At the foot of the Llano Estacado, in following the ravines where

the headwaters of the Rio Colorado flow, and at Big Spring, is found a sub-chalky whitish limestone, containing fossils, such as *Exogyra Texana*, *Ostrea anorreaiformis*, *Ostrea vesicularis varancellor*, which indicate that these rocks belong to the group of the marly chalk of the cretaceous formation. It is probable that these strata of marly chalk are found again along the Rio Colorado, and are in continuous relation with those of the bluffs in the environs of Austin, New Braunfelds, Fredericksburg, and the Rios Guadalupe and Piedernales, &c.

By the side of these cretaceous rocks, at the foot even of the Llano, are beds of red sandstone, with variegated marls, forming the summit of the Trias; which are surmounted by whitish-gray limestone with flint. Some beds are oolitic, very white sub-chalk, and the first strata are formed of a very hard conglomerate, often very fine-grained, and then passing to a pinkish sandstone. These rocks, covering the variegated marls of the Trias, form the whole plain of the Llano Estacado as far as the river Pecos; they belong to the Jurassic epoch. Fragments of the *Gryphea Tucumcaris* are found in the limestone—a species of fossil very characteristic of this formation at Plaza Largo and at Tucumcari, near the Canadian river. These rocks of the Llano Estacado dip gently east-southeast; and as the heads of the strata outcrop at the foot of the Rocky mountains—called here Sierra de Mautana, Sierra Blanca, Sierra del Sacramento—in having artesian wells on any point of the Llano, abundant columns of water would be found to gush out over this immense plain; so that the want of water is not an objection to the establishment of a railroad on the Llano Estacado, for it may be obtained everywhere. Descending the cliffs of the Llano Estacado which border the river Pecos, at the foot of the bluffs are found again the variegated marl, red sandstone, and finally the crystallized and saccharoid or amorphous gypsum.

At the junction of the Delaware creek with the Pecos, there are found in the bed of the Rio Pecos thick strata of oolitic limestone; further down it is red, friable sandstone, very easily decomposed. On both sides of the Pecos there is drift and a sort of quarternary conglomerate, formed of the rolled fragments of all the strata through which the Pecos runs, from its source to the east of Santa Fe. This drift is chiefly composed of quartzose sand, and rocks in small, rolled fragments.

Ascending Delaware creek to the base of the Guadalupe mountains, there is an immense field, for fifty-eight miles, of white gypsum, amorphous or crystallized, with some beds of red and gray sandstone of the Trias. These gypsum rocks are prolonged along the river Pecos to Horse Head crossing, and they surround the southern foot of the Sierra of Guadalupe, forming the saliferous basins of the Salt lake, fifteen miles to the south of the road to El Paso.

At the headwaters of Delaware creek, Independence spring and the Ojo of San Martine come out from grayish Jurassic limestone, the same as that forming the Llano Estacado. As the beds here are raised by the dislocation of the Sierra of Guadalupe, the Cornudas, Los Alamos, Sacramento, &c., in ascending to the Guadalupe Pass, all the strata of the Trias and Jurassic are passed through; the Jurassic lime-

stone being covered here by grayish-white sandstone, often yellow, as at Tucumcari and Cañon Blanco, near Anton Chico.

In descending the west side of the Sierra of Guadalupe, and traversing the various other chains which intervene before reaching El Paso, the carboniferous limestones are found strongly upheaved and in contact with the eruptive rocks, which are granite, red sienite, and black sienite, with hornblende, with the trap forming a part of the Organ mountains, and finally with white horizontal sandstone, extending into the valley between the sierras. This sandstone is very friable, and decomposes into white sand. As far as I can judge without having the fossils of this sandstone, I think it represents the *upper chalk*, and is only a continuation of the sandstone which extends into the valley of the Rio Grande between Peña Blanco, Albuquerque, and Las Lunas.

The Organ mountains are celebrated for their rich mines of argentiferous lead, of which you have collected magnificent specimens. As regards the construction of a railroad, the rocks between Delaware creek and El Paso are very favorable. There are sandstone, limestone, granite; and it is probable that in choosing the points, artesian wells could be established with success by selecting the carboniferous limestone, or the white sandstone, for the operation.

Accompanying this will be found a rough sketch of a geological section of the country traversed by the survey, which I have made as complete as possible, not having gone over the ground myself.

JULES MARCOU,
Geologist and Mineralogist.

Captain JOHN POPE,
Corps Topographical Engineers.

CHAPTER XIV.—BOTANICAL REPORT.

[This report not being furnished in time, it is necessarily omitted in its proper place.]

CHAPTER XV.—NATURAL HISTORY.

SMITHSONIAN INSTITUTION,
Washington, October 1, 1854.

SIR: I have duly received the zoological collections made during your exploration of the country between El Paso and Fort Smith, and, in obedience to your request, herewith present a brief memorandum of their character and extent. The materials thus gathered prove to be of very high interest; as, besides a number of very rare or hitherto undescribed species, there are many the geographical distribution of which can be determined with a degree of precision hitherto unattainable. The most important of your contributions to natural science is to be found in the department of ornithology, which, as will be seen, numbers one hundred and twenty (120) species, including the collections made by Dr. Henry, U. S. A. The mammals are in considerable variety, as are the reptiles and fishes likewise. The precise number of the last-mentioned objects cannot now be given with exactness, as they are still in the fourteen large jars in which they were received; from which they will, however, be transferred and assorted as soon as suitable bottles can be procured. There are, of—

	Specimens.	Species.
Mammals.....	26	13
Birds.....	283	120
Reptiles (about).....	33	20
Fishes (about).....	30	17
Insects and other invertebrata, say.....	200	60
Total.....	572	230

Of these, probably thirty species are entirely new. I hope at the earliest possible moment to present you with a full report on these various specimens, with the necessary descriptions and illustrations. Until then, believe me,

Very respectfully, your obedient servant,
SPENCER F. BAIRD..

Capt. JOHN POPE,
United States Army.

CHAPTER XVI.—SOILS AND MINERAL WATERS.

PHILADELPHIA, *October 24, 1854.*

DEAR SIR: I have completed the examination of the eighteen specimens of soils which you forwarded to me; and, although a more thorough examination might be made of them, and with advantage, yet the limited time would not admit of it; and perhaps the present results may sufficiently meet your designs.

The annexed Table I, presents the per-centage composition of the soils in an absolutely dry state, together with numbers and localities by which you designated them. (See Table I.)

Of Table No. I, I remark, first, that the amount of lime was determined in all cases where there appeared to be about one per cent., but its presence was proved in all other cases. The deficiency in the total column is partly due to ingredients which were only tested for, but chiefly to the carbonic acid united with lime in the soil. In some of them, as in Nos. 1, 5, 6, and 17, a portion of the lime only is carbonated; the remainder being united with organic matter, except the small quantity existing as sulphate of lime.

Magnesia, manganese, chlorine, phosphoric and sulphuric acids, were severally tested for, but their quantities not determined. Their relative amounts, approximately determined, are indicated by the figures 1, 2, and 3. The alkaline test, similarly indicated, is chiefly due to lime. The organic matter is, in many cases, too high to express that portion which is generally regarded as contributive to fertility; and part of it is due to fine rootless, which were separated with difficulty and imperfectly. It may be observed, however, that the water originally in the air-dried soil bears a proportion to the content of organic matter.

The analysis of No. 4 shows that it is not a soil, but chiefly gypsum, or plaster of paris. The following is a better expression of its composition:

Dry sulphate of lime.....	71.23	} Gypsum = 90.08 per cent.
Water of the sulphate.....	18.85	
Carbonate of lime.....	0.46	
Silica.....	8.44	
Alumina and oxide of iron.....	0.74	
Hygroscopic moisture.....	0.45	
	<hr/>	
	100.17	
	<hr/>	

Since silica forms the frame-work of every soil, I have calculated the annexed Table II from the former, so as to compare the several ingredients with 100 parts of silex. No. 4 not being a soil, is omitted. (See Table II.)

The texture of soils is due to their content of alumina and oxide of iron, and the state of division of silex and silicates. Since the proportion of the two former varies from $3\frac{1}{2}$ to 6 in 14 out of the 17 soils, is about

11 in No. 18, and is nearly 3 in No. 14, all except one (13) have a good texture.

In the bases—lime, magnesia, and manganese—the soils are not in general deficient. The most important (lime) is contained in all, and in some of them in large proportion. Magnesia is wanting only in two cases, while more than one-half contain manganese, which is the least important.

The soils contain only minute quantities of the acid constituents, as is usually the case. Chlorine, indicative of common salt, is only wanting in two cases. Sulphuric acid, indicating sulphate of lime, is contained in thirteen soils, and in sufficient quantity. The most important, phosphoric acid, is found in only six specimens, and in one of these its presence is doubtful. But I may remark of this acid, that exceedingly minute quantities are known to produce a fertilizing effect; and yet its detection, in such cases, lies just at the limit of our capacity of testing its presence.

Judging from the mineral composition of the soils, as above developed by analysis, I would consider them all either as good soils or capable of a high degree of improvement. Nos. 1, 2, 3, 5, and 13, are light soils, the last one of which is inferior. Nos. 6, 8, 9, 10, 11, and 14, are heavier loams of good quality; but No. 6 appears to have but little depth, and No. 8 is rather too heavy. Nos. 12, 15, 16, 17, and 18, are similar in composition and texture, and appear to contain available organic matter; the first and last of these appear to be superior to the rest. No. 18 contains all the ingredients requisite to a good soil, except the alkalies, which were not tested for.

Analysis of waters.—The quantity of water was, in some cases, too small to make a thorough analysis of the substances dissolved; a qualitative examination of the constituents was therefore made in order to determine the peculiar character of each water. The gallon is here taken at 60,000 grains.

No. 1. Head of Delaware creek, spring, temperature 60° Fahr., March 4, 1854. This water contains 330 grains of solid matter per gallon, and it consists of a large quantity of sulphate and muriate of soda, of some sulphate of magnesia, of a small amount of sulphate of lime, and of a portion of sulphuret of sodium. The annexed Table III exhibits the approximate quantities of the several substances named above in all the waters. (See Table III.)

Nos. 1, 2, 6, and 7, are strong enough to allow of a detailed examination of their constitution, although the table sufficiently expresses their character.

I have the honor to be, your obedient servant,
JAS. C. BOOTH.

Capt. JOHN POPE,
U. S. Top. Engs., Washington, D. C.

TABLE I.

Number.	Description of locality.	Silica.	Alumina and oxide of iron.	Manganese.	Lime.	Magnesia.	Organic matter.	Phosphoric acid.	Sulphuric acid.	Chlorine.	Total.	Alkalinity.	Water originally in air-dried soil.
1	Bottom land, Delaware Springs	87.08	3.53	1	6.07	1	1.56	.....	2	1	98.24	1	3.50
2	Valley bottom, junction of Pecos river and Delaware creek	83.71	3.88	2	5.65	1	2.35	.....	2	1	95.59	2	2.02
3	East bank of Pecos, mouth of Delaware creek—high ground	89.13	4.04	2	2.70	1	2.17	.....	.....	1	98.05	1	2.42
4	First camp Delaware creek—high ground	8.44	0.74	.....	29.59	2	.....	.....	41.90	.....	99.97	1	19.30
5	Highland junction of Delaware creek and Pecos	79.96	3.58	2	8.31	1	3.51	.....	.....	1	95.36	1	2
6	Eighty miles east of Pecos, on Llano Estacado	81.66	3.12	.....	7.87	1	3.21	.....	1	1	95.86	.....	2.54
7	Llana Estacado, at camp, night of March 27	74.16	4.64	3	8.09	3	4.18	.....	1	1	91.07	1	3.98
8	Valley of Colorado, April 15	90.05	3.90	.....	2.22	1	1.79	1	.....	1	97.96	1	3.60
9	Rolling country, at camp, night of April 27	91.98	5.69	1	2	1	1.83	1	2	1	99.50	.....	2.96
10	At camp, at noon, April 26	91.68	5.71	2	2	.....	2.19	1	1	.....	99.58	.....	2.28
11	From a bend in Elm creek, en route, April 20	92.32	5.07	1	2	1	2.07	.....	2	1	99.46	.....	3.38
12	Cross Timbers, en route, forenoon of May 9	91.94	3.40	.....	2	1	3.70	1	1	.....	99.04	.....	7.02
13	Cross Timbers, en route, May 9	98.03	1.16	.....	2	1	0.87	1?	.....	1	100.06	1	1.52
14	Camp in night of May 7	95.63	2.62	.....	2	.....	1.19	.....	2	2	99.44	1	2.26
15	.....	91.62	4.23	.....	2	1	3.19	.....	2	1	99.04	1	5.86
16	Rolling country, en route, May 13	92.64	4.76	.....	2	1	1.96	.....	1	1	99.36	1	5.10
17	At camp, on night of May 11	89.85	3.20	.....	1.25	1	5.19	.....	2	1	99.49	2	7.94
18	En route, May 10—rolling country	81.14	9.43	2	2	1	6.75	1	1	1	97.32	1	11.08

TABLE II.

Number.	Results of analysis compared with 100 parts of silica.											Description.	
	Silica.	Alumina and oxide of iron.	Manganese.	Lime.	Magnesia.	Organic matter.	Phosphoric acid.	Sulphuric acid.	Chlorine.	Alkalinity.	Water originally in air-dried soil.	Color.	Texture.
1	100	4.05	1	6.97	1	1.79	.....	2	1	1	3.50	Light colored.....	Fine sandy.
2	100	4.64	2	6.75	1	2.81	.....	2	1	2	2.02	Light yellowish.....	Fine sandy.
3	100	4.53	2	3.01	1	2.44	.....	.....	1	1	2.42	Reddish.....	Fine sandy.
5	100	4.47	2	10.40	1	4.39	.....	.....	1	1	2	Light colored.....	Fine sandy.
6	100	3.82	.....	9.63	1	3.92	.....	1	1	.....	2.54	Reddish.....	Tenaceous loam; at one foot below surface the specimen consists of silicious stones.
7	100	6.26	3	10.90	2	5.64	.....	1	1	1	3.98	Grayish.....	Fine sandy, full of lumps of limestone and gravel.
8	100	4.34	.....	2.47	1	1.98	1	.....	1	1	3.60	Red.....	Very tenaceous, clayey.
9	100	6.19	1	2	1	1.99	1	2	1	.....	2.96	Reddish.....	Slightly tenaceous, clay and fine sand.
10	100	6.23	2	2	.....	2.39	1	1	.....	.....	2.28	Light reddish.....	Loam, clay, and fine sand.
11	100	5.49	1	2	1	2.24	.....	2	1	.....	3.38	Light reddish.....	Loamy, clay and fine sand.
12	100	3.70	.....	2	1	4.03	1	1	.....	.....	7.02	Dark.....	Tenaceous, clay and very fine sand.
13	100	1.18	.....	2	1	0.89	1?	.....	1	1	1.52	Gray.....	Fine and a little coarse sand.
14	100	2.74	.....	2	.....	1.24	.....	2	2	1	2.26	Reddish.....	Somewhat tenaceous, clay, coarse and fine sand.
15	100	4.62	.....	2	1	3.48	.....	2	1	1	5.86	Dark.....	Tenaceous, clay and very fine sand.
16	100	5.14	.....	2	1	2.12	.....	1	1	1	5.10	..do.....	Tenaceous, clay and very fine sand.
17	100	3.56	.....	1.39	1	5.78	.....	2	1	2	7.94	..do.....	Tenaceous, clay and very fine sand.
18	100	10.94	2	2	1	7.82	1	1	1	1	11.08	..do.....	Tenaceous, clay and very fine sand.

TABLE III.—MINERAL WATERS.

Number.	Locality of water.	Chloride of sodium.	Sulphide of sodium.	Sulphide of soda.	Carbonate of soda and lime.	Sulphate of lime.	Sulphate of magnesia.	Silica, alumina, and oxide of iron.	Total solid matter per gallon.	Alkalinity of unevaporated water.	Remarks.
1	Head Delaware creek, spring, temp. 60° Fahr., March 4, 1854.....	3	2	1	1	1	320	Alk.	The waters are alkaline previous to evaporation, except No. 5, and this alkalinity is chiefly due to sulphide of sodium; partly also to the alkaline carbonate. The carbonate is chiefly that of soda; only a small amount being carbonate of lime. The approximate amounts—little, much, and very much—are expressed by the figures 1, 2, and 3. It is interesting to observe that the sulphuretted salt waters of the springs Nos. 1, 2, and 3, as they pass down Delaware creek, lose their sulphuretted character in No. 4; their sulphur having been oxidized into sulphuric acid, so as to form sulphate of soda and lime. It appears, however, that in the Pecos the sulphuric acid has almost entirely disappeared.
2	Spring head Delaware creek.....	3	3	.....	1	.....	.....	1	315	Alk.
3	Spring head Delaware creek, temp. 61° Fahr., March 4, 1854.....	3	2	.....	1	.....	1	1	60	Alk.
4	Delaware creek, thirty miles below springs, ten miles above mouth....	3	.....	2	.....	1	1	1	187	Alk.
5	Pecos river.....	3	.....	.....	.....	.....	.....	.....	166½	Neutral.*
6	Mustang springs, or "La laguna"....	3	3	2	1	1	1	1	230½	Alk.	
7	Stream, camp No. 40.....	3	3	1	.....	1	1	1	392	Alk.
8	Sulphur springs, Colorado.....	3	2	.....	1	.....	1	1	51	Alk.

* Contains much chloride of calcium.

CHAPTER XVII.

Meteorological observations on survey for route for Pacific Railroad from Doña Ana, New Mexico, to Preston, Texas, under the command of Brevet Captain John Pope, Corps of Topographical Engineers.

Date.	Place of observation.	Distance from camp to camp.	Temperature of the air.					Temperature of the earth three feet beneath the surface.	Temperature of the water at camping places.	Remarks in reference to springs and water at camping places.	Winds.		Remarks concerning the weather and the state of vegetation.	
			A. M.		P. M.						Course.	Nature of—		
			Sunrise.	Noon.	Two o'clock.	Sundown.	Nine o'clock.					Morning.		Afternoon.
1854. Feb. 22	Waco Tanks	Miles.	°	° 57½	° 67	° 50	° 42	° 48	° 43 at the Tanks.	Water found in natural tanks in the rocks within caves.	E.	High wind...	High wind...	Weather clear and fine; vegetation backward.
23	Plain.....	4.2	39	58	64	55½	51	48	No water....	No water.....	SW.	High wind...	Breeze	Day clear; evening cloudy.
24	Cotton Wood Springs...	20.3	42	66	62	48½	45	48	49	A spring with a scanty supply.	SW.	Breeze	High wind...	Morning clear; afternoon slight rain.
25	Thorn's Wells (Las Cornudas.)	9	34	51	56	46	31	47½	50½	Natural cisterns exposed to the sky.	NW.	Breeze	Breeze	Morning cloudy; evening clear.
26	Plain.....	12	11½	59	70	56	35	47½	No water....	No water.....	SW.	Breeze	Calm.....	Day clear; evening clear.
27	Ojo del Cuervo (Crow Springs.)	17.1	32	69	78	55	38	51	48	Springs and a lake, both brackish; soil moist.	SW.	Calm.....	Breeze	Fine weather; perfectly clear.
28	Plain.....	12.4	28	78	78	60	54	51	No water....	No water.....	W.	Calm.....	Calm.....	Morning clear; evening cloudy.
Mar. 1	Guadalupe Pass.....	11.8	51	59	55½	53	40	50½	45½	Spring at the foot of the "High Peak."	W.	Stormy.....	Stormy.....	Morning cloudy; day clear.
2	Pinery.....	4.1	34	55	56	44	25	49	58½	Spring at the foot of a mountain.	W.	High wind...	Breeze	Day clear; vegetation backward.
3	Independence Springs..	6.3	38	68	72	48	32	50	64	Two springs about 40 yds. apart. Water clear and good.	W.	High wind...	High wind...	Day clear; vegetation improving as we descend from high table-land.
4	Delaware Springs.....	16.1	20	60	66	51	37	51	60°	Spring of sulphur No. 1, (see samples.)	E.	Calm.....	Breeze	Day clear.
5	.....do.....	0	30	.....	72	64	49	51	64°	Spring of sulphur No. 3, (see samples.)	E.	Breeze	Calm.....	Cloudy all day.
6	.....do.....	0	45½	70	75½	68	53½	51	61°	Spring of sulphur No. 2, (see samples.)	SW.	Calm.....	Breeze	Cloudy; rain in the evening; thunder-storm at night.
7	Delaware Creek	12.2	40	80½	79	72	48	57	65	Spring of fresh water, (see samples.)	SW.	Breeze	Breeze	Day clear; night cloudy.
8	.....do.....	13.9	38	77	77	60	46	49	58	Clear stream, 6 feet wide	W.	Breeze	High wind...	Morning cloudy; afternoon clear.

METEOROLOGICAL OBSERVATIONS—Continued.

Date.	Place of observation.	Distance from camp to camp.	Temperature of the air.					Temperature of the earth three feet beneath the surface.*	Temperature of the water at camping places.	Remarks in reference to springs and water at camping places.	Winds.		Remarks concerning the weather and the state of vegetation.	
			A. M.		P. M.						Course.	Nature of—		
			Sunrise.	Noon.	Two o'clock.	Sundown.	Nine o'clock.					Morning.		Afternoon.
1854. Mar. 9	Falls of the Rio Pecos, mouth of Delaware Creek.	Miles. 6	40	65	69	53½	42	49½	57	Muddy and rapid stream, about 80 feet wide. Delaware Creek has an average width of about 6 feet at and above its junction with the Pecos; water clear and transparent, but very brackish. The water of the Pecos is muddy and brackish.	N.	High wind...	High wind...	Day cloudy; evening cloudy.
10	do.	0	28	67	71	60	42	51	57	.....	W.	Calm.....	Breeze.....	Day clear.
11	do.	0	24	73	79	67	57½	51	57	.....	NW.	Breeze.....	Breeze.....	Day clear.
12	do.	0	36	82	76½	68½	65	51	57	.....	W.	Breeze.....	Strong breeze	Day cloudy; threatening rain.
13	do.	0	46	71	70½	64½	54	51	57	.....	W.	Breeze.....	Breeze.....	Day cloudy.
14	do.	0	43	82	81½	58	49	52	60	.....	E.	Calm.....	Calm.....	Day cloudy; evening floating clouds.
15	do.	0	37½	63	88	73	58	53	62	.....	SW.	Breeze.....	Breeze.....	Day and evening clear.
16	do.	0	42	89	94	78	52½	54	65	.....	W.	Calm.....	Breeze.....	Morning floating clouds; evening clear.
17	do.	0	41	91	98	81	73	54	65	.....	W.	Breeze.....	Strong breeze	Morning floating clouds; evening clear.
18	do.	0	45	82	82	68	62	55½	63	.....	SW.	Breeze.....	Breeze.....	Morning floating clouds; evening cloudy.
19	East side of Rio Pecos..	12.4	53	55	54	54½	53	66	60	Water brackish and muddy	E.	Breeze.....	Breeze.....	Morning slight rain; evening appearance as if clearing up.
20	do.	19.6	50	80	89	87	54	66	63	Water brackish.....	SE.	Calm.....	Breeze.....	Morning cloudy and misty; evening clear.
21	do.	17.2	41	84	81	67	58	66	63	.....do.....	W.	Breeze.....	Breeze.....	Morning clear; afternoon cloudy.
22	do.	20.4	52	82	82	74	68	63	64	.....do.....	W.	Calm.....	Calm.....	Day cloudy; a few drops of rain at night.
23	do.	7.2	58	88	82	73	68½	68	66	.....do.....	SW.	Calm.....	Breezy.....	Floating clouds; evening dark clouds.
24	do.	19.8	51	88	93	72	72	63	No water....	W.	Calm.....	Breeze.....	Clear day; rain in the night with lightning.	
25	Llano Estacado.....	16.4	49	73	76	46	40	63	70	Ponds of rainwater.....	W.	Breeze.....	High wind...	Clear day.
26	Sand Hills.....	12.6	44	50½	56	50	42	63	No water....	E.	Breeze.....	Calm.....	Cloudy all day.	
27	Llano Estacado.....	18.9	34	74	76	66	56	63	No water....	SE.	Breeze.....	Breeze.....	Clear day; heavy dew in the morning for the first time on our journey; the plain covered with flowers.	

28	Llano Estacado.....	28.8	47	80	82	64	60	62	No water....	Dry beds of ponds, but no water at present.	SE.	Breeze	Strong breeze	Dew in the morning; atmosphere more humid. A heavy mass of clouds driving from SE. clouded the sky in the morning for a few hours; the day afterwards clear; grass greener to-day.
29	Mustang Springs.....	13	54	84	88	70½	58	60	69	Lakes of water somewhat saline.	S.	Breeze	Breeze.....	Fog in the morning; day clear.
30	Llano Estacado.....	10.8	60	88	88	76	64	62	No water....	No water.....	W.	Breeze	High wind...	Fog in the morning; day clear, the wind changing gradually from SE. to W.
31	Big Springs of the Colorado.	10.8	48	58½	59	50	41	Rocky underneath the soil.	62	A fine spring issuing in a deep pool 30 yards in diameter, situated amid surrounding rocks; water good; runs off in a stream about as thick as a man; a beautiful camping place.	N.	High wind...	High wind...	A high wind all night, the wind shifting gradually north about 9 a. m.; floating clouds; no dew.
April 1	Llano Estacado.....	10.6	29	59	63	51½	42	62	No water....	No water.....	SE.	Breeze	Strong breeze	The wind shifting from SE. to S., and back again to SE., during the day; light clouds floating all day. Day clear; no dew in the morning.
2	Sulphur Springs of the Colorado.	16	31	67	74	69	54	62½	59	A number of slender springs issuing from the side of a ravine; the water of one spring impregnated slightly with sulphur; the water of the remainder of good quality, holding a small quantity of lime in solution.	SE.	Strong breeze	Strong breeze	Day clear; no dew this morning, the wind blowing with a strong current SE. all night.
3	.....do.....	0	44	79	84	70	59	62½	59	.....	S.	High wind...	High wind...	Calm during the night; wind rose in the morning; clear morning; afternoon white clouds; evening clear and calm.
4	.....do.....	0	54	78	76	61½	44	62½	59	.....	N.	High wind...	Strong breeze	Heavy dew in the morning; the day clear; beautiful sunset.
5	.....do.....	0	32	84	88	66	46½	62½	59	.....	SW.	Calm.....	Breeze	Day clear.
6	.....do.....	0	34	92	92½	70	58	62½	59	.....	SW.	Gentle breeze	Gentle breeze	In the morning occasional dark clouds driving over the sky; the rest of the day more cloudy. In the evening a beautiful sunset, the remainder of the sky being overcast.
7	.....do.....	0	45	91	94	73	69	62½	59	.....	S.	Strong breeze	Strong breeze	Night high wind. In the morning cloudy towards sunrise; day, thin white clouds, occasionally; wind changed to the north towards evening.
8	.....do.....	0	56	80	82	66	50	62½	59	.....	W.	Strong breeze	Strong breeze	Morning clear; wind changeable. In the evening light filmy clouds. The cold nights seem to retard vegetation.
9	.....do.....	0	28	62½	68	56	42	62½	59	.....	N.	Strong breeze	Strong breeze	Morning cloudy; afternoon clear; the wind changed round to the south towards evening.
10	.....do.....	0	41	68	74	60	49½	62½	59	.....	E.	Strong breeze	Strong breeze	

METEOROLOGICAL OBSERVATIONS—Continued.

Date.	Place of observation.	Distance from camp to camp.	Temperature of the air.					Temperature of the earth three feet beneath the surface.	Temperature of the water at the camping places.	Remarks in reference to springs and water at camping places.	Winds.		Remarks concerning the weather and the state of vegetation.	
			A. M.		P. M.						Course.	Nature of—		
			Sunrise.	Noon.	Two o'clock.	Sundown.	Nine o'clock.					Morning.		Afternoon.
1854.		Miles.	°	°	°	°	°	°						
April 11	Sulphur Springs of the Colorado.	0	38½	87	88	60	47½	62½	59	.....	W.	Gentle breeze	Gentle breeze	Dew in the morning; the day clear; evening calm.
12	.....do.....	0	36	89½	88	78½	64	62½	59	.....	SW.	Gentle breeze	High wind...	Slight dew; entire day clear; the wind changed to south towards evening.
13	Plain	11.4	49	79	81	68	58	66	No water....	No water	W.	High wind...	High wind...	Morning clear; afternoon occasional clouds.
14	.....do.....	15.1	44	70	69	58	47	66	No water....	No water	NW.	High wind...	High wind...	Day unclouded.
15	Rio Colorado.....	18.2	32	69½	80	60	47	64	63	A stream about 3 ft. wide and 6 inch. deep: water red color and brackish.	N.	Breeze	Strong breeze	Dew in the morning; sky clear; afternoon occasional clouds, and a few drops of rain.
16	On a ravine.....	12.1	40	80	79	62	53	66	64	An affluent of the Colorado; water running in small stream and brackish.	NW.	Breeze	Calm.....	The wind very changeable in its course; no dew in the morning; day unclouded; grass green, and three or four inches high.
17	On divide of the Colorado and Brazos rivers.	16.2	43	82	87	75	64	65	No water....	We passed a stream of good water at noon.	S.	Strong breeze	Strong breeze	Day clear.
18	Camp 39.....	16	53	87	86	76	66	65	Small pools..	Small pools of water somewhat stagnant. Passed during the day ravines having pools of water very saline.	S.	Calm.....	Gentle breeze	The morning sultry and hazy; the afternoon filmy white clouds passing over the sky; night cloudy.
19	Camp 40, on the plain..	17.6	62	82½	75	70	70	66	No water....	No water.....	SE.	Breeze	Breeze	Morning cloudy, with rain towards the west; afternoon cloudy, with a few drops of rain; at night a heavy cloud, with lightning towards the west.
20	Camp 41, on a ravine with stagnant water.	18.1	68	90½	96	73	69	68	No water....	Pools of stagnant water slightly brackish.	SW.	Breeze	Breeze	Morning cloudy; afternoon occasional white clouds.
21	Camp 42, on Elm creek.	17.4	66	98	94	83	74	69	.....	A ravine with pools of stagnant water slightly brackish.	SW.	Breeze	Breeze	Morning clear; afternoon occasional clouds.

22	Camp 43, Clear Fork of Brazos, running stream.	12.8	62	80	79	74	71	72	73	A stream of good water about 20 feet wide and a few inches deep.	SE.	Breeze	High wind...	Early in the morning clear; from 7 to 12 o'clock cloudy and threatening rain; afternoon cloudy; at night a high wind, with lightning towards the southeast.
23	Camp 44, same stream..	6.6	57	86	86	72	69	72	73	Same stream.....	S.	Breeze	Breeze	A storm last night, with thunder and lightning and some rain; morning clear; afternoon occasional clouds.
24	Camp 44.....	.....	58	80	86	68	55	72	73	Same stream.....	SW.	Gentle breeze	Strong breeze	Cloudy last night, with a heavy storm, accompanied with thunder, lightning, and rain; day clear.
25	Camp 45, on Elm creek and Clear Fork of the Brazos.	.....	50	88	90	72	56	68	73	Same stream.....	SW.	Gentle breeze	Strong breeze	Day clear; earth moist; appearances of recent rains.
26	Camp 46, on plain.....	18.7	63	90	97	69	62	68	No water....	No water.....	W.	Strong breeze	Gentle breeze	Day clear; grass from six to eight inches high.
27	Camp 47, a mile west of the Brazos river.	16.4	55	80	73	59	57	72	Rainwater in pools at camp.	Rainwater in pools.....	NE.	Strong breeze	Strong breeze	High wind last night, with clouds and lightning towards the north; wind in the north in the forenoon, and gradually changing round to the east by evening; morning clear; afterwards occasional clouds.
28	Camp 48, running stream	10.9	44	85	69	54	48	68	68	A running stream of good water about 3 feet wide.	NE.	Strong breeze	Strong breeze	Morning clear; afternoon occasional clouds.
29	Camp 49, on ravine.....	17.5	38	68	70	60	54	69	.....	Pools of water.....	SE.	Gentle breeze	Gentle breeze	Heavy dew in the morning; morning clear; occasional thin white clouds in afternoon; grass very fine, six to eight inches high.
30	Camp 50, on ravine.....	13.6	45	75	76	66	62	69	.....	Pools of water in a small ravine.	SE.	Strong breeze	Strong breeze	Occasional thin white clouds; grass very fine, from six to eight inches high.
May 1	.....do.....	0	58	79	79	71	68	69	.....	.....	SE.	High wind...	Strong breeze	Occasional clouds all day; evening cloudy; a few drops of rain.
2	.....do.....	0	62	75	78	71	67	69	.....	.....	SE.	Gentle breeze	Gentle breeze	Day cloudy; a few drops of rain in the afternoon.
3	.....do.....	0	64	80	81	68	67	69	.....	.....	SE.	Gentle breeze	Gentle breeze	The entire day cloudy, with occasional showers of rain; a fall of rain last night.
4	.....do.....	0	63	78	78	68	64	69	.....	.....	NE.	Gentle breeze	Strong breeze	A heavy thunder shower last night; the morning cloudy; afternoon occasional showers.
5	.....do.....	0	62	85	68	62	61	69	.....	.....	NE.	Gentle breeze	Gentle breeze	Morning cloudy, with showers of rain; afternoon cloudy and misty.
6	.....do.....	0	62	75	78	74	66	69	.....	.....	SW.	Strong breeze	Strong breeze	A shower of rain early in the forenoon; the remainder of the day occasional white clouds; evening clear.
7	.....do.....	0	60	80	78	72	69	69	.....	.....	S.	Strong breeze	Strong breeze	Clear day; the wind changeable in the morning, hovering between east and south.

METEOROLOGICAL OBSERVATIONS—Continued.

Date.	Place of observation.	Distance from camp to camp.	Temperature of the air.					Temperature of the earth three feet beneath the surface.	Temperature of the water at camping places.	Remarks in reference to springs and water at camping places.	Winds.	Remarks concerning the weather and the state of vegetation.			
			A. M.		P. M.								Course.	Nature of—	
			Sunrise.	Noon.	Two o'clock.	Sundown.	Nine o'clock.							Morning.	Afternoon.
1854. May 8	Camp No. 51, on a ravine.	Miles. 11.8	68	90	94	75	72	70½	.....	S.	Strong breeze	Gentle breeze	Morning clear overhead, but a cloud, with lightning, to the south; afternoon clear; light clouds in the evening.	
9	Camp No. 52, Buffalo Springs.	27.5	70	71	68	66	65	71½	66	S.	Strong breeze	Strong breeze	Morning cloudy, with showers of rain, with hail and lightning in the afternoon.		
10	Camp No. 53.....	14.4	58	76	75	64	56	68	67	NE.	Strong breeze	Strong breeze	Clear day; trees everywhere full of foliage.		
11	Camp No. 54.....	9.2	50	81	85	70	68	67½	69	SE.	Gentle breeze	Gentle breeze	Occasional clouds all day; a heavy dew in the morning.		
12	Camp No. 55, Dry Fork of Trinity.	11	70	72	77	73	72	70	70	S.	High wind...	High wind...	Last night cloudy; forenoon cloudy, with a shower of rain.		
13	Camp No. 56, on a ravine.	12.6	63	84	83	64	58	69	70½	W.	Gentle breeze	Strong breeze	Early in the morning cloudy; forenoon clear; afternoon same; clear night.		
14	Camp No. 57, near a spring.	14.4	52	76	80	67	64	68	74	E.	Gentle breeze	Gentle breeze	Heavy dew last night; forenoon clear; wind somewhat variable, fluctuating between east and south in the forenoon.		
15	Camp No. 58, 6 miles west of Preston.	14.4	58	88	84	78	76	69	74	S.	Gende breeze	Gentle breeze	Heavy dew last night; morning clear; afternoon cloudy, with a few drops of rain.		
16	Camp No. 59, east side of Red river.	0	74	80	81	67	63	.....	.....	S.	Strong breeze	High wind...	Early in the morning cloudy; the remainder of the forenoon clear; afternoon clear; the wind gradually changed round to the NW, towards evening.

17	.....do.....	0	53	76	79½	69	62	.....	.....	.....	.....	W.	Gentle breeze	Gentle breeze	Slight dew in the morning; forenoon clear; afternoon occasional clouds.
18	.....do.....	0	52	84	85	72	69	.....	.....	.....	.....	SW.	Gentle breeze	Gentle breeze	Heavy dew in the morning; forenoon clear; afternoon clear.
19	.....do.....	0	64	84	84	74	70	.....	.....	.....	.....	S.	Gentle breeze	Gentle breeze	Slight dew; forenoon clear; afternoon occasional white clouds; evening clear.
20	.....do.....	0	62	86	74	65	64	.....	.....	.....	.....	S.	Strong breeze	Strong breeze	Forenoon occasional heavy clouds; heavy rain in the afternoon.
21	.....do.....	0	62	70	72½	68	65	.....	.....	.....	.....	NE.	Calm.....	Gentle breeze	Cloudy day.
22	.....do.....	0	68	80	70	69	69	.....	.....	.....	.....	NE.	Gentle breeze	Gentle breeze	Morning occasional clouds; afternoon heavy showers of rain.
23	.....do.....	0	68	77	80	73	70	.....	.....	.....	.....	SE.	Gentle breeze	Gentle breeze	Rainy last night; showers of rain in the forenoon; afternoon sunshine alternating with heavy showers of rain; evening clear.
24	.....do.....	0	65	82	84	69	66	.....	.....	.....	.....	SW.	Gentle breeze	Gentle breeze	Morning clear; afternoon occasional heavy clouds, and thunder in the distance. Evening slight rain.

Table of latitudes, longitudes,

Date.	Station.	Latitudes.			Longi- Lunar distances.
		Stars observed.	Results.	Latitudes adopted.	
			° ' "	° ' "	
Feb'y 21	Dofia Ana, principal station.....			32 22 00	
	El Paso, principal station.....			31 44 15.7	
	Waco Tanks.....			31 56 37.5	
	22 Waco Pass.....	{ Sirius.....	32 02 13	} 32 01 34.5	
		{ Polaris.....	32 00 56		
	23 Alamos.....	{ Sun.....	32 08 47	} 32 03 53	
24 Cornudas.....	{ Sun, α Ursæ Majoris.....	32 07 06			
26 Ojo del Cuerdo.....	{ Sirius Polaris.....		} 31 57 28		
28 South point Guadalupe Mt.....				31 51 04	
March 1	Pinery, east side Guadalupe Mt.	{ Sirius.....	31 57 57	} 31 57 12.5	
		{ Polaris.....	31 56 28		
3 and 4	Head Delaware creek, principal astronomical station.	{ Sirius.....		} 31 54 39	Aldebaran 12.....
8 to 19	Pecos river, mouth Delaware creek, principal astronomical station.	{ Polaris.....				Spica Virginis 12.
24	Emigrant crossing of Pecos....	{ Sirius.....		} 31 56 49	Mars 12.....
		{ Polaris.....				Spica Virginis 24.
24	White sand hills, west side.....	{ Sun.....		} 31 20 54	
26	White sand hills, east side.....	{ Sirius Polaris.....				31 39 43.7
29	Mustang Springs.....	{ Sun.....		} 31 42 51.5	
		{ Spica Virginis.....	32 01 09		} 32 00 37
		{ Polaris.....	32 00 05		
31	Big Springs of Colorado.....	{ Spica Virginis.....	32 05 36	} 32 05 02.5	
		{ Polaris.....	32 04 29		
April 3 to 12	Sulphur Springs of Colorado, principal astronomical station.	{ Spica Virginis.....		} 32 23 59	Sun 48, Saturn 24.
		{ Polaris.....				Spica Virginis 48.
16	Colorado river.....	{ Spica Virginis.....	32 35 44.2	} 32 35 18	
		{ Polaris.....	32 34 51.5		
17	Tributary of Brazos river.....	{ Polaris.....	32 40 27.8	} 32 41 39	
		{ Spica Virginis.....	32 42 49.8		
20	Tributary of Brazos river.....	{ Polaris.....	32 53 45.1	} 32 54 15	
		{ Spica Virginis.....	32 54 45.8		
24	Clear Fork of Brazos.....	{ Polaris.....	32 59 24.3	} 33 00 07	
		{ Spica Virginis.....	33 00 49.2		
26	Brazos river.....	{ α Ursæ Majoris.....		}	
		{ Spica Virginis.....			
28	West Fork of Trinity.....	{ Polaris.....	33 28 06.9	} 33 29 07	
		{ Spica Virginis.....	33 30 07.5		
April 29 to May 7.	Waters of Trinity, principal astronomical station.	{ Polaris.....	33 31 35	} 33 31 59	Sun 24.....
May 10	Elm Fork of Trinity, principal astronomical station.	{ Spica Virginis.....	33 32 48			Spica Virginis 24.
13	Four miles east of Lower Cross Timbers.	{ Polaris.....	33 41 42	} 33 41 41	Pollux 24.....
		{ Regulus.....	33 41 40		
22	Preston.....	{ Polaris*.....		} 33 48 25	
		{ Spica Virginis.....			
June 22	Fort Washita, C. N.....	{ Polaris*.....		} 34 09 18	
		{ Spica Virginis.....			

The points marked thus (*) have been only approximately determined.

XVIII.

and magnetic declinations.

tudes.		Azimuths.				Observers.
Results.	Longitudes adopted.	Stars observed.	True bearing from north.	Mag. bearing from north.	Variations of compass.	
<i>h. m. s.</i>	<i>h. m. s.</i>		<i>° ' "</i>	<i>° ' "</i>	<i>° ' "</i>	
	7 07 00.7					Boundary Com.
	7 05 39.4					Do.
						Pope, Top. Eng.
						Do.
						Do.
						Do.
						Johnstone, Top. Engineers.
						Pope, Top. Eng.
}	6 58 04.7*					Do.
}	6 55 28.7*					Do.
						Do.
	6 50 40					Do.
	6 47 17.2					Do.
	6 45 35					Do.
}	6 47 22*					Do.
	6 44 21					Do.
						Do.
		{ Polaris.....	1 20 00 W.	11 50 00 W.	} E.10 30 25	Do.
		{ Spica Virginis....	141 10 50 E.	130 40 00 E.		
	6 36 58.5	{ Polaris.....	1 01 00 W.	12 30 00 W.	} E.11 12 20	Do.
		{ Spica Virginis....	150 55 40 E.	140 00 00 E.		
						Johnstone, Top. Engineers.
	6 35 27.5	{ Polaris.....	1 00 20 W.	11 20 00 W.	} E.10 16 51	Pope, Top. Eng.
		{ Spica Virginis....	142 43 02 E.	132 30 00 E.		
6 34 46.5	} 6 34 41.5	{ Polaris.....	0 46 40 E.	9 50 00 W.	} E.10 27 56	Do.
6 34 36.5		{ Spica Virginis....	141 19 12 E.	131 00 00 E.		
6 29 31	6 29 31	Polaris.....	0 14 00 W.	10 50 00 W.	E.10 36 00	Do.
						Do.
	6 25 28 3*					Do.
	6 25 48.5*					Do.

The final results are not yet computed.

CHAPTER XIX.

ASTRONOMICAL OBSERVATIONS.

AT DONA ANA, NEW MEXICO, FOR RATING THE CHRONOMETER.

Determination of time, January 28, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	18	04	65	28	00	2	09	17
10	20	37	65	48	30	2	07	45
10	21	35	66	15	40	2	05	44
10	23	49	66	32	30	2	04	30
10	24	21	66	51	30	2	03	05
10	26	47	67	11	30	2	01	32
10	27	17	67	32	00	2	00	00

Determination of time, January 29, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	15	44	65	14	40	2	12	02
10	17	04	65	33	50	2	10	38
10	18	32	65	54	40	2	09	13
10	20	06	66	16	50	2	07	33
10	21	40	66	37	10	2	06	00
10	23	46	67	05	00	2	04	00
10	25	23	67	27	10	2	02	18

Determination of time, January 30, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	26	15	68	07	10	2	01	47
10	27	51	68	27	30	2	00	12
10	30	07	68	56	40	Lost.		
10	32	03	69	21	40	Lost.		
10	33	59	69	46	00	Lost.		
10	35	45	70	06	40	Lost.		
10	37	32	70	29	20	Lost.		

Determination of time, January 31, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	21	18	67	17	40	2	06	46
10	22	46	67	39	00	2	05	10
10	24	14	67	58	00	2	03	44
10	26	01	68	22	10	Lost.		
10	27	32	68	41	40	2	00	27
10	29	22	69	05	40	1	58	38
10	31	18	69	30	40	1	56	54

Determination of time, February 1, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	30	30	69	56	10	1	56	48
10	31	55	70	14	20	1	58	38
10	32	08	70	38	40	Lost.		
10	34	28	70	46	10	Lost.		
10	35	49	71	02	30	Lost.		
10	37	12	71	19	10	Lost.		
10	38	24	71	34	20	Lost.		

Determination of time, February 2, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	31	40	70	39	30	1	57	23
10	33	18	71	00	50	1	55	44
10	34	36	71	17	30	1	54	24
10	35	56	71	34	40	1	53	02
10	37	00	71	54	30	1	51	21
10	38	54	72	10	50	Lost.		
10	39	10	72	25	50	Lost.		

Determination of time, February 4, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	26	04	70	30	30	2	03	28
10	27	17	70	47	00	2	02	16
10	28	43	71	06	00	2	00	53
10	29	54	71	21	40	1	59	43
10	31	14	71	39	10	1	58	21
10	32	20	71	53	20	1	57	13
10	33	36	72	10	20	1	55	55

Determination of time, February 5, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	35	18	73	09	00 (?)	1	45	38
10	37	05	73	21	40	1	47	07
10	38	26	73	37	50	1	48	26
10	39	44	73	54	00	1	49	59
10	41	18	74	12	40	1	51	17
10	42	36	74	29	00	1	52	38
10	44	06	74	46	30	1	53	36

AT CAMP, FOUR AND TWO-TENTHS MILES EAST OF THE WACO TANKS.

Determination of latitude, February 22, 1854.—Double altitudes of Sirius, in the east.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	41	04	80	41	30
7	43	40	80	58	20
7	46	03	81	10	00
7	48	44	81	24	10
7	50	27	81	32	30
7	52	52	81	44	00

Thermometer 42° Fahrenheit.

Heavens very hazy, with heavy clouds.

STATION ONE AND A HALF MILE EAST OF SIERRA DE LOS ALAMOS.

Determination of time, February 24, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	27	46	84	33	00
10	28	24	84	43	00
10	29	11	84	54	10
10	29	54	85	04	40
10	30	34	85	13	30
10	31	17	85	24	00
10	31	58	85	32	10

Thermometer 66° Fahrenheit

STATION ON SUMMIT OF SIERRA ALTO.

Determination of time, February 23, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	34	17	85	12	30
10	35	16	85	26	40
10	36	16	85	41	20
10	37	11	85	53	30
10	38	56	86	17	30
10	39	53	86	29	40
10	40	46	86	41	00

Thermometer 58° Fahrenheit.

POINT ABOUT EIGHT AND A HALF MILES FROM THE SIERRA ALTO.

Determination of time, February 23, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	44	42	85	47	20
1	45	44	85	32	50
1	47	10	85	13	00
1	48	11	84	59	30
1	49	11	84	44	00
1	49	59	84	33	20
1	50	47	84	22	20

Thermometer 53° Fahrenheit.

STATION ONE AND A HALF MILE EAST OF THE SIERRA DE LOS ALAMOS.

DETERMINATION OF LATITUDE.

Determination of time, February 24, 1854.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	27	46	84	33	00
10	28	24	84	43	00
10	29	11	84	54	10
10	29	54	85	04	40
10	30	34	85	13	30
10	31	17	85	24	00
10	31	58	85	32	10

Thermometer 66° Fahrenheit.

CAMP AT CORNUDAS.

Determination of latitude, February 24, 1854.—Double altitudes of Sirius, in the east.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	21	28	79	24	40
7	24	08	79	42	30
7	26	17	79	58	40
7	28	20	80	11	40
7	31	05	80	28	00
7	32	23	80	37	40
7	34	00	80	46	30

Thermometer 45° Fahrenheit.

Observations discontinued. Night suddenly clouded up.

Determination of time, February 25, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	22	09	83	57	40
10	23	04	84	10	40
10	23	54	84	23	20
10	24	28	84	32	00
10	25	12	84	43	00
10	25	54	84	53	20
10	26	35	85	04	10

Thermometer 50° Fahrenheit.

AT CAMP TWELVE AND ONE-TWENTIETH MILES EAST OF THE CORNUDAS.

DETERMINATION OF LATITUDE.

Determination of time, February 25, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	38	51	88	14	00
1	39	55	87	59	40
1	40	44	87	48	00
1	41	18	87	41	00
1	42	19	87	26	30
1	42	59	87	17	30
1	43	36	87	09	00

Thermometer 51° Fahrenheit.

Determination of latitude, February 25, 1854.—Double altitudes of Sirius, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	37	25	72	45	30
6	39	16	73	08	10
6	40	48	73	25	10
6	42	44	73	47	20
6	44	51	74	12	40
6	45	58	74	26	30
6	47	05	74	38	10

Double altitudes of Procyon, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	53	09	98	58	20
6	54	22	99	22	40
6	55	54	99	54	30
6	56	54	100	15	00
6	58	18	100	44	00
7	00	58	101	40	00
7	02	33	102	11	40

Thermometer 31° Fahrenheit.

Determination of latitude.—Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	41	30	73	07	40
7	43	51	73	43	40
7	45	56	74	09	40
7	49	46	75	03	30
7	51	34	75	29	20
7	52	54	75	45	40
7	55	13	76	20	00

Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	27	45	64	14	40
8	30	41	64	09	40
8	33	12	64	08	00

Thermometer 31° Fahrenheit.

Determination of time, February 25, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	38	51	88	14	00
1	39	55	87	59	40
1	40	44	87	48	00
1	41	18	87	41	00
1	42	19	87	26	30
1	42	59	87	17	30
1	43	36	87	09	00

Thermometer 51° Fahrenheit.

BED OF SALT LAKE, THREE MILES WEST OF THE OJO DEL CUERBO.

Determination of time, February 26, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	34	38	88	02	00
10	35	30	88	13	20
10	36	23	88	24	30
10	37	12	88	37	20
10	38	04	88	47	40
10	38	45	88	57	00
10	39	26	89	06	10

Thermometer 59° Fahrenheit.

CAMP AT OJO DEL CUERBO, FEBRUARY 26, 1854.

Magnetic amplitude of the Sun's centre at his setting, 22° 00' 00" south.
 Variation of compass - - - - - 11 09 30 east.

SAND HILLS, FOUR MILES EAST OF THE OJO DEL CUERBO.

Determination of time, February 27, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	30	51	88	01	40
10	31	32	88	11	30
10	32	15	88	21	20
10	32	51	88	29	30
10	33	30	88	38	40
10	34	10	88	47	40
10	44	43	88	55	40

Thermometer 69° Fahrenheit.

NEAR THE GUADALUPE MOUNTAINS, (WEST SIDE.)

Determination of time, February 28, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	40	37	91	23	20
10	41	46	91	38	00
10	42	30	91	47	30
10	43	08	91	54	30
10	43	50	92	03	40
10	44	24	92	11	00
10	44	58	92	18	10

Thermometer 78° Fahrenheit.

NEAR THE SOUTH POINT OF THE GUADALUPE MOUNTAINS—EAST SIDE.

DETERMINATION OF LATITUDE.

Determination of time, February 28, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	00	49	84	00	00
2	01	40	83	47	00
2	02	22	83	36	30
2	02	54	83	26	20
2	03	39	83	13	40
2	04	14	83	03	20
2	04	53	82	52	40

Thermometer 78° Fahrenheit.

CAMP IN CAÑON NEAR SOUTH POINT OF GUADALUPE MOUNTAINS.

Determination of latitude, February 28, 1854.—Double altitudes of Sirius, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	29	13	82	21	20
7	30	30	82	26	30
7	31	26	82	31	00
7	32	57	82	35	40
7	34	15	82	40	00
7	35	36	82	45	10

Thermometer 78° Fahrenheit.

NEAR THE SOUTH POINT OF THE GUADALUPE MOUNTAINS—EAST SIDE.

Determination of time, April 28, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	00	49	84	00	00
2	01	40	83	47	00
2	02	22	83	36	30
2	02	54	83	26	20
2	03	39	83	13	30
2	04	14	83	03	20
2	04	53	82	52	40

Thermometer 78° Fahrenheit.

CAMP EAST SIDE OF THE GUADALUPE MOUNTAINS—PINERY.

DETERMINATION OF LATITUDE.

Determination of time, March 1, 1854.—Double altitudes of Sirius, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	57	41	81	12	10
6	59	08	81	22	30
7	01	10	81	33	30
7	02	17	81	40	10
7	03	29	81	46	00
7	04	36	81	50	10

Double altitudes β Orionis, in the west.

Time.			Altitudes.			
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
7	51	01	85	54	30	
7	52	58	85	27	20	
7	55	39	84	45	20	
7	57	21	84	20	00	
7	59	44	83	42	40	doubtful.
8	03	28	82	42	30	

Thermometer 40° Fahrenheit.

Determination of latitude, March 1, 1854.—Double altitudes of Sirius, in the east.

Time.			Altitudes.			
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
6	57	41	81	12	10	
6	59	08	81	22	30	
7	01	10	81	33	30	
7	02	17	81	40	10	
7	03	29	81	46	00	
7	04	36	81	50	10	

Double altitudes of Polaris, in the west.

Time.			Altitudes.			
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
7	08	42	64	44	20	
7	12	50	64	41	10	
7	16	23	64	38	00	
7	20	23	64	34	00	doubtful.
7	26	05	64	30	40	
7	31	05	64	28	00	

Double altitudes of β Orionis, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	51	01	85	54	30
7	52	58	85	27	20
7	55	39	84	45	20
7	57	21	84	20	00
7	59	44	83	42	40 doubtful.
8	03	28	82	42	30

Thermometer 40° Fahrenheit.

Note.—Night suddenly clouded up, with high wind.*Determination of time, March 1, 1854.—Double altitudes of the Sun's upper limb.*

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	37	19	87	11	40
1	38	19	86	57	20
1	39	05	86	45	10
1	39	08	86	37	10
1	41	02	86	14	10
1	42	01	85	59	40

Thermometer 59° Fahrenheit.

Determination of time, March 1, 1854.—Double altitudes of Sirius, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	57	41	81	12	10
6	59	08	81	22	30
7	01	10	81	33	30
7	02	17	81	40	10
7	03	29	81	46	00
7	04	36	81	50	10

Double altitudes of β Orionis, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	51	01	85	54	30
7	52	58	85	27	20
7	55	39	84	45	20
7	57	21	84	20	00
7	59	44	83	42	40 doubtful.
8	03	28	82	42	30

Thermometer 40° Fahrenheit.

BED OF DELAWARE CREEK, THIRTEEN MILES FROM INDEPENDENCE SPRINGS.

Determination of time, March 3, 1854—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	25	49	90	43	00
1	27	09	90	22	30
1	28	00	90	12	20
1	29	57	89	48	50
1	30	33	89	39	40
1	31	10	89	30	40
1	31	54	89	20	30

Thermometer 55° Fahrenheit.

CAMP AT THE HEAD OF DELAWARE CREEK.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Determination of time, March 4, 1854.—Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	74	50	50

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

Determination of longitude by lunar distances, March 4, 1854.—The Moon's western limb and Aldebaran, east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	33	36	13	23	40
7	38	45	13	21	00
7	42	57	13	19	10
7	47	55	13	17	10

Double altitudes of the Moon's bright (lower) limb, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	55	52	78	20	20

Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	04	04	95	53	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	07	45	13	10	40
8	12	35	13	08	50
8	17	34	13	06	50
8	22	26	13	04	20

Double altitudes of the Moon's bright (lower) limb, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	26	05	65	25	20

Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	28	49	85	20	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	33	55	13	01	30
8	38	41	12	59	20
8	43	48	12	57	50

Thermometer 37° Fahrenheit.

DETERMINATION OF LATITUDE.

Determination of time, March 3, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	56	31	82	05	40
7	58	15	81	58	00
7	59	31	81	52	10
8	00	48	81	47	00
8	02	16	81	40	40
8	03	41	81	34	20
8	04	53	81	28	00
8	07	26	81	14	40
8	08	54	81	06	20

Double altitudes of α Leonis (Regulus,) in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	36	23	107	15	00
8	38	22	107	48	40
8	39	39	108	21	00
8	41	09	108	54	40
8	42	26	109	22	20
8	43	59	109	58	30
8	45	45	110	37	40
8	47	24	111	17	00
8	48	50	111	50	20

Thermometer 32° Fahrenheit.

Determination of latitude, March 3, 1854.—Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	06	50	74	11	40
7	10	25	75	00	30
7	12	00	75	21	30
7	14	15	75	52	30
7	16	15	76	21	30
7	17	48	76	43	00

Double altitudes of α Leonis (Regulus,) in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	36	23	107	15	00
8	38	22	107	48	40
8	39	39	108	21	00
8	41	09	108	54	40
8	42	26	109	22	20
8	43	59	109	58	30
8	45	45	110	37	40
8	47	24	111	17	00
8	48	50	111	50	20

Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	28	12	63	43	40
7	32	55	63	40	10
7	37	55	63	37	00
7	42	05	63	34	00
7	46	48	63	30	20
7	51	53	63	26	40

Thermometer 32° Fahrenheit.

Determination of latitude, March 3, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	56	31	82	05	40
7	58	15	81	58	00
7	59	31	81	52	10
8	00	48	81	47	00
8	02	16	81	40	40
8	03	41	81	34	20
8	04	53	81	28	00
8	07	26	81	14	40
8	08	54	81	06	20

Double altitudes of β Orionis, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	13	27	76	26	40
8	15	08	75	56	30
8	16	25	75	34	00
8	18	37	74	53	20
8	20	22	74	21	00
8	22	11	73	47	30
8	23	43	73	18	40
8	24	53	72	56	40

Thermometer 32° Fahrenheit.

Determination of time, March 4, 1854.—Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	54	50	50

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

Determination of latitude, March 4, 1854.—Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	74	50	50

Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	57	28	103	05	00
8	58	50	102	37	20
9	00	39	101	57	10
9	01	40	101	36	20
9	02	40	101	26	00

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

Determination of time, March 3, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	56	31	82	05	40
7	58	15	81	58	00
7	59	31	81	52	10
8	00	48	81	47	00
8	02	16	81	40	40
8	03	41	81	34	20
8	04	53	81	28	00
8	07	26	81	14	40
8	08	54	81	06	20

Double altitudes of α Leonis, (Regulus,) in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	36	23	107	15	00
8	38	22	107	48	40
8	39	39	108	21	00
8	41	09	108	54	40
8	42	26	109	22	20
8	43	59	109	58	30
8	45	45	110	37	40
8	47	24	111	17	00
8	48	50	111	50	20

Thermometer 32° Fahrenheit.

Meridian altitude of Sirius.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	22	32	82	57	00

Magnetic amplitude of the Sun's centre at his setting, 20° south.

Determination of time, March 4, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	26	56	95	26	10
10	28	23	95	45	00
10	29	29	95	59	40
10	30	44	96	14	00
10	31	56	96	29	30
10	33	14	96	44	20
10	34	24	96	58	30

Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	24	28	91	05	40
1	25	28	90	50	00
1	26	19	90	37	40
1	27	15	90	24	00
1	27	57	90	03	50
1	28	46	90	01	10
1	29	37	89	47	00
1	30	23	89	35	10
1	30	57	89	27	00
1	31	33	89	17	30

Thermometer 60° Fahrenheit.

Double altitudes of Aldebaran, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	21	77	19	10
8	49	45	76	42	50
8	51	29	75	57	50
8	52	56	75	21	10
8	54	07	74	50	50

Double altitudes of β Leonis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	09	57	85	18	00
9	11	44	86	03	10
9	13	46	86	54	40
9	15	13	87	30	40
9	16	29	88	02	20

Thermometer 37° Fahrenheit.

CAMP ON DELAWARE CREEK.

Observations for the variation of the compass, March 7, 1854.

Magnetic amplitude of the Sun's centre at his setting, 18° 00' 00" south.
 Variation - - - - - 11 53 00

FALLS OF THE PECOS, MOUTH OF THE DELAWARE CREEK.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Determination of time, March 10, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	01	04	67	42	05
9	02	18	67	24	25
9	03	24	67	08	05
9	04	29	66	53	05
9	05	36	66	35	25
9	06	54	66	16	45
9	07	50	66	02	35
9	08	47	65	48	45
9	09	56	65	30	55
9	10	58	65	15	25

Double altitudes of the Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	20	33	86	49	25
12	22	50	87	17	35
12	24	57	87	40	05
12	26	13	87	55	45
12	27	37	88	10	35
12	28	54	88	25	05
12	30	08	88	38	25
12	31	26	88	52	35

Thermometer 42° Fahrenheit.

Determination of longitude by lunar distances, March 10, 1854.—The Moon's western limb and Spica Virginis, in the east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	06	06	73	35	35
11	10	53	73	32	25
11	15	35	73	29	55
11	20	48	73	28	35 doubtful.

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	25	40	118	52	25

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	33	27	75	26	25

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	37	51	73	14	15
11	42	54	73	11	15
11	47	52	73	08	35
11	52	52	73	06	25

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	55	00	106	39	35

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	58	01	81	49	55

Time.			Angular distance.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	01	14	73	03	05
12	06	14	73	00	55
12	11	13	72	58	55
12	16	20	72	56	55

Thermometer 42° Fahrenheit.

Determination of time, March 14, 1854.—Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	48	50	83	52	55
11	50	27	84	14	45
11	51	30	84	29	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	84	03	05
11	55	04	85	15	45
11	56	07	85	29	05
11	57	12	85	43	05
11	58	10	85	54	25

Thermometer 49° Fahrenheit.

Determination of longitude by lunar distances, March 14, 1854.—The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	52	08	22	08	15
10	56	30	22	05	35
11	00	40	22	03	55
11	04	35	22	01	25

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	07	50	114	46	25

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	14	42	75	26	25

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	16	22	21	56	45
11	19	29	21	55	25
11	22	34	21	54	05
11	25	28	21	52	35

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	31	43	80	00	25

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	33	48	119	34	45

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	36	28	21	48	35
11	39	22	21	46	55
11	42	22	21	45	35
11	45	23	21	44	35

Thermometer 49° Fahrenheit.

Determination of time, March 16, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	25	49	70	26	50
8	27	38	70	01	40
8	29	20	69	40	00
8	30	27	69	24	20
8	31	27	69	10	20
8	33	46	68	37	30
8	35	33	68	14	00
8	36	29	67	59	30
8	37	46	67	40	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	43	18	85	18	50
10	44	35	85	51	20
10	45	45	86	19	20
10	47	01	86	52	40
10	47	59	87	16	30
10	49	19	87	51	20
10	50	18	88	15	30
10	51	13	88	38	50

Thermometer $52\frac{1}{2}$ ° Fahrenheit.

Determination of longitude by lunar distances, March 16, 1854.—The Moon's western limb and Mars, west.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	39	12	58	10	20
11	45	05	58	13	00
11	50	07	58	15	30
11	55	09	58	17	40

Double altitude of the Moon's bright (lower) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	57	51	81	17	30

Double altitude of Mars, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	59	58	123	02	30

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	02	39	58	20	00
12	06	37	58	22	00
12	10	26	58	24	00
12	13	58	58	25	50

Double altitude of Mars, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	17	58	116	20	00

Double altitude of the Moon's bright (lower) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	20	45	86	38	00

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	22	59	58	29	20
12	26	31	58	30	40
12	30	16	58	32	00
12	34	10	58	33	30

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.

DETERMINATION OF LATITUDE.

Determination of time, March 10, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	01	04	67	42	05
9	02	18	67	24	25
9	03	24	67	08	05
9	04	29	66	53	05
9	05	36	66	35	25
9	06	54	66	16	45
9	07	50	66	02	35
9	08	47	65	48	45
9	09	56	65	30	55
9	10	58	65	15	25

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	20	38	86	49	25
12	22	50	87	17	35
12	24	57	87	40	05
12	26	13	87	55	45
12	27	37	88	10	35
12	28	54	88	25	05
12	30	08	88	38	25
12	31	26	88	52	35

Thermometer 42° Fahrenheit.

Determination of latitude, March 10, 1854.—Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	43	18	101	30	55
8	45	14	100	50	55
8	47	11	100	09	15
8	48	28	99	43	05
8	49	51	99	14	45
8	51	17	98	46	25
8	52	46	98	06	25
8	53	52	97	44	25
8	55	40	97	04	45
8	56	41	96	43	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	20	38	86	49	25
12	22	50	87	17	35
12	24	57	87	40	05
12	26	13	87	55	45
12	27	37	88	10	35
12	28	54	88	25	05
12	30	08	88	38	25
12	31	26	88	52	35

Thermometer 42° Fahrenheit.

NOTE.—Northern heavens very hazy.

Determination of time, March 14, 1853.—Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	48	50	83	52	55
11	50	27	84	14	45
11	51	30	84	29	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	84	03	05
11	55	04	85	15	45
11	56	07	85	29	05
11	57	12	85	43	05
11	58	10	85	54	25

Thermometer 49° Fahrenheit.

Determination of latitude, March 14, 1853.—Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	23	34	62	13	45
10	28	08	62	10	35
10	32	36	62	08	35
10	38	04	62	04	45
10	43	32	62	02	05

Northern stars clouded up.

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	41	10	68	23	55
8	42	54	67	58	35
8	43	57	67	43	05
8	45	01	67	27	55
8	45	59	67	13	05
8	47	08	66	56	25
8	48	11	66	41	05
8	49	38	66	19	25

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	21	11	108	42	35
9	22	27	108	19	55
9	23	29	108	00	45
9	24	36	107	39	25
9	25	39	107	18	25
9	26	30	107	02	25
9	27	28	106	43	55
9	28	47	106	18	05

Thermometer 49° Fahrenheit.

Determination of latitude, March 14, 1854.—Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Thermometer 49° Fahrenheit.

Determination of latitude, March 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	48	50	83	52	55
11	50	27	84	14	45
11	51	30	84	24	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	85	03	05
11	55	04	85	15	45
11	56	07	85	29	05
11	57	12	85	43	05
11	58	10	85	54	25

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	01	20	115	35	35
12	02	34	116	06	25
12	03	55	116	40	25
12	04	54	117	04	35
12	06	11	117	35	25
12	07	09	117	59	35
12	08	07	118	23	05
12	09	01	118	44	55
12	09	55	119	07	25
12	10	45	119	27	05

Thermometer 49° Fahrenheit.

Northern heavens clouded up.

Determination of time, March 16, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	25	49	70	26	30
8	27	38	70	01	40
8	29	20	69	40	00
8	30	27	69	24	20
8	31	27	69	10	20
8	33	46	68	37	30
8	35	33	68	14	00
8	36	29	67	59	30
8	37	46	67	40	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	43	18	85	18	50
10	44	35	85	51	20
10	45	45	86	19	20
10	47	01	86	52	40
10	47	59	87	16	30
10	49	19	87	51	20
10	50	18	88	15	30
10	51	13	88	38	50

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.*Determination of latitude, March 16, 1854.—Double altitudes of Polaris, in the west.*

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	37	54	63	31	40
7	42	12	63	27	40
7	46	35	63	24	30
7	50	18	63	22	00
7	53	57	63	19	10

Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	41	33	93	56	30
8	43	00	93	24	00
8	44	02	93	02	50
8	45	02	92	41	50
8	46	11	92	18	30
8	47	46	91	45	20
8	49	04	91	18	10
8	50	28	90	48	00

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	57	10	114	03	50
8	58	12	113	46	40
8	59	11	113	31	00
9	00	35	113	06	00
9	01	42	112	46	20
9	03	10	112	20	10

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.*Determination of latitude, March 16, 1854.—Double altitudes of Sirius, in the west.*

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	25	49	70	26	30
8	27	38	70	01	40
8	29	20	69	40	00
8	30	27	69	24	20
8	31	27	69	10	20
8	33	46	68	37	30
8	35	33	68	14	00
8	36	29	67	59	30
8	37	46	67	40	50

Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	10	12	96	40	20
8	12	08	97	08	50
8	13	54	97	35	30
8	16	20	98	12	00
8	18	08	98	37	40
8	19	51	99	01	30

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of latitude, March 16, 1854.—Double altitudes of η Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	34	40	82	55	00
9	36	29	83	29	40
9	37	34	83	50	40
9	39	58	84	47	30
9	42	21	85	23	00
9	43	34	85	47	00
9	44	43	86	09	00

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	43	18	85	18	50
10	44	35	85	51	20
10	45	45	86	19	20
10	47	01	86	52	40
10	47	59	87	16	30
10	49	19	87	51	20
10	50	18	88	15	30
10	51	13	88	38	58

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of latitude.—Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	14	02	76	43	50

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.

NOTE.—This star was so near the moon, it was impossible to get any more observations upon it.

Determination of time, March 9, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Times, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	19	23	96	28	35	1	16	44
10	20	25	96	43	35		clouds	
10	21	13	96	55	05		clouds	
10	21	59	97	05	35	1	14	07
10	22	50	97	17	05	1	13	20
10	23	42	97	28	55	1	12	28
10	24	31	97	41	15	1	11	36
10	25	22	97	52	15	1	10	40
10	26	15	98	04	35	1	09	53
10	27	07	98	16	05		lost	

Thermometer 77° Fahrenheit.

Observations for the variation of compass.

Magnetic amplitude of the Sun's centre at his setting, 17° 30' 00" south.

Determination of time, March 10, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	24	09	98	00	05	1	13	59
10	25	03	98	12	25	1	13	04
10	25	47	98	22	45	1	12	17
10	26	36	98	34	55	1	11	24
10	27	29	98	47	05	1	10	33
10	28	14	98	57	05	1	09	54
10	29	07	99	08	25	1	08	55
10	29	53	99	18	05	1	08	06

Thermometer 67° Fahrenheit.

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	01	04	67	42	05
9	02	18	67	24	25
9	03	24	67	08	05
9	04	29	66	53	05
9	05	36	66	35	25
9	06	54	66	16	45
9	07	50	66	02	35
9	08	47	65	48	45
7	09	56	65	30	55
9	10	58	65	15	25

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
12	20	38	86	49	25
12	22	50	87	17	35
12	24	57	87	40	05
12	26	13	87	55	45
12	27	37	88	10	35
12	28	54	88	25	05
12	30	08	88	38	25
12	31	26	88	52	35

Thermometer 42° Fahrenheit.

NOTE.—Northern heavens very hazy.

Determination of time, March 11, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	34	04	101	19	55	1	00	52
10	34	58	101	31	25	12	59	53
10	35	52	101	43	45	12	58	51
10	36	49	101	54	25	12	58	00
10	37	48	102	06	25	12	57	03
10	38	44	102	18	25	12	56	02
10	39	45	102	29	35	12	55	04
10	40	43	102	41	05	12	54	08
10	41	40	102	51	35	12	53	05
10	42	43	103	03	45	12	52	04

Thermometer 73° Fahrenheit.

Determination of time, March 14, 1854.—Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	59	49	89	37	05
9	02	48	88	36	55
9	03	53	88	14	25
9	05	05	87	48	25
9	06	12	87	25	05
9	07	11	87	03	55
9	09	03	86	25	25
9	10	04	86	04	05
9	11	09	85	42	25
9	12	02	85	22	55

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	49	50	83	52	55
11	50	27	84	14	45
11	51	30	84	29	55
11	52	20	84	39	55
11	53	10	84	51	05
11	54	06	84	03	05
11	55	04	85	15	45
11	56	07	85	29	05
12	57	12	85	43	05
11	58	10	85	54	25

Thermometer 49° Fahrenheit.

Determination of time, March 15, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	17	55	100	24	40	1	15	58
10	18	43	100	38	20	1	15	05
10	19	35	100	50	10	1	14	17
10	20	11	100	59	10	1	13	38
10	21	02	101	12	20	1	12	46
10	21	47	101	22	40	1	12	01
10	22	37	101	34	50	1	11	13
10	23	38	101	48	50	1	10	11
10	24	20	101	59	20	1	09	30
10	25	17	102	12	20	1	08	35

Thermometer 83° Fahrenheit.

Determination of time, March 16, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	15	28	100	17	30	1	20	06
10	16	17	100	29	10	1	19	16
10	17	10	100	43	00	1	18	22
10	17	56	100	53	50	1	17	39
10	18	43	101	06	20	1	16	52
10	19	34	101	18	20	1	16	03
10	20	36	101	35	20	1	14	55
10	21	30	101	48	20	1	14	02

Thermometer 89° Fahrenheit.

Determination of time, March 16, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	25	49	70	26	30
8	27	38	70	01	40
8	29	20	69	40	00
8	30	27	69	24	20
8	31	27	69	10	20
8	33	46	68	37	30
8	35	33	68	14	00
8	36	29	67	59	30
8	37	46	67	40	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	43	18	85	18	50
10	44	35	85	51	20
10	45	45	86	19	20
10	47	01	86	52	40
10	47	59	87	16	30
10	49	19	87	51	20
10	50	18	88	15	30
10	51	13	88	38	50

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.

OBSERVATIONS FOR THE VARIATION OF COMPASS.

Double altitude of Sirius, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	30	27	69	24	20	S. 21	30	00 W.

Double altitude of Polaris, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	37	54.	63	31	40	N. 14	00	00 W.

Thermometer $52\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of time, March 18, 1854.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	42	43	108	17	40	12	49	32
10	43	34	108	27	40	Lost		
10	44	34	108	38	50	Lost		
Clouds for a few moments.								
10	47	30	109	12	40	12	44	27
10	48	14	109	21	00	12	43	38
10	49	03	109	29	30	12	42	54
10	49	45	109	36	40	12	42	29
10	50	30	109	44	40	12	41	46

Thermometer 82° Fahrenheit.

SULPHUR SPRINGS OF THE COLORADO.

DETERMINATION OF LATITUDE.

Determination of time, April 5, 1854.—Double altitudes of Sirius, in the west.

Approximate latitude to be used in first computation of time, 32° 28' 55".

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	20	73	31	50
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	23	20
6	45	20	72	11	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	22	36	88	33	00
9	23	51	88	06	20
9	24	40	88	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of latitude, April 5, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	54	50	63	48	50
6	57	31	63	46	10
7	00	34	63	43	30
7	04	01	63	41	50
7	09	50	63	37	30
7	12	42	63	35	50
7	15	45	63	34	00
7	18	43	63	32	20

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	20	73	31	50
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	22	20
6	45	20	72	11	10

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	13	44	73	03	50
8	14	40	72	44	40
8	15	53	72	19	50
8	16	40	72	01	50
8	17	43	71	42	20
8	18	54	71	18	40
8	19	44	71	01	40
8	20	54	70	36	50
8	21	47	70	18	40
8	22	37	70	02	10

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	26	29	94	29	10
8	27	36	94	04	30
8	28	31	93	44	20
8	29	25	93	24	20
8	30	28	93	01	40
8	31	24	92	40	20
8	32	36	92	14	40
8	33	41	91	51	20
8	34	48	91	26	20
8	35	46	91	05	00

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.*Double altitudes of α Ursæ Majoris, in the east.*

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	59	05	117	41	30
8	01	08	118	00	10
8	02	29	118	12	20
8	03	42	118	22	40
8	04	44	118	32	10
8	05	38	118	39	40
8	06	35	118	49	00
8	07	41	118	57	10
8	08	45	119	05	30
8	09	52	119	14	50

Double altitudes of γ Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	41	06	94	53	20
8	42	08	95	12	50
8	43	15	95	34	40
8	44	27	95	57	10
8	45	25	96	16	00
8	46	27	96	36	10
8	47	28	96	56	00
8	48	29	97	14	40
8	49	24	97	32	30
8	50	33	97	55	10

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	22	36	88	33	00
9	23	51	89	06	20
9	24	40	89	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	59	45	91	27	40
11	00	50	91	36	10
11	01	45	91	43	20
11	02	39	91	50	10
11	03	40	91	56	40
11	04	36	92	03	30
11	05	35	92	10	10
11	06	25	92	15	30
11	07	13	92	21	30
11	08	06	92	26	10

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of time, April 6, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	51	09	70	12	30
6	52	10	69	59	30
6	53	02	69	48	10
6	54	05	69	35	00
6	55	05	69	22	10
6	55	57	69	09	00
6	56	58	68	55	30
6	58	02	68	41	00
6	58	54	68	29	00
7	00	05	68	13	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	04	75	29	40
8	49	10	75	59	40
8	50	01	76	19	50
8	51	02	76	45	40
8	51	57	77	09	10
8	52	50	77	31	40
8	53	36	77	51	00
8	54	28	78	12	00
8	55	18	78	33	50
8	56	06	78	56	00

Determination of latitude, April 6, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	04	32	63	40	20
7	06	55	63	39	30
7	10	11	63	36	50
7	12	31	63	35	40
7	15	35	63	33	40
7	17	40	63	32	00
7	19	35	63	30	00
7	21	36	63	28	30
7	23	50	63	27	00
7	26	01	63	25	50

Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	29	06	87	14	10
7	30	14	86	49	30
7	31	15	86	28	00
7	32	20	86	05	10
7	33	12	85	48	10
7	34	07	85	29	20
7	35	04	85	09	00
7	36	00	84	49	40
7	36	53	84	31	30
7	37	43	84	13	30

Thermometer 58° Fahrenheit.

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	06	11	100	23	40
8	08	25	99	36	00
8	09	35	99	12	50
8	10	29	98	54	30
8	11	30	98	31	30
8	12	23	98	12	00
8	13	24	97	51	10
8	14	14	97	34	10
8	15	40	97	02	40
8	16	34	96	44	00

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	51	09	70	12	30
6	52	10	69	59	30
6	53	02	69	48	10
6	54	05	69	35	00
6	55	05	69	22	10
6	55	57	69	09	00
6	56	58	68	55	30
6	58	02	68	41	00
6	58	54	68	29	00
7	00	05	68	13	10

Thermometer 58° Fahrenheit.

Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	41	38	111	43	00
7	42	48	111	53	50
7	43	54	112	03	50
7	45	08	112	13	20
7	46	14	112	23	30
7	47	21	112	33	40
7	48	23	112	40	40
7	49	22	112	49	20
7	50	21	112	58	10
7	51	35	113	08	10

Double altitudes of η Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	55	11	81	16	40
7	56	21	81	38	20
7	57	20	81	58	00
7	58	12	82	15	10
7	59	09	82	33	40
8	00	07	82	52	10
8	00	59	83	08	30
8	01	50	83	25	40
8	02	41	83	42	10
8	03	36	83	59	30

Thermometer 58° Fahrenheit.

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	04	75	29	40
8	49	10	75	59	40
8	50	01	76	19	50
8	51	02	76	45	40
8	51	57	77	09	10
8	52	50	77	31	40
8	53	36	77	51	00
8	54	28	78	12	00
8	55	18	78	33	50
8	56	06	78	56	00

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	33	51	73	50	30
9	34	44	74	05	40
9	35	43	74	22	30
9	36	38	74	37	00
9	37	39	74	54	30
7	38	36	75	10	10
0	39	35	75	26	00
9	40	32	75	41	40
9	41	29	75	57	30
9	42	34	76	15	10

Thermometer 58° Fahrenheit.

Determination of time, April 8, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	47	03	69	50	35
6	48	16	69	33	55
6	49	13	69	22	35
6	50	16	69	07	55
6	51	21	68	52	45
6	52	21	68	39	05
6	53	24	68	25	25
6	54	43	68	08	45
6	55	43	67	52	15
6	56	47	67	37	35

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	18	28	90	42	55
9	20	43	91	40	35
9	21	46	92	07	35
9	22	35	92	28	05
9	23	31	92	52	40
9	24	23	93	14	05
9	25	16	93	36	15
9	26	20	94	02	45
9	27	16	94	26	35
9	28	10	94	50	25

Thermometer 50° Fahrenheit.

Determination of latitude, April 8, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	11	39	63	30	35
7	14	08	63	28	55
7	16	30	63	27	25
7	18	52	63	27	55
7	21	59	63	24	25
7	26	21	63	21	35
7	28	26	63	19	55
7	31	07	63	17	55
7	33	09	63	16	15
7	35	25	63	14	45
7	37	45	63	13	05
7	39	56	63	11	55
7	42	09	63	10	25
7	44	08	63	08	55
7	47	00	63	06	35
7	49	37	63	04	45
7	52	05	63	03	25
7	54	04	63	02	35
7	57	47	63	01	05
7	59	50	62	59	55

Thermometer 50° Fahrenheit.

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	31	54	74	51	55
9	32	56	75	09	35
9	34	00	75	26	55
9	35	12	75	46	25
9	36	06	76	01	45
9	36	53	76	13	35
9	38	07	76	34	05
9	39	05	76	48	45
9	40	03	77	04	15
9	41	01	77	20	25
9	43	10	77	54	35
9	44	15	78	10	05
9	45	24	78	29	15
9	46	32	78	44	55
9	47	27	79	00	45
9	48	30	79	15	55
9	49	27	79	30	05
9	50	23	79	43	55
9	51	29	80	01	15
9	52	28	80	14	55
9	53	41	80	32	25
9	54	31	80	44	55

Thermometer 50° Fahrenheit.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Determination of time, April 3, 1854.—Double altitudes of Sirius, in the west.

Approximate latitude to be used in first computation of time, 32° 28' 55".

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	34	29	74	39	40
6	35	52	74	24	20
6	37	03	74	10	50
6	38	34	73	54	50
6	39	37	73	42	40
6	40	32	73	32	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	47	16	72	45	10
8	28	21	73	13	20
8	49	17	73	37	30
8	50	20	74	03	50
8	51	18	74	27	50
8	52	38	75	01	30

Thermometer $62\frac{1}{2}^{\circ}$ Fahrenheit.*Determination of longitude by lunar distances, April 3, 1854.—The Moon's western limb and Saturn, west.*

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	46	39	39	37	20
6	49	39	39	38	40
6	52	22	39	39	50
6	55	25	39	40	50

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	57	24	132	13	50

Double altitude of Saturn, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	00	32	53	07	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	02	26	39	43	00
7	05	08	39	44	00
7	08	11	39	45	10
7	11	32	39	46	20

Double altitude of Saturn, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	13	47	47	36	10

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	15	18	124	54	50

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	16	56	39	48	30
7	19	58	39	49	40
7	22	50	39	50	50
7	25	54	39	51	40

Thermometer $62\frac{1}{2}^{\circ}$ Fahrenheit.

The Moon's western limb and Aldebaran, west.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	27	51	31	51	50
7	30	44	31	52	50
7	33	41	31	53	50
7	36	35	31	54	50

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	38	20	115	27	40

Double altitude of Aldebaran, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	41	30	50	32	20

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	43	23	31	57	20
7	46	20	31	58	50
7	49	20	31	59	50
7	52	18	32	01	00

Double altitude of Aldebaran, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	54	11	45	12	20

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	55	52	108	13	50

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	57	39	32	02	40
8	00	28	32	03	30
8	03	22	32	04	40
8	06	20	32	05	50

Thermometer 62½° Fahrenheit.

Determination of time, April 5, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	20	73	31	50
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	23	20
6	45	20	72	11	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	22	36	88	33	00
9	23	51	88	06	20
9	24	40	88	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of longitude, April 5, 1854.—The Moon's western limb and Aldebaran, west.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	28	08	43	48	20
7	29	26	43	48	50
7	31	03	43	49	20
7	32	00	43	49	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.	Altitude.
<i>h. m. s.</i> 7 33 59	<i>d. m. s.</i> 138 16 10

Double altitude of Aldebaran, in the west.

Time.	Altitude.
<i>h. m. s.</i> 7 36 24	<i>d. m. s.</i> 51 49 10

Time.	Angular distances.
<i>h. m. s.</i> 7 37 55	<i>d. m. s.</i> 43 50 50
7 39 27	43 51 20
7 40 40	43 52 10
7 41 29	43 53 00

Double altitude of Aldebaran, in the west.

Time.	Altitude.
<i>h. m. s.</i> 7 43 55	<i>d. m. s.</i> 48 41 00

Double altitude of the Moon's bright (lower) limb, in the west.

Time.	Altitude.
<i>h. m. s.</i> 7 46 20	<i>d. m. s.</i> 133 15 50

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	48	28	43	54	40
7	49	33	43	55	00
7	50	25	43	55	30
7	51	25	43	55	50

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	49	58	90	24	50
9	51	18	90	23	50
9	52	25	90	23	20
9	53	25	90	22	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	55	38	80	06	00

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	57	30	79	12	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	59	31	90	20	00
10	01	12	90	19	20
10	02	34	90	18	40
10	04	03	90	18	10

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	07	03	81	31	30

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	09	05	74	36	50

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	10	52	90	15	20
10	12	38	90	14	30
10	14	30	90	13	20
10	16	26	90	12	40

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of time, April 6, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
9	56	10	112	38	20	1	05	29
9	56	56	112	52	40	1	04	40
9	57	33	113	03	30	1	04	05
9	58	15	113	15	30	1	03	25
9	58	57	113	28	40	1	02	27
9	59	41	113	41	40	1	01	56
10	00	24	113	53	10	1	01	19
10	01	09	114	07	10	1	00	30
10	01	43	114	18	00	12	59	55
10	02	27	114	30	50	12	59	10

Thermometer 92° Fahrenheit.

Determination of longitude by lunar distances, April 6, 1854.—Moon's western limb and nearest limb of the Sun, west.

Time, p. m.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	25	26	104	02	40
2	27	48	104	03	30
2	30	12	104	04	10
2	31	50	104	05	00

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	35	49	69	45	30

Double altitude of the Sun's upper limb, in the west.

Time			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	37	05	79	51	20

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	38	20	104	06	50
2	39	38	104	07	20
2	40	59	104	08	10
2	42	24	104	09	00

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	43	44	77	12	50

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	45	34	73	45	20

Moon's western limb and nearest limb of the Sun.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	47	02	104	09	50
2	48	25	104	10	40
2	49	56	104	11	10
2	51	25	104	11	50

Thermometer 58° Fahrenheit.

Second series.—April 6, 1854.

Time, p. m.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	15	16	104	20	10
3	17	12	104	20	40
3	19	08	104	21	10
3	20	51	104	21	30

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	27	01	90	44	00

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	28	27	59	01	30

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	29	36	104	23	30
3	30	52	104	24	20
3	32	25	104	25	10
3	33	51	104	25	50

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	35	00	56	18	20

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	36	43	94	43	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	38	03	104	26	40
3	39	37	104	27	20
3	40	56	104	28	00
3	42	41	104	28	50

Thermometer 58° Fahrenheit.

Determination of time, April 6, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	51	09	70	12	30
6	52	10	69	59	30
6	53	02	69	48	10
6	54	05	69	35	00
6	55	05	69	22	10
6	55	57	69	09	00
6	56	58	68	55	30
6	58	02	68	41	00
6	58	54	68	29	00
7	00	05	68	13	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	04	75	29	40
8	49	10	75	59	40
8	50	01	76	19	50
8	51	02	76	45	40
8	51	57	77	09	10
8	52	50	77	31	40
8	53	36	77	51	00
8	54	28	78	12	00
8	55	18	78	33	50
8	56	06	78	56	00

Thermometer 58° Fahrenheit.

Determination of longitude by lunar distances, April 6, 1854.—The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	02	43	78	40	00
9	04	30	78	39	10
9	07	08	78	38	30
9	09	06	78	37	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	10	29	117	52	40

Double altitudes of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	12	09	67	23	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	14	23	78	35	40
9	16	08	78	35	00
9	18	03	78	34	20
9	19	57	78	33	30

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	21	34	70	15	40

Double altitude of the Moon's bright (lower) limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	23	33	112	30	40

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	25	01	78	30	50
9	27	35	78	30	00
9	29	30	78	29	20
9	31	41	78	28	30

Thermometer 58° Fahrenheit.

Second series, April 6, 1854.—The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	50	03	78	22	30
9	51	58	78	21	30
9	53	47	78	20	40
9	55	36	78	19	50

Double altitude of the Moon's bright (lower) limb, in the west.

Time.	Altitude.
<i>h. m. s.</i> 9 57 05	<i>d. m. s.</i> 98 39 20

Double altitude of Spica Virginis, in the east.

Time.	Altitude.
<i>h. m. s.</i> 9 59 21	<i>d. m. s.</i> 80 32 40

Time.	Angular distances.
<i>h. m. s.</i> 10 00 53	<i>d. m. s.</i> 78 17 10
10 02 58	78 16 20
10 04 53	78 15 30
10 07 00	78 14 50

Double altitude of Spica Virginis, in the east.

Time.	Altitude
<i>h. m. s.</i> 10 09 00	<i>d. m. s.</i> 82 49 20

Double altitude of the Moon's bright (lower) limb, in the west.

Time.	Altitude.
<i>h. m. s.</i> 10 11 08	<i>d. m. s.</i> 92 51 00

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	12	37	78	13	00
10	14	50	78	12	00
10	17	00	78	11	00
10	18	58	78	10	10

Thermometer 58° Fahrenheit.

Determination of time, April 8, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	17	45	119	33	55	12	46	52
10	18	25	119	44	35	12	46	06
10	19	03	119	54	35	12	45	27
10	19	41	120	04	35	12	44	50
10	20	21	120	14	45	12	44	08
10	21	10	120	27	45	12	43	20
10	21	56	120	39	05	12	42	33
10	22	42	120	51	05	12	41	45
10	23	30	121	03	05	12	40	57
10	24	25	121	13	35	12	40	13

Thermometer 80° Fahrenheit.

Determination of longitude by lunar distances, April 8, 1854.—Moon's western limb and nearest limb of the Sun, west.

Time, p. m.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	35	18	127	04	05
3	36	50	127	04	35
3	38	00	127	05	15
3	39	05	127	05	45

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	47	08	53	40	35

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	50	03	51	25	45

Time, p. m.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	53	34	127	10	55
3	55	41	127	11	55
3	57	34	127	12	35
3	58	51	127	13	05

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
4	00	33	47	05	10

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
4	02	39	59	00	05

Time, p. m.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
4	05	30	127	15	15
4	07	44	127	16	05
4	09	30	127	16	45
4	11	05	127	17	35

Thermometer 50° Fahrenheit.

Determination of time, April 8, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	47	03	69	50	35
6	48	16	69	33	55
6	49	13	69	22	35
6	50	16	69	07	55
6	51	21	68	52	45
6	52	21	68	39	05
6	53	24	68	25	25
6	54	43	68	08	45
6	55	43	67	52	15
6	56	47	67	37	35

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	18	28	90	42	55
9	20	43	91	40	35
9	21	46	92	07	35
9	22	35	92	28	05
9	23	31	92	52	40
9	24	23	93	14	05
9	25	16	93	36	15
9	26	20	94	02	45
9	27	16	94	26	35
9	28	10	94	50	25

Thermometer 50° Fahrenheit.

Determination of longitude by lunar distances, April 8, 1854.—The Moon's western limb and Pollux, west.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	58	56	37	18	05
10	01	00	37	19	05
10	02	42	37	20	05
10	04	38	37	21	35

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	06	43	126	32	25

Double altitude of Pollux, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	13	29	71	28	25

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	16	29	37	26	25
10	18	29	37	27	25
10	20	13	37	28	15
10	22	01	37	28	55

Double altitude of Pollux, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	26	38	66	04	55

Double altitudes of the Moon's bright (lower) limb, in the w st.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	28	25	118	34	45

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	32	58	37	31	25
10	34	43	37	32	15
10	36	50	37	33	05
10	39	03	37	33	55

Thermometer 50° Fahrenheit.

The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	46	20	53	10	45
10	48	13	53	10	05
10	50	02	53	09	15
10	52	02	53	08	35

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	53	31	108	52	15

Double altitude of Spica Virginis, in the east.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	55	54	91	53	25

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	57	50	53	07	05
10	59	38	53	06	15
11	01	34	53	05	35
11	03	46	53	04	55

Double altitude of Spica Virginis, in the east.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	06	05	92	57	00

Double altitude of the Moon's bright (lower) limb, in the west.

<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	08	49	102	47	45

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
11	10	30	53	00	45
11	12	32	53	00	05
11	14	54	52	59	15
11	17	15	52	58	45

Thermometer 50° Fahrenheit.

DETERMINATION OF TIME AND RATE OF CHRONOMETER.

Determination of time, April 3, 1854.—Equal altitudes of Sun's upper limb.

Approximate latitude to be used in the first computation of time,
32° 28' 55".

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
9	57	56	111	03	00	1	04	11
9	58	38	111	15	20	Lost.		
9	59	18	111	27	00	Lost.		
9	59	59	111	38	20	1	02	12
10	00	41	111	50	50	1	01	27
10	01	30	112	05	20	1	00	35
10	02	28	112	21	40	12	59	32
10	03	27	112	37	30	12	58	43

Thermometer 79° Fahrenheit.

Determination of time, April 3, 1854.—Double altitudes of Sirius in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	34	29	74	39	40
6	35	52	74	24	20
6	37	03	74	10	50
6	38	34	73	54	50
6	39	37	73	42	40
6	40	32	73	32	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	47	16	72	45	10
8	48	21	73	13	20
8	49	17	73	37	30
8	50	20	74	03	50
8	51	18	74	27	50
8	52	38	75	01	30

Thermometer 62½° Fahrenheit.

Determination of time, April 4, 1854.—Double altitudes of the Sun's upper limb.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	55	50	111	53	25
9	56	37	112	07	35
9	57	26	112	20	55
9	58	15	112	35	35
9	59	04	112	49	45
9	59	50	113	03	15
10	00	48	113	20	05
10	01	39	113	34	25
10	02	24	113	46	45
10	03	09	113	59	55

Thermometer 78° Fahrenheit.

Determination of time, April 5, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	09	14	115	49	15	12	52	07
10	09	53	115	59	45	12	51	28
10	10	36	116	11	05	12	50	44
10	11	24	116	24	35	12	50	00
10	12	25	116	40	25	12	48	59
10	13	14	116	54	35	12	48	05
10	14	07	117	07	55	12	47	12
10	14	58	117	21	25	12	46	22
10	15	46	117	33	55	12	45	35
10	16	33	117	46	25	12	44	42

Thermometer 84° Fahrenheit.

Determination of time, April 5, 1854—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	20	73	31	20
6	39	22	73	19	40
6	40	31	73	07	10
6	41	31	72	55	20
6	42	32	72	44	20
6	43	23	72	33	40
6	44	17	72	23	20
6	45	20	72	11	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	22	36	88	33	00
9	23	51	89	06	20
9	24	40	89	27	40
9	25	33	89	48	50
9	26	26	90	11	50
9	27	15	90	33	10
9	28	07	90	53	40
9	28	46	91	10	40
9	29	38	91	32	10
9	30	22	91	50	40

Thermometer $46\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of time, April 6, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
9	56	10	112	38	20	1	05	29
9	56	56	112	52	40	1	04	40
9	57	33	113	03	30	1	04	05
9	58	15	113	15	30	1	03	25
9	58	57	113	28	40	1	02	27
9	59	41	113	41	40	1	01	56
10	00	24	113	53	10	1	01	19
10	01	09	114	07	10	1	00	30
10	01	43	114	18	00	12	59	55
10	02	27	114	30	50	12	59	10

Thermometer 92° Fahrenheit.

Determination of time, April 6, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	51	09	70	12	10
6	52	10	69	59	30
6	53	02	69	48	10
6	54	05	69	35	00
6	55	05	69	22	10
6	55	57	69	09	00
6	56	58	68	55	30
6	58	02	68	41	00
6	58	54	68	29	00
7	00	05	68	13	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	48	04	75	29	40
8	49	10	75	59	40
8	50	01	76	19	50
8	51	02	76	45	40
8	51	57	77	09	10
8	52	50	77	31	40
8	53	36	77	51	00
8	54	28	78	12	00
8	55	18	78	33	50
8	56	06	78	56	00

Thermometer 58° Fahrenheit.

Determination of time, April 7, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	00	16	114	24	55	1	01	29
10	01	05	114	40	45	1	00	38
10	01	58	114	55	25	12	59	50
10	02	37	115	06	55	12	59	07
10	03	20	115	19	25	12	58	25
10	03	57	115	29	55	12	57	50
10	04	35	115	41	15	12	57	08
10	05	26	115	55	25	12	56	15
10	06	08	116	07	45	12	55	30
10	09	08	116	24	45	12	54	38

Thermometer 91° Fahrenheit.

Determination of time, April 8, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
10	17	45	119	33	55	12	46	52
10	18	25	119	44	35	12	46	06
10	19	03	119	54	35	12	45	27
10	19	41	120	04	35	12	44	50
10	20	21	120	14	45	12	44	08
10	21	10	120	27	45	12	43	20
10	21	56	120	39	05	12	42	33
10	22	42	120	51	05	12	41	45
10	23	30	121	03	05	12	40	57
10	24	15	121	13	35	12	40	13

Thermometer 80° Fahrenheit.

Determination of time, April 8, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	47	03	69	50	35
6	48	16	69	33	55
6	49	13	69	22	35
6	50	16	69	07	55
6	51	21	68	52	45
6	52	21	68	39	05
6	53	24	68	25	25
6	54	43	68	08	45
6	55	43	67	52	15
6	56	47	67	37	35

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	18	28	90	42	55
9	20	43	91	40	35
9	21	46	92	07	35
9	22	35	92	28	05
9	23	31	92	52	40
9	24	23	93	14	05
9	25	16	93	36	15
9	26	20	94	02	45
9	27	16	94	26	35
9	28	10	94	50	25

Thermometer 50° Fahrenheit.

Determination of time, April 9, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
9	52	45	112	35	10	1	13	53
9	53	23	112	46	40	1	13	18
9	53	57	112	57	30	1	12	42
9	54	34	113	09	30	1	12	04
9	55	12	113	21	10	1	11	28
9	55	44	113	31	20	1	10	55
9	56	19	113	42	50	1	10	19
9	57	01	113	55	50	1	09	36
9	57	35	114	06	50	1	09	03
9	58	13	114	17	30	1	08	25
9	58	50	114	28	40	1	07	48
9	59	29	114	42	00	1	07	08
10	00	07	114	52	50	1	06	30
10	00	44	115	04	20	1	05	55
10	01	24	115	16	10	1	05	15
10	02	04	115	28	10	1	04	33
10	02	53	115	42	10	1	03	45
10	03	31	115	54	20	1	03	06
10	04	10	116	05	50	1	02	27
10	04	07	116	16	40	1	01	50

Thermometer 62½ Fahrenheit.

Determination of time, April 10, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	57	53	64	52	50
6	58	57	64	34	20
6	59	59	64	18	30
7	00	55	64	04	50
7	01	56	63	49	20
7	02	45	63	35	40
7	03	34	63	23	30
7	04	34	63	08	10
7	05	23	62	55	00
7	06	16	62	39	50

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	39	26	78	37	20
8	40	22	79	00	50
8	41	10	79	21	20
8	41	59	79	41	40
8	42	42	80	00	00
8	43	37	80	23	30
8	44	28	80	44	40
8	45	21	81	07	30
8	46	14	81	29	50
8	46	55	81	47	20

Thermometer $49\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of time, April 11, 1854.—Equal altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.			Time, p. m.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
9	45	14	112	09	00	1	15	41
9	45	58	112	22	40	1	15	01
9	46	38	112	35	30	1	14	24
9	47	16	112	48	10	1	13	44
9	47	56	113	00	50	1	13	04
9	48	32	113	12	40	1	12	28
9	49	08	113	24	40	1	11	51
9	49	53	113	38	40	1	11	08
9	50	29	113	50	10	1	10	33
9	51	04	114	02	00	1	09	52
9	51	38	114	13	30	1	09	13
9	52	17	114	24	40	1	08	43
9	52	48	114	35	30	1	08	10
9	53	22	114	45	40	1	07	39
9	53	58	114	57	40	1	06	58
9	54	45	115	12	20	1	06	14
9	55	13	115	22	20	1	05	41
9	56	07	115	37	00	1	04	57
9	56	48	115	50	00	1	04	11
9	57	24	116	00	40	1	03	37
9	58	01	116	13	20	1	02	55

Thermometer 87° Fahrenheit.

Magnetic amplitude of the sun's centre at his setting, 1° 30' north.

Observations for the variation of the compass.—Double altitude of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	11	10	63	21	50	N. 13	10	00 W.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	08	08	71	41	30	S. 55	30	00 E.

CAMP ON RIO PECOS, MARCH 20, 1854.

Observations for the variation of the compass.

Magnetic amplitude of the Sun's centre at his setting, 11° 45' south.

CAMP ON RIO PECOS, SEVENTY-SIX MILES BELOW MOUTH OF DELAWARE CREEK.

Determination of time, March 23, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	04	58	108	58	05
1	06	01	108	42	35
1	06	53	108	29	35
1	07	50	108	15	05
1	08	35	108	02	55
1	09	34	107	47	35
1	10	19	107	36	15
1	11	23	107	19	05

Thermometer 82° Fahrenheit.

CAMP ON MARCY'S TRAIL, FIFTEEN MILES FROM EMIGRANT'S CROSSING
OF THE RIO PECOS, (East.)

DETERMINATION OF LATITUDE.

*Determination of time, March 24, 1854.—Double altitudes of the Sun's
upper limb.*

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	27	18	103	23	35
1	27	57	103	11	15
1	28	35	103	01	25
1	29	14	102	50	25
1	29	51	102	38	05
1	30	34	102	25	45

Thermometer 88° Fahrenheit.

*Determination of latitude, March 24, 1854.—Double altitudes of Sirius, in
the west.*

Time.			Altitudes.			
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
6	41	58	82	33	55	
6	43	41	82	23	05	
6	44	55	82	17	15	
6	46	18	82	09	05	
6	47	30	82	00	05	
6	48	21	81	58	05	doubtful.
6	49	35	81	50	55	
6	50	39	81	44	55	

Double altitude of α Ursæ Majoris, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	37	12	98	33	05

Observations discontinued ; the heavens suddenly clouded up.

Observations for the variation of the compass.—Double altitude of Sirius, in the west.

Time.	Altitude.	Magnetic bearing.
<i>h. m. s.</i> 6 41 58	<i>d. m. s.</i> 82 33 55	<i>d. m. s.</i> S. 00 30 00 W.

Thermometer 72° Fahrenheit.

Determination of time, March 24, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.	Altitudes.
<i>h. m. s.</i> 1 27 18	<i>d. m. s.</i> 103 23 35
1 27 57	103 11 15
1 28 35	103 01 25
1 29 14	102 50 25
1 29 51	102 38 05
1 30 34	102 25 45

Thermometer 86° Fahrenheit.

POINT ON EAST RIDGE OF THE SAND HILLS.

Determination of time, March 27, 1854.

Time.	Altitudes.
<i>h. m. s.</i> 9 56 14	<i>d. m. s.</i> 103 20 40
9 56 56	103 33 10
9 57 35	103 44 50
9 59 22	103 59 20
9 59 20	104 17 10
10 00 04	104 30 20
10 00 45	104 42 00
10 01 32	104 57 00
10 02 10	105 09 10
10 02 58	105 22 20

Thermometer 74° Fahrenheit.

CAMP AT MUSTANG SPRINGS.

DETERMINATION OF LATITUDE.

Determination of time, March 29, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	39	48	68	21	40
7	41	03	68	04	10
7	42	09	67	48	00
7	42	59	67	36	40
7	44	06	67	20	30
7	45	07	67	05	40
7	45	57	66	51	40
7	46	52	66	38	30

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	21	45	74	10	30
9	22	51	74	47	50
9	24	15	75	26	10
9	25	10	75	46	40
9	26	26	76	19	00
9	27	22	76	43	50
9	28	18	77	06	20
9	29	16	77	30	40

Thermometer 58° Fahrenheit.

Determination of latitude, March 29, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	39	48	68	21	40
7	41	03	68	04	10
7	42	09	67	48	00
7	42	59	67	36	40
7	44	06	67	20	30
7	45	07	67	05	40
7	45	57	66	51	40
7	46	52	66	38	30

Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	53	21	91	30	20
7	54	38	91	03	20
7	55	38	90	43	30
7	56	27	90	25	40
7	57	30	90	04	20
7	58	24	89	45	40
7	59	23	89	25	00
8	00	19	89	05	40

Thermometer 58° Fahrenheit.

Determination of latitude, March 29, 1854.—Double altitudes of α Geminorum, (Castor,) in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	42	50	125	41	10
8	44	07	125	08	20
8	45	17	124	38	50
8	46	50	123	59	50
8	48	16	123	22	50
8	49	28	122	52	00
8	50	30	122	27	10
8	51	33	122	00	10

Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	08	31	114	05	50
8	10	41	114	30	20
8	11	46	114	41	40
8	12	56	114	54	00
8	17	59	115	22	40
8	19	05	115	33	20

Thermometer 58° Fahrenheit.

Determination of latitude, March 29, 1854—Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	26	46	79	19	00
8	28	10	79	46	00
8	29	20	80	07	40
8	30	25	80	30	00
8	31	25	80	48	30
8	32	29	81	10	00
8	33	35	81	29	10
8	34	35	81	49	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	21	45	74	10	30
9	22	51	74	47	50
9	24	15	75	26	10
9	25	10	75	46	40
9	26	26	76	19	00
9	27	22	76	43	50
9	28	18	77	06	20
9	29	16	77	30	40

Thermometer 58° Fahrenheit.

Observations for the variation of the compass, March 29, 1854.—Double altitude of Sirius, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	39	48	68	21	40	S. 22	30	00 W.

Double altitude of Capella, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	53	21	91	30	20	N. 66	30	00 W.

Double altitude of η Ursæ Majoris, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	26	46	79	19	00	N. 37	50	00 E.

Double altitude of Arcturus, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	21	45	74	10	30	N. 76	45	00 E.

Determination of time, March 29, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	02	34	110	58	50
1	03	07	110	49	30
1	03	54	110	37	10
1	04	26	110	28	00
1	04	59	110	18	50
1	05	38	110	08	10
1	06	13	109	59	00
1	06	50	109	48	40
1	07	30	109	37	00
1	08	02	109	28	30

Thermometer 84° Fahrenheit.

Determination of time, March 29, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	39	48	68	21	40
7	41	03	68	04	10
7	42	09	67	48	00
7	42	59	67	36	40
7	44	06	67	20	30
7	45	07	67	05	40
7	45	57	66	51	40
7	46	42	66	38	30

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	21	45	74	10	30
9	22	51	74	47	50
9	24	15	75	26	10
9	25	10	75	46	40
9	26	26	76	19	00
9	27	22	76	43	50
9	28	18	77	06	20
9	29	16	77	30	40

Thermometer 58° Fahrenheit.

Determination of time, March 30, 1854.—Double altitudes of the Sun's upper limb.

Time, a. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	41	25	102	30	45
9	42	06	102	44	25
9	42	38	102	53	05
9	43	14	103	05	55
9	43	44	103	15	05
9	44	11	103	24	25
9	44	37	103	32	25
9	45	05	103	41	35

Thermometer 88° Fahrenheit.

AT BIG SPRINGS OF THE COLORADO.

DETERMINATION OF LATITUDE.

Determination of time, March 31, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	47	57	63	26	00
7	49	06	63	08	30
7	50	03	62	53	00
7	50	53	62	39	10
7	51	47	62	24	50
7	52	42	62	10	20
7	53	44	61	54	20
7	54	35	61	27	20 error.
7	55	51	61	06	50

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	38	04	67	33	10
9	39	01	67	51	20
9	40	01	68	09	20
9	40	57	68	26	10
9	41	51	68	43	10
9	42	46	69	00	00
9	43	44	69	17	00
9	44	31	69	32	30

Thermometer 41° Fahrenheit.

Determination of latitude, March 31, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	21	17	63	48	40
7	25	44	63	44	20
7	30	19	63	41	50
7	34	56	63	38	40
7	39	38	63	35	50
7	43	46	63	32	30

Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	47	57	63	26	00
7	49	06	63	08	30
7	50	03	62	53	00
7	50	53	62	39	10
7	51	47	62	24	50
7	52	42	62	10	20
7	53	44	61	54	20
7	54	35	61	27	20 error.
7	55	51	61	06	50

Thermometer 41° Fahrenheit.

Determination of latitude, March 31, 1854.—Double altitudes of Capella, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	59	00	85	48	50
8	00	12	85	23	40
8	01	03	85	06	20
8	02	00	84	46	40
8	02	56	84	26	20
8	03	46	84	08	50
8	05	10	83	40	50
8	06	30	83	12	50

Double altitudes of α Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	09	00	115	53	00
8	10	14	116	03	50
8	11	10	116	14	00
8	12	20	116	24	00
8	13	36	116	35	50
8	14	37	116	47	10
8	15	42	116	57	40
8	16	35	117	05	40

Thermometer 41° Fahrenheit.

Determination of latitude, March 31, 1854.—Double altitudes of η Ursæ Majoris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	19	29	80	24	10
8	20	31	80	44	40
8	21	23	81	02	40
8	22	12	81	18	40
8	22	57	81	32	40
8	23	51	81	48	40
8	24	47	82	06	50
8	25	42	82	24	50

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	38	04	67	33	10
9	39	01	67	51	20
9	40	01	68	09	20
9	40	57	68	26	10
9	41	51	68	43	10
9	42	46	69	00	00
9	43	44	69	17	00
9	44	31	69	32	30

Thermometer 41° Fahrenheit.

Observations for the variation of the compass, March 31, 1854.—Double altitude of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	21	17	63	48	40	N. 13	30	00 W.

Double altitude of Sirius, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	47	57	63	26	00	S. 27	10	00 W.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	38	04	67	33	10	S. 59	00	00

Determination of time, March 31, 1854.—Double altitudes of Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	14	49	107	34	50
1	15	25	107	24	10
1	16	02	107	13	30
1	16	42	107	00	50
1	17	25	106	48	20
1	18	06	106	35	30
1	18	47	106	22	40
1	19	27	106	10	20

Thermometer $55\frac{1}{2}^{\circ}$ Fahrenheit.

Determination of time, March 31, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	47	57	63	26	00
7	49	06	63	08	30
7	50	03	62	53	00
7	50	53	62	39	10
7	51	47	62	24	50
7	52	42	62	10	20
7	53	44	61	54	20
7	54	35	61	27	20
7	55	51	61	06	50

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	38	04	67	33	10
9	39	01	67	51	20
9	40	01	68	09	20
9	40	57	63	26	10
9	41	51	68	43	10
9	42	46	69	00	00
9	43	44	69	17	00
8	44	31	69	32	30

Thermometer 41° Fahrenheit.

CAMP FORTY-FOUR MILES EAST OF SULPHUR SPRINGS OF THE COLORADO.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in the first computation of time, $32^{\circ} 30'$.

Determination of time, April 14, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.			Chronometer slow of mean time.
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
7	07	01	57	44	50	
7	08	19	57	32	40	
7	11	05	56	35	00	
7	12	03	56	18	00	
7	13	29	55	53	30	
7	14	29	55	37	00	
7	15	27	55	18	20	
7	16	18	55	03	40	
7	17	12	54	47	40	<i>h.</i> <i>m.</i> <i>s.</i>
7	18	23	54	26	10	0 32 17.09

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
8	04	06	70	33	20	
8	05	13	71	02	00	
8	06	07	71	24	40	
8	07	01	71	47	40	
8	08	10	72	16	30	
8	09	54	72	39	50	
8	09	57	73	02	00	
8	10	54	73	25	10	
8	11	51	73	50	20	<i>h.</i> <i>m.</i> <i>s.</i>
8	12	50	74	14	50	0.32 15 04

Thermometer 47° Fahrenheit.

Determination of latitude, April 14, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	21	56	63	30	30			
7	24	30	63	28	30			
7	26	08	63	27	00			
7	27	59	63	25	50			
7	29	48	63	24	30	32	34	35.89
7	31	26	63	23	40			
7	33	13	63	22	50			
7	35	09	63	22	00			
7	37	07	63	20	50			
7	39	41	63	19	30	32	34	39.74
7	41	28	63	18	10			
7	43	41	68	17	00			
7	45	41	63	16	10			
7	47	38	63	14	50			
7	49	51	63	13	50	32	34	49.23
7	51	36	63	12	30			
7	53	40	63	11	20			
7	55	40	63	10	30			
7	58	00	63	09	00			
8	00	21	63	08	10			
8	02	08	63	07	10	32	34	44.22

Thermometer 47° Fahrenheit.

Determination of latitude, April 14, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	14	55	59	05	30			
8	16	09	59	29	50			
8	17	11	59	52	20			
8	18	08	60	09	50			
8	18	54	60	24	50	32	35	28
8	20	11	60	50	10			
8	21	05	61	07	50			
8	21	55	61	24	20			
8	22	45	61	40	20			
8	23	52	61	02	50	32	35	56
8	25	06	62	26	10			
8	26	16	62	49	50			
8	27	12	63	07	30			
8	28	35	63	33	40			
8	29	34	63	54	00	32	35	56
8	30	27	64	10	30			
8	31	53	64	38	00			
8	33	04	64	01	00			
8	33	58	65	17	20			
8	35	02	65	37	30			
8	36	22	66	02	10	32	35	45

Thermometer 47° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in the first computation of time—
32° 30' 00".

Determination of time, April 14, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	07	01	57	44	50
7	08	19	57	32	40
7	11	05	56	35	00
7	12	03	56	18	00
7	13	29	55	53	30
7	14	29	55	37	00
7	15	27	55	18	20
7	16	18	55	03	40
7	17	12	54	47	40
7	18	23	54	26	10

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	04	06	70	33	20
8	05	13	71	02	00
8	06	07	71	24	40
8	07	01	71	47	40
8	08	10	72	16	30
8	09	04	72	39	50
8	09	57	73	02	00
8	10	54	73	25	10
8	11	51	73	50	20
8	12	50	74	14	50

Thermometer 47° Fahrenheit.

MOST EASTERN TRIBUTARY OF THE COLORADO.

Determination of time, April 16, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
1	09	20	114	28	20
1	10	23	115	06	30
1	11	02	113	53	20
1	11	38	113	41	00
1	12	10	113	30	40
1	12	39	113	19	50
1	13	22	113	05	30
1	13	55	112	54	00
1	14	26	112	43	10
1	15	10	112	28	10
1	15	48	112	15	10
1	16	26	112	02	10
1	17	04	111	48	30
1	17	39	111	36	50
1	18	10	111	25	40
1	18	43	111	14	40
1	19	11	111	04	00

Thermometer 80° Fahrenheit.

CAMP ELEVEN AND FOUR-TENTHS MILES EAST OF THE SULPHUR SPRINGS
OF THE COLORADO.

April 12, 1854.

	<i>d.</i>	<i>m.</i>	<i>s.</i>
Magnetic amplitude of the Sun's centre at his setting -	00	00	00
Variation - - - - -	9	58	50

CAMP ON DIVIDING RIDGE OF THE COLORADO AND BRAZOS RIVERS.

April 17, 1854.

	<i>d.</i>	<i>m.</i>	<i>s.</i>
Magnetic amplitude of the Sun's centre at his rising -	N. 24	30	00

CAMP ON TRIBUTARY OF THE BRAZOS RIVER.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in the first computation of time, $32^{\circ} 45'$.

Determination of time, April 17, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	32	05	62	31	00			
6	33	11	62	12	40			
6	34	50	61	47	40			
6	35	48	61	32	10			
6	36	44	61	16	20	0	37	36.75
6	37	46	61	00	20			
6	38	41	60	45	50			
6	39	50	60	27	10			
6	40	52	60	10	10			
6	41	51	59	52	40	0	37	36.39

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
7	54	05	73	32	20			
7	55	04	73	55	10			
7	56	07	74	22	40			
7	57	05	74	46	09			
7	58	20	75	18	50	0	37	30.28
7	59	17	75	42	00			
8	00	15	76	07	20			
8	01	11	76	32	00			
8	02	11	76	56	40			
8	03	21	77	24	50	0	37	30.60

Thermometer 64° Fahrenheit.

Determination of latitude, April 17, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.			Deduced latitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	14	58	63	35	40			
7	17	04	63	34	20			
7	18	57	63	33	20			
7	21	43	63	32	00			
7	23	02	63	30	40	32	40	39.15
7	25	29	63	28	50			
7	27	46	63	27	40			
7	29	26	63	26	50			
7	30	59	63	25	40			
7	32	32	63	24	50	32	40	23.69
7	34	19	63	23	50			
7	36	00	63	22	50			
7	38	01	63	21	40			
7	39	49	63	20	50			
7	41	15	63	20	00			
7	42	44	63	19	30	32	40	23.91
7	44	29	63	18	30			
7	46	31	63	17	30			
7	48	10	63	16	20			
7	49	58	63	15	20			
7	51	42	63	14	10	32	40	24.41

Thermometer 64° Fahrenheit.

Determination of latitude, April 17, 1854.—Double altitudes of *Spica Virginis*, in the east.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	35	26	70	45	10			
8	36	31	71	05	40			
8	37	30	71	22	40			
8	38	29	71	39	40			
8	39	26	71	56	10	32	42	51
8	40	23	72	11	20			
8	41	18	72	29	40			
8	42	09	72	42	30			
8	43	02	72	57	40			
8	43	57	73	13	10			
8	44	55	73	29	40	32	42	53.3
8	45	50	73	44	20			
8	46	44	73	59	50			
8	47	34	74	13	20			
8	48	34	74	32	10			
8	49	27	74	45	30			
8	50	15	74	58	10	32	42	40
8	51	10	75	12	40			
8	52	01	75	27	00			
8	52	59	75	42	10			
8	53	51	75	56	00			
8	54	44	76	10	00	32	42	55

Thermometer 64° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in the first computation of time, $32^{\circ} 45'$.

Determination of time, April 17, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	32	05	62	31	00
6	33	11	62	12	40
6	34	50	61	47	40
6	35	48	61	32	10
6	36	44	61	16	20
5	37	46	61	00	20
6	38	41	60	45	50
6	39	50	60	27	10
6	40	52	60	10	10
6	41	51	59	52	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	54	05	73	32	20
7	55	04	73	55	10
7	56	07	74	22	40
7	57	05	74	46	00
7	58	20	75	18	50
7	59	17	75	42	00
8	00	15	76	07	20
8	01	11	76	32	00
8	02	11	76	56	40
8	03	21	77	24	50

Thermometer 64° Fahrenheit.

AT CAMP ON TRIBUTARY OF THE BRASOS, TEN MILES WEST OF THE CLEAR FORK.

DEDUCTION OF LATITUDE.

Approximate latitude to be used in the first computation of time, $32^{\circ} 51'$.

Determination of time, April 20, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	24	01	59	48	50			
6	25	46	59	19	40			
6	26	50	59	02	00			
6	27	39	58	48	30			
6	28	33	58	33	00	0	42	44.66
6	29	25	58	18	10			
6	30	18	58	04	20			
6	31	04	57	51	20			
6	31	55	57	37	30			
6	32	55	57	20	20	0	42	43.74

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
7	58	15	82	26	10			
7	59	13	82	49	00			
8	00	16	83	15	40			
8	01	15	83	38	40			
8	02	26	84	08	40	0	42	37.08
8	03	17	84	30	30			
8	04	05	84	52	10			
8	04	58	85	14	40			
8	06	11	85	43	10			
8	07	05	86	07	20	0	42	37.35

Thermometer 69° Fahrenheit.

Determination of latitude, April 20, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
7	14	26	63	52	20			
7	15	56	63	51	20			
7	17	37	63	50	20			
7	19	48	63	49	10			
7	22	01	63	48	10	32	53	46.38
7	23	52	63	47	00			
7	25	55	63	46	00			
7	28	25	63	44	40			
7	31	38	63	43	30			
7	34	43	63	41	40	32	53	54.28
7	36	30	63	40	10			
7	39	00	63	38	50			
7	41	27	63	37	40			
7	43	29	63	36	40			
7	45	24	63	35	30			
7	47	20	63	34	40	32	53	41.73
7	49	05	63	34	00			
7	50	52	63	33	00			
7	52	28	63	32	00			
7	54	26	63	31	00			
7	56	20	63	30	20	32	53	37.87

Thermometer 69° Fahrenheit.

Determination of latitude, April 20, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	37	34	75	46	30			
8	38	47	76	06	20			
8	39	45	76	21	10			
8	40	32	76	33	20			
8	41	34	76	49	50	32	54	53
8	42	28	77	04	00			
8	43	19	77	16	50			
8	44	13	77	30	30			
8	46	02	77	58	40			
8	46	43	78	08	40			
8	47	27	78	20	40	32	54	48
8	48	15	78	31	50			
8	49	03	78	44	10			
8	49	53	78	55	20			
8	50	38	79	07	30			
8	51	39	79	22	20			
8	52	29	79	34	40	32	54	43
8	53	20	79	46	30			
8	54	03	79	57	10			
8	55	01	80	10	00			
8	55	52	80	23	10			
8	56	37	80	33	40	32	54	39

Thermometer 69° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in first computation of time, $32^{\circ} 51'$.

Determination of time, April 20, 1854.—Double altitudes of Sirius, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	24	01	59	48	50
6	25	46	59	19	40
6	26	50	59	02	00
6	27	39	58	48	30
6	28	33	58	33	00
6	29	25	58	18	10
6	30	18	58	04	20
6	31	04	57	51	20
6	31	55	57	37	30
6	32	55	57	20	20

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	58	15	82	26	10
7	59	13	82	49	00
8	00	16	83	15	40
8	01	15	83	38	40
8	02	26	84	08	40
8	03	17	84	30	30
8	04	05	84	52	10
8	04	58	85	14	40
8	06	11	85	43	10
8	07	05	86	07	20

Thermometer 69° Fahrenheit.

Observations for the variation of the compass, April 20, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	36	30	63	40	10	N. 11	50	00 W.

Variation of compass, E. $10^{\circ} 30'$.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	38	47	76	06	20	S. 49	20	40 E.

Variation of compass, E. $10^{\circ} 30' 50''$. Thermometer 69° Fahrenheit.

AT CLEAR FORK OF THE BRAZOS.—CROSSING OF THE ROAD.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in first computation of time, $32^{\circ} 55'$.

Determination of time, April 24, 1854.—Double altitudes of Procyon, in the west.

Time.			Altitudes.			
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
7	14	31	86	43	20	} error; re- jected.
7	15	34	86	18	20	
7	17	37	85	32	30	
7	18	37	85	10	50	
7	19	27	84	51	40	
7	20	07	84	36	10	
7	20	51	84	19	00	
7	21	39	84	01	40	
7	22	25	83	43	20	
7	23	16	83	24	50	

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	13	29	97	49	00
8	14	49	98	22	10
8	15	32	98	40	10
8	16	19	99	00	00
8	17	07	99	20	10
8	17	55	99	39	00
8	18	44	99	59	40
8	19	34	100	20	40
8	20	13	100	39	40
8	21	01	100	57	20

Thermometer 55° Fahrenheit.

Determination of latitude, April 24, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	26	40	63	45	40			
7	28	30	63	44	50			
7	30	28	63	43	50			
7	32	45	63	43	10			
7	34	56	63	42	00	32	59	18.5
7	36	55	63	41	00			
7	39	05	63	40	00			
7	41	30	63	38	50			
7	43	11	63	38	00			
7	46	16	63	36	40			
7	48	58	63	35	30	32	59	27.6
7	51	05	63	34	40			
7	53	51	53	33	40			
7	56	02	63	32	50			
7	58	10	63	32	00			
8	00	17	63	31	10	32	59	23.08
8	02	30	63	30	10			
8	04	50	63	29	10			
8	07	19	63	28	20			
8	09	55	63	27	20			
8	11	31	63	26	30	32	59	28.08

Thermometer 55° Fahrenheit.

Determination of latitude, April 24, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	49	53	83	39	50			
8	50	45	83	50	20			
8	51	28	84	00	10			
8	52	07	84	08	10			
8	53	08	84	20	00	33	01	01
8	53	54	84	29	10			
8	54	42	84	39	00			
8	55	22	84	46	50			
8	56	08	84	56	20			
8	56	48	85	03	20			
8	57	27	85	11	10	33	00	47
8	53	07	85	18	40			
8	58	48	85	27	00			
8	59	36	85	35	30			
9	00	15	85	43	40			
9	00	58	85	51	40			
9	01	36	85	58	00	33	00	45
9	02	17	86	06	00			
9	03	03	86	14	20			
9	03	44	86	21	20			
9	04	23	86	28	10			
9	05	08	86	36	00	33	00	44

Thermometer 55° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in first computation of time, $32^{\circ} 55'$.

Determination of time, April 24, 1854.—Double altitudes of Procyon, in the west.

Time.			Altitudes.			
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	
7	14	31	86	43	20	error.
7	15	34	86	18	20	
7	17	37	85	32	30	
7	18	37	85	10	50	
7	19	27	85	51	40	
7	20	07	84	36	10	
7	20	51	84	19	00	
7	21	39	84	01	40	
7	22	25	83	43	20	
7	23	16	83	24	50	

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	13	29	97	49	00
8	14	49	98	22	10
8	15	32	98	40	10
8	16	19	99	00	00
8	17	07	99	20	10
8	17	55	99	39	00
8	18	44	99	59	40
8	19	34	100	20	40
8	20	13	100	39	40
8	21	01	100	57	20

Thermometer 55° Fahrenheit.

Observations for the variation of the compass, April 24, 1854.—Double altitude of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	32	45	63	43	10	N.	12	30 00 W.

Variation of compass, E. $11^{\circ} 49'$.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	51	28	84	00	10	S.	40	00 00 E.

Variation of compass, E. $10^{\circ} 55' 40''$. Thermometer 55° Fahrenheit.

AT CAMP ON WEST SIDE OF THE BRAZOS, OPPOSITE FORT BELKNAP.

DETERMINATION OF LATITUDE.

Determination of time, April 26, 1854.—Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	27	05	83	25	20
7	28	03	83	52	20
7	28	54	84	13	30
7	29	42	84	31	50
7	30	22	84	50	20
7	30	56	85	04	40
7	31	38	85	22	00
7	32	15	85	37	30
7	32	56	85	55	40
7	33	43	86	13	50

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	35	26	73	54	40
7	36	15	73	34	00
7	37	07	73	14	10
7	37	54	72	55	20
7	38	43	72	36	10
7	39	35	72	15	20
7	40	26	71	54	40
7	41	11	71	37	30
7	42	04	71	16	50
7	42	55	70	57	20

Thermometer 62° Fahrenheit.

Determination of latitude, April 26, 1854.—Double altitudes of α Ursæ Majoris, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	14	00	125	34	00
8	15	42	125	27	00
8	16	54	125	22	30
8	18	10	125	17	10
8	20	11	125	08	20
8	21	20	125	02	30
8	22	38	124	56	50
8	23	44	124	51	40
8	24	52	124	45	50
8	26	05	124	39	40
8	27	18	124	33	40
8	28	54	124	25	20
8	30	52	124	14	10
8	32	11	124	06	30
8	33	27	123	58	50
8	34	26	123	52	50
8	35	23	123	47	00
8	36	41	123	38	30
8	37	51	123	30	50
8	39	05	123	24	20
8	40	10	123	15	50

Thermometer 62° Fah. Clouds in the north obscured Polaris.

Determination of latitude, April 26, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	44	53	70	06	10
7	45	44	70	22	10
7	46	27	70	34	20
7	47	11	70	47	20
7	47	50	70	58	10
7	48	33	71	10	50
7	49	16	71	23	00
7	50	36	71	45	50
7	51	24	71	58	30
7	52	14	72	13	00
7	52	59	72	25	20
7	53	50	72	39	40
7	54	37	72	53	00
7	55	26	73	07	10
7	56	22	73	22	20
7	57	10	73	34	10
7	57	58	73	47	50
7	58	47	74	01	40
7	59	41	74	15	30
8	00	31	74	29	50
8	01	15	74	42	20
8	02	00	74	54	00

Thermometer 62° Fahrenheit.

Determination of time, April 26, 1854.—Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	27	05	83	25	20
7	28	03	83	52	20
7	28	54	84	13	30
7	29	42	84	31	50
7	30	22	84	50	20
7	30	56	85	04	40
7	31	38	85	22	00
7	32	15	85	37	30
7	32	56	85	55	40
7	33	43	86	13	50

Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	35	26	73	54	40
7	36	15	73	34	00
7	37	07	73	14	10
7	37	54	73	55	20
7	38	43	73	36	10
7	39	35	72	15	20
7	40	26	71	54	40
7	41	11	71	37	30
7	42	04	71	16	50
7	42	55	70	57	20

Thermometer 62° Fahrenheit.

Observations for variation of the compass, April 26, 1854.—Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	49	16	71	23	00	S. 53	30	00 E.

Thermometer 62° Fahrenheit.

CAMP FOUR MILES EAST OF THE WEST FORK OF THE TRINITY.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in first computation of time, 33° 10'.

Determination of time, April 28, 1854.—Double altitudes of Procyon, west.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	42	15	90	20	10			
6	43	28	89	53	10			
6	44	58	89	20	10			
6	45	50	89	02	20			
6	46	32	88	46	20	0	54	8.46
6	47	22	88	28	20			
6	48	10	88	10	20			
6	48	58	87	53	10			
6	49	47	87	34	00			
6	50	30	87	18	40	0	54	8.53

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
7	47	35	95	43	50			
7	48	41	96	10	40			
7	49	18	96	30	00			
7	50	19	96	51	40			
7	51	07	97	11	10	0	54	2.23
7	51	59	97	33	10			
7	52	57	97	57	00			
7	54	06	98	25	20			
7	55	11	98	53	20			
7	56	02	99	13	50	0	54	5.22

Thermometer 48° Fahrenheit.

Determination of latitude, April 28, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	06	33	64	42	40			
7	09	57	64	40	50			
7	12	19	64	39	50			
7	13	42	64	39	10			
7	14	56	64	38	30	33	28	07.52
7	16	10	64	37	40			
7	18	00	64	36	50			
7	19	14	64	36	20			
7	20	58	64	35	50			
7	22	18	64	35	10	33	28	04.42
7	26	00	64	33	40			
7	28	07	64	33	00			
7	29	48	64	32	20			
7	31	05	64	31	40			
7	32	45	64	31	00			
7	34	25	64	30	10	33	28	16.57
7	37	47	64	28	30			
7	39	26	64	27	50			
7	41	08	64	27	10			
7	43	38	64	26	20			
7	45	44	64	25	40	33	27	59.01

Thermometer 48° Fahrenheit.

Determination of latitude, April 28, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	59	50	76	16	50			
8	00	45	76	24	40			
8	01	32	76	36	50			
8	02	22	76	50	10			
8	03	10	77	01	20			
8	03	59	77	12	40	33	30	05
8	04	45	77	24	40			
8	05	31	77	36	10			
8	06	17	77	47	10			
8	07	07	77	59	40			
8	07	50	78	09	50	33	30	11
8	08	29	78	19	50			
8	09	10	78	30	00			
8	09	55	78	39	50			
8	10	41	78	50	10			
8	11	24	79	01	10			
8	12	12	79	13	00	33	30	01
8	13	11	79	26	00			
8	13	58	79	36	30			
8	14	45	79	48	00			
8	15	34	79	59	00			
8	16	21	80	10	10	33	30	13

Thermometer 48° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in first computation of time, $33^{\circ} 10'$.

Determination of time, April 28, 1854.—Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	42	15	90	20	10
6	43	28	89	53	10
6	44	58	89	20	10
6	45	50	89	02	20
6	46	32	88	46	20
6	47	22	88	28	20
6	48	10	88	10	20
6	48	58	88	53	10
6	49	47	87	34	00
6	50	30	87	18	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	47	34	93	43	50
7	48	41	96	10	40
7	49	18	96	30	00
7	50	19	96	51	40
7	51	07	97	11	10
7	51	59	97	33	10
7	52	57	97	57	00
7	54	06	98	25	20
7	55	11	98	53	20
7	56	02	99	13	50

Thermometer 48° Fahrenheit.

Observations for the variation of the compass, April 28, 1854.—Double altitude of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	22	18	64	35	10	N.	11	20 00 W.

Variation of compass, E. $10^{\circ} 19' 40''$.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	00	45	76	24	40	S.	47	30 00 E.

Variation of compass, E. $10^{\circ} 13' 02''$. Thermometer 48° Fahrenheit.

NOTE.—Continuous rain from the night of the 29th of April to the morning of the 6th of May, 1854.

CAMP ON THE WATERS OF THE TRINITY.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Approximate latitude to be used in first computation of time, $33^{\circ} 31' 35''$.

Determination of time, May 6, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>			
2	17	27	85	44	55			
2	19	52	84	44	55			
2	22	24	83	42	55			
2	23	15	83	21	45			
2	23	42	83	09	55			
2	24	17	82	55	25			
2	24	47	82	43	15			
2	25	25	82	27	45			
2	25	59	82	13	35			
2	26	30	82	00	25			
2	27	08	81	45	25			
2	27	37	81	33	25	<i>h.</i>	<i>m.</i>	<i>s.</i>
						0	56	54.79

Thermometer 78° Fahrenheit.

Determination of longitude by lunar distances, May 6, 1854.—The Moon's western limb and nearest limb of the Sun, west.

Time, p. m.	Angular distances.	Deduced longitude, (in arc.)
<i>h. m. s.</i>	<i>d. m. s.</i>	<i>h. m. s.</i>
2 33 08	107 27 25	
2 34 50	107 28 15	
2 36 04	107 29 05	6 34 43
Lost.	Clouds.	

Double altitude of the Moon's bright (upper) limb, in the east.

Time.	Altitude.
<i>h. m. s.</i>	<i>d. m. s.</i>
2 45 44	69 57 15

Double altitude of the Sun's upper limb, in the west.

Time.	Altitude.
<i>h. m. s.</i>	<i>d. m. s.</i>
2 47 29	73 18 25

Time, p. m.	Angular distances.	Deduced longitude.
<i>h. m. s.</i>	<i>d. m. s.</i>	<i>h. m. s.</i>
2 48 59	107 33 55	
2 50 10	107 34 25	
2 51 41	107 34 55	
2 53 04	107 35 25	6 35 17

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	54	59	70	19	25

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	57	41	74	46	15

Time, p. m.			Angular distances.			Deduced longitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
2	59	20	107	36	35			
3	01	38	107	37	25			
3	03	42	107	38	25			
3	05	39	107	39	35	6	33	28

Thermometer 66° Fahrenheit.

Second series.—The Moon's western limb and nearest limb of the Sun, west.

Time, p. m.			Angular distances.			Deduced longitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
3	21	15	107	44	45			
3	23	05	107	45	55			
3	27	29	107	47	35			
3	29	10	107	48	15	6	35	08

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	31	19	88	11	35

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	32	37	54	32	05

Time, p. m.			Angular distances.			Deduced longitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
3	35	35	107	50	25			
3	37	25	107	51	05			
3	40	43	107	52	15			
3	42	18	107	52	45	6	34	55

Double altitude of the Sun's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	43	24	50	03	35

Double altitude of the Moon's bright (upper) limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
3	45	12	93	39	25

Time, p. m.	Angular distances.	Deduced longitude.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>	<i>h.</i> <i>m.</i> <i>s.</i>
3 46 30	107 53 45	
3 48 15	107 54 15	
3 49 44	107 54 45	
3 51 15	107 55 15	6 35 10

Thermometer 66° Fahrenheit.

Determination of time, May 6, 1854.—Double altitudes of Procyon, in the west.

Time.	Altitudes.	Chronometer slow of mean time.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>	<i>h.</i> <i>m.</i> <i>s.</i>
6 43 05	77 05 10	
6 44 19	76 36 40	
6 45 32	76 07 10	
6 46 24	75 47 50	
6 47 16	75 26 50	0 56 59.75
6 48 12	75 05 20	
6 49 02	74 46 40	
6 49 55	74 25 10	
6 50 51	74 03 10	
6 51 43	73 42 40	0 56 59.85

Double altitudes of Arcturus, in the east.

Time.	Altitudes.	Chronometer slow of mean time.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>	<i>h.</i> <i>m.</i> <i>s.</i>
6 53 26	87 32 40	
6 54 15	87 52 20	
6 55 05	88 12 50	
6 55 48	88 31 00	
6 56 28	88 48 10	0 56 56.33
6 57 12	89 05 40	
6 58 26	89 36 50	
6 59 14	89 57 00	
6 59 54	90 14 20	
7 00 36	90 31 20	0 56 57.33

Thermometer 66° Fahrenheit.

Determination of longitude by lunar distances, May 6, 1854.—The Moon's western limb and Pollux, west.

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	47	23	44	16	20
7	51	19	44	18	10
7	53	20	44	19	00
7	55	17	44	19	40

Double altitude of the Moon's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	57	30	128	37	20

Double altitude of Pollux, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	00	31	70	01	20

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	03	54	44	22	40
8	09	30	44	24	40
8	11	02	44	25	20
8	12	30	44	26	00

Double altitude of Pollux, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	15	24	64	00	10

Double altitude of the Moon's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	18	13	122	06	10

Time.			Angular distances.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	19	55	44	29	30
8	21	43	44	30	10
8	23	30	44	31	00
8	25	20	44	31	50

Thermometer 66° Fahrenheit.

Determination of longitude by lunar distances, May 6, 1854.—The Moon's western limb and Spica Virginis, east.

Time.			Angular distances.			Deduced longitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
8	33	26	46	15	10			
8	35	23	46	14	40			
8	36	57	46	14	00			
8	38	55	46	13	10	6	34	41

Double altitude of the Moon's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	40	31	114	21	10

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	45	42	90	28	40

Time.			Angular distances.			Deduced longitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
8	50	12	46	08	20			
8	53	19	46	07	00			
8	55	29	46	06	10			
8	57	32	46	05	20	6	35	52

Double altitude of Spica Virginis, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	01	05	91	36	00

Double altitude of the moon's upper limb, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
9	03	02	106	00	00

Time.	Angular distances.	Deduced longitude.
<i>h. m. s.</i>	<i>d. m. s.</i>	<i>h. m. s.</i>
9 07 31	46 01 40	
9 09 34	46 01 00	
9 11 22	46 00 20	
9 13 29	45 59 30	6 35 23

Thermometer 66° Fahrenheit.

Second series.—The Moon's western limb and Spica Virginis, east.

Time.	Angular distances.	Deduced longitude.
<i>h. m. s.</i>	<i>d. m. s.</i>	<i>h. m. s.</i>
9 56 13	45 42 40	
9 58 03	45 42 00	
9 59 32	45 41 20	
10 00 44	45 40 30	6 33 57

Double altitude of the Moon's upper limb, in the west.

Time	Altitude.
<i>h. m. s.</i>	<i>d. m. s.</i>
10 02 52	82 30 30

Double altitude of Spica Virginis, in the west.

Time.	Altitude.
<i>h. m. s.</i>	<i>d. m. s.</i>
10 04 28	89 50 40

Time.	Angular distances.	Deduced longitude.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>	<i>h.</i> <i>m.</i> <i>s.</i>
10 05 48	45 38 50	
10 07 11	45 38 00	
10 08 57	45 37 00	
10 10 24	45 36 20	6 33 54

Double altitude of Spicu Virginis, in the west.

Time.	Altitude.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>
10 11 47	89 00 10

Double altitude of the Moon's upper limb, in the west.

Time.	Altitude.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>
10 13 29	78 12 10

Time.	Angular distances.	Deduced longitude.
<i>h.</i> <i>m.</i> <i>s.</i>	<i>d.</i> <i>m.</i> <i>s.</i>	<i>h.</i> <i>m.</i> <i>s.</i>
10 15 12	45 34 50	
10 16 38	45 34 00	
10 17 59	45 33 10	
10 19 45	45 32 20	6 33 50

Thermometer 66° Fahrenheit.

DETERMINATION OF LATITUDE.

Approximate latitude to be used in the first computation of time—
33° 31' 35".

*Determination of time, April 29, 1854.—Double altitudes of Procyon, in
the west.*

Time.			Altitudes.			Chronometers slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	39	14	89	04	30			
6	40	44	88	31	40			
6	41	34	88	14	10			
6	42	30	87	53	40			
6	43	26	87	32	20	0	56	17.71
6	44	19	87	13	40			
6	45	07	86	54	10			
9	45	54	86	37	50			
6	46	46	86	19	20			
6	47	34	66	01	40	0	56	18.82

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometers slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
7	24	39	88	47	40			
7	25	47	89	16	30			
7	26	40	89	38	50			
7	27	34	90	00	50			
7	28	21	90	21	40	0	56	17.27
7	29	04	90	38	40			
7	29	50	90	57	50			
7	30	46	91	21	20			
7	31	36	91	41	50			
7	32	23	92	01	40	0	56	17.57

Thermometer 54° Fahrenheit.

Determination of latitude, April 29, 1854.—Double altitudes of Polaris, in the west.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	35	22	64	32	50			
7	37	21	64	32	10			
7	39	31	64	31	20			
7	41	47	64	30	10			
7	43	55	64	29	20	33	31	07.8
7	48	40	64	28	10			
7	50	41	64	27	30			
7	53	54	64	26	40			
7	56	22	64	25	50			
8	00	20	64	24	40	33	31	22.1
8	03	22	64	23	50			
8	05	27	64	22	40			
8	07	45	64	22	00			
8	10	03	64	21	00			
8	12	58	64	20	10			
8	15	38	64	19	30	33	31	11.3
8	17	34	64	19	00			
8	19	55	64	18	30			
8	21	59	64	18	00			
8	23	56	64	17	20			
8	25	54	64	16	40	33	31	04.5

Thermometer 54° Fahrenheit.

Determination of latitude, April 29, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.			Deduced latitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	28	10	83	52	10			
8	29	17	84	04	20			
8	30	55	84	23	40			
8	31	38	84	32	10			
8	32	23	84	40	50	33	33	09
8	33 ^a	06	84	48	50			
8	33	48	84	56	00			
8	34	34	85	04	50			
8	35	19	85	12	30			
8	36	05	85	20	10			
8	36	56	85	30	00	33	32	54.4
8	37	45	85	38	30			
8	38	40	85	47	50			
8	39	29	85	56	50			
8	40	18	86	05	20			
8	40	59	86	12	20			
8	41	48	86	20	40			
8	42	25	86	26	00			
8	43	15	86	33	30			
8	43	59	86	42	00			
8	44	48	86	49	00			
8	45	33	86	55	40	33	32	47

Thermometer 54° Fahrenheit.

Determination of time, May 6, 1854.—Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	43	05	77	05	10
6	44	19	76	36	40
6	45	32	76	07	10
6	46	24	75	47	50
6	47	16	75	26	50
6	48	12	75	05	20
6	49	02	74	46	40
6	49	55	74	25	10
6	50	51	74	03	10
6	51	43	73	42	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	53	26	87	32	40
6	54	15	87	52	20
6	55	05	88	12	50
6	55	48	88	31	00
6	56	28	88	48	10
6	57	12	89	05	40
6	58	26	89	36	50
6	59	14	89	57	00
6	59	54	90	14	20
7	00	36	90	31	20

Thermometer 66° Fahrenheit.

Determination of latitude, May 6, 1854.—Double altitudes of Polaris, in the east.

Time.			Altitudes.			Deduced latitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>			
10	22	08	64	18	50			
10	24	46	64	19	20			
10	28	29	64	20	10			
10	32	13	64	21	20			
10	34	16	64	22	10			
10	36	16	64	23	00			
10	38	34	64	23	50			
10	40	19	64	24	30			
10	42	23	64	25	10			
10	45	08	64	26	00			
10	47	04	64	26	40			
10	49	43	64	27	10			
10	51	51	64	27	50			
10	53	56	64	28	40			
10	55	57	64	29	20			
10	57	35	64	30	00			
10	59	34	64	30	50			
11	01	40	64	31	30			
11	03	38	64	32	20			
11	05	18	64	33	40			
11	07	25	64	34	20	<i>d.</i>	<i>m.</i>	<i>s.</i>
						33	31	58

Determination of latitude, May 6, 1854.—Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	16	30	73	47	10
7	17	28	74	02	40
7	18	11	74	14	30
7	18	55	74	26	10
7	19	38	74	36	50
7	20	20	74	48	40
7	21	03	74	59	30
7	21	50	75	11	20
7	22	36	75	24	10
7	23	20	75	35	00
7	24	00	75	45	40
7	24	53	75	59	10
7	25	37	76	10	10
7	26	27	76	22	10
7	27	11	76	33	40
7	28	01	76	46	20
7	28	53	76	59	10
7	29	42	77	11	20
7	30	27	77	23	10
7	31	13	77	33	50
7	32	02	77	46	00
7	32	53	77	57	50

Thermometer 66° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in the first computation of time—
33° 31' 35".

*Determination of time, April 29, 1854.—Double altitudes of Procyon, in
the west.*

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	39	14	89	04	30
6	40	44	88	31	40
6	41	34	88	14	10
6	42	30	87	53	40
6	43	26	87	32	20
6	44	19	87	13	40
6	45	07	86	54	10
6	45	54	86	37	50
6	46	46	86	19	20
6	47	34	86	01	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	24	39	88	47	40
7	25	47	89	16	30
7	26	40	89	38	50
7	27	34	90	00	50
7	28	21	90	21	40
7	29	04	90	38	40
7	29	50	90	57	50
7	30	46	91	21	20
7	31	36	91	41	50
7	32	23	92	01	40

Thermometer 54° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in the first computation of time—
 $33^{\circ} 31' 35''$.

Determination of time, May 6, 1854.—Double altitudes of the Sun's upper limb.

Time, p. m.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
2	17	27	85	44	55
2	19	52	84	44	55
2	22	24	83	42	55
2	23	15	83	21	45
2	23	42	33	09	55
2	24	17	82	55	25
2	24	47	82	43	15
2	25	25	82	27	45
2	25	59	82	13	35
2	26	30	82	00	25
2	27	08	81	45	25
2	27	37	81	33	25

Thermometer 78° Fahrenheit.

Determination of time, May 6, 1854.—Double altitudes of Procyon, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	43	05	77	05	10
6	44	19	76	36	40
6	45	32	76	07	10
6	46	24	75	47	50
6	47	16	75	26	50
6	48	12	75	05	20
6	49	02	74	46	40
6	49	55	74	25	10
6	50	51	74	03	10
6	51	43	73	42	40

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	53	26	87	32	40
6	54	15	87	52	20
6	55	05	88	12	50
6	55	48	88	31	00
6	56	28	88	48	10
6	57	12	89	05	46
6	58	26	89	36	50
6	59	14	89	57	00
6	59	54	90	14	20
7	00	36	90	31	20

Thermometer 66° Fahrenheit.

Observations for the variation of the compass, May 6, 1854.—Double altitude of Polaris, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
10	24	46	64	19	20	N. 9	50	00 W.

Variation of compass, E. 10° 36' 40".

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	21	03	74	59	30	S. 49	00	00 E.

Variation of compass, E. 10° 19' 12". Thermometer 66° Fah.

ON ELM FORK OF TRINITY RIVER.

DETERMINATION OF LONGITUDE BY LUNAR DISTANCES.

Approximate latitude to be used in first computation of time, $33^{\circ} 45'$.

Determination of time, May 10, 1854.—Double altitudes of Pollux, in the west.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	38	24	94	44	25	1	3	15.4 R
6	39	33	94	17	05	1	3	12.3
6	40	22	93	56	55	1	3	12.4
6	41	18	93	34	15	1	3	16.5 R
6	42	13	93	10	05	1	3	14.5
6	43	05	92	48	25	1	3	13.5
6	43	57	92	27	45	1	3	12.0
6	44	55	92	03	05	1	3	13.8
6	45	40	91	44	15	1	3	13.0
6	46	33	91	22	55			

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	48	23	94	32	45	1	3	14.3
6	49	22	94	57	05	1	3	13.8
6	50	27	95	25	55	1	3	16.4 R
6	51	13	95	43	05	1	3	14.6
6	51	57	96	01	05	1	3	13.8
6	52	53	96	24	35	1	3	14.6
6	53	47	96	47	35	1	3	16.4 R
6	54	34	97	06	05	1	3	14.4
6	55	17	97	24	25	1	3	15.6 R
6	56	13	97	47	05	1	3	14.6

Thermometer 56° Fahrenheit.

Determination of longitude by lunar distances.—The Moon's western limb and Pollux, west.

Time.	Angular distances.	Deduced longitude.
<i>h. m. s.</i>	<i>d. m. s.</i>	<i>h. m. s.</i>
7 00 31	98 06 15	
7 03 19	98 07 35	
7 05 18	98 08 35	
7 07 03	98 09 25	6 29 07

Double altitude of the Moon's upper limb, in the east.

Time.	Altitude.
<i>h. m. s.</i>	<i>d. m. s.</i>
7 08 49	69 20 55

Double altitude of Pollux, in the west.

Time.	Altitude.
<i>h. m. s.</i>	<i>d. m. s.</i>
7 11 30	81 08 15

Time.	Angular distances.	Deduced longitude.
<i>h. m. s.</i>	<i>d. m. s.</i>	<i>h. m. s.</i>
7 13 17	98 11 45	
7 15 00	98 12 55	
7 16 55	98 14 05	
7 18 59	98 15 05	6 29 08

Double altitude of Pollux, in the west.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	22	07	76	46	55

Double altitude of the Moon's upper limb, in the east.

Time.			Altitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	23	38	73	27	35

Time.			Angular distances.			Deduced longitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
7	26	10	98	18	35			
7	27	57	98	19	35			
7	29	45	98	20	15			
7	31	21	98	20	55	6	30	18.5

DETERMINATION OF LATITUDE.

Approximate latitude to be used in first computation of time, $33^{\circ} 45'$.

Determination of time, May 10, 1854.—Double altitudes of Pollux, in the west.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	38	24	94	44	25	1	3	15.3 R.
6	39	33	94	17	05	1	3	12.3
6	40	22	93	56	55	1	3	12.4
6	41	18	93	34	15	1	3	16.5 R.
6	42	13	93	10	05	1	3	14.5
6	43	05	92	48	25	1	3	13.4
6	43	57	92	27	45	1	3	12.5
6	44	55	92	03	05	1	3	13.8
6	45	40	91	44	15	1	3	12.8
6	46	33	91	22	55	1	3	11.8

Double altitudes of Arcturus, in the east.

Time.			Altitudes.			Chronometer slow of mean time.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
6	48	23	94	32	45	1	3	14.3
6	49	22	94	57	05	1	3	13.8
6	50	27	95	25	55	1	3	16.4 R.
6	51	13	95	43	05	1	3	14.6
6	51	57	96	01	05	1	3	13.8
6	52	53	96	24	35	1	3	14.6
6	53	47	96	47	35	1	3	16.7 R.
6	54	34	97	06	05	1	3	14.4
6	55	17	97	24	25	1	3	15.6 R.
6	56	13	97	47	05	1	3	14.6

Thermometer 56° Fahrenheit.

Determination of latitude, May 10, 1854.—Double altitudes of Regulus, in the west.

Time.			Altitudes.			Deduced latitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	00	51	104	37	25			
8	02	02	104	12	15			
8	03	08	103	47	15			
8	04	03	103	25	25			
8	04	49	103	09	05			
8	05	35	102	51	25			
8	06	33	102	29	15			
8	07	28	102	08	25			
8	08	33	101	44	25			
8	09	18	101	26	25	33	41	40

Double altitudes of Polaris, in the east.

Time.			Altitudes.			Deduced latitude.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>			
8	15	27	64	28	55			
8	17	00	64	29	45			
8	18	41	64	30	45			
8	20	31	64	31	25			
8	23	47	64	29	15			
8	26	38	64	29	55			
8	28	25	64	30	25	<i>d.</i>	<i>m.</i>	<i>s.</i>
						33	41	42

Stars very dim.

Thermometer 56° Fahrenheit.

DETERMINATION OF TIME.

Approximate latitude to be used in first computation of time, 33° 45'.

Determination of time, May 10, 1454—Double altitudes of Pollux, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	24	94	44	25
6	39	33	94	17	05
6	40	22	93	56	55
6	41	18	93	34	15
6	42	13	93	10	05
6	43	05	92	48	25
6	43	57	92	27	45
6	44	55	92	03	05
6	45	40	91	44	15
6	46	33	91	22	55

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	48	23	94	32	45
6	49	22	94	57	05
6	50	27	95	25	55
6	51	13	95	43	05
6	51	57	96	01	05
6	52	53	96	24	35
6	53	47	96	47	35
6	54	34	97	06	05
6	55	17	97	24	25
6	56	13	97	47	05

Thermometer 56° Fahrenheit.

Observations for the variation of the compass, May 10, 1854.—Double altitude of Polaris, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	23	47	64	29	15	N. 10	50	00 W.

Variation of compass, E. 10° 36' 00".

CAMP FOUR MILES EAST OF THE LOWER CROSS TIMBERS.

DETERMINATION OF LATITUDE.

Determination of time, May 13, 1854.—Double altitudes of Pollux, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	48	02	84	26	25 doubtful.
6	48	59	84	07	15
6	50	12	83	48	05
6	51	00	83	18	15
6	51	47	82	58	15
6	52	42	82	35	45
6	53	42	82	12	25
6	56	40	80	58	55
6	57	30	80	37	15
6	58	25	80	16	15

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	57	96	55	25
6	39	51	97	16	35
6	40	36	97	35	05
6	41	21	97	51	55
6	42	04	98	12	55
6	42	46	98	29	15
6	43	24	98	44	25
6	44	06	99	01	15
6	44	43	99	16	25
6	45	23	99	34	05

Thermometer 58° Fahrenheit.

Determination of latitude, May 13, 1854.—Double altitudes of Polaris, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	11	07	64	33	15
8	12	52	64	33	55
Observations suspended; night wet and misty.					
8	53	56	64	33	05
8	56	20	64	34	35
9	05	10	64	33	55

Observations discontinued; night wet and misty.

Thermometer 58° Fahrenheit.

Double altitudes of Spica Virginis, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	11	40	81	18	25
7	12	35	81	29	25
7	13	19	81	38	35
7	14	13	81	50	35
7	15	10	82	02	35
7	16	03	82	12	55
7	17	07	82	26	35
7	18	00	82	37	15
7	19	02	82	47	55
7	20	03	83	01	25
7	21	22	83	17	35
7	22	35	83	31	25
7	23	37	83	43	55
7	24	52	83	57	35
7	25	42	84	06	25
7	26	25	84	15	05
7	27	05	84	23	25
7	27	50	84	31	25
7	28	38	84	39	45
7	29	18	84	47	25
7	30	06	84	55	25
7	31	04	85	05	35

Thermometer 58° Fahrenheit.

Determination of time, May 13, 1854.—Double altitudes of Pollux, in the west.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	48	02	84	26	25
6	48	59	84	07	15
6	50	12	83	48	05
6	51	00	83	18	15
6	51	47	82	58	15
6	52	42	82	35	45
6	53	42	82	12	25
6	56	40	80	58	55
6	57	30	80	37	15
6	58	25	80	16	15

Double altitudes of Arcturus, in the east.

Time.			Altitudes.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
6	38	57	96	55	25
6	39	51	97	16	35
6	40	36	97	35	05
6	41	21	97	51	55
6	42	04	98	12	55
6	42	46	98	29	15
6	43	24	98	44	25
6	44	06	99	01	15
6	44	43	99	16	25
6	45	23	99	34	05

Thermometer 58° Fahrenheit.

Observations for the variation of the compass, May 13, 1854.—Double altitude of Polaris, in the west.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
8	12	52	64	33	55	N. 10	55	00 W.

Double altitude of Spica Virginis, in the east.

Time.			Altitude.			Magnetic bearing.		
<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>	<i>d.</i>	<i>m.</i>	<i>s.</i>
7	19	02	82	47	55	S. 39	30	00 E.

Thermometer 58° Fahrenheit.

CHAPTER XIX.

Altitudes of stations above the sea-level.

No. of station.	Distance in feet from station to station.	Elevation above sea, in feet.	Remarks.
1	-----	3830	Molino, on the Rio Grande, near El Paso.
2	2870	3860. 4	
3	2334. 3	3897. 4	
4	1287. 6	3904. 4	
5	382. 6	3911. 8	
6	2793. 5	3927. 2	
7	1505. 1	3991. 7	Summit of Mesa.
8	32616	3991. 7	
9	472	3986. 3	
10	9579	3980. 8	
11	1097. 1	3975. 2	
12	3061. 6	3975. 2	
13	1620	3961. 3	
14	35945. 1	3955. 2	
15	6709. 3	3948. 2	
16	25154	3935. 2	Waco Tanks.
17	892. 9	3935. 2	
18	13890. 8	3935. 2	West edge of Waco Pass.
19	3635. 4	4000. 7	In Waco Pass.
20	2015. 5	4035. 2	Do.
21	1301. 1	4058. 2	Do.
22	1262. 8	4078	Do.
23	. 684. 7	4086. 9	Do.
24	2233. 2	4122. 7	Do.
25	1773	4190. 2	Do.
26	994. 9	4245. 1	Do.
27	1224. 5	4289. 9	
28	1989. 8	4623. 9	
29	1791. 4	4762. 4	In Waco Pass.
30	1530. 7	4811. 8	Summit of Pass.
31	4974. 6	4657	In Waco Pass.
32	3826. 7	4584. 7	
33	6683. 8	4650. 8	
34	4757. 8	4697. 8	
35	1898. 4	4695. 6	
36	29784. 3	4738. 9	
37	48981. 4	4568	Sierra de los Alamos.
38	10765. 7	4659. 4	
39	8881. 3	4502. 9	
40	4234. 8	4568. 1	
41	9247. 8	4543. 9	
42	7053. 9	4371. 6	
43	3061. 4	4361. 8	Las Cornudas.
44	29312. 3	4350	
45	29133. 7	4346. 8	Open Plain.
46	6518	4468. 5	
47	4694	4386. 6	
48	9617. 7	4160. 8	
49	19707. 4	4164. 8	
50	16234. 1	3974	
51	7334. 4	3893	Salt Lake.
52	20472. 7	3893	Ojo del Cuerbo.
53	38075. 4	3898	
54	9617. 7	4063	West edge of Guadalupe Pass.
55	3214. 3	4168. 5	In Guadalupe Pass.
56	10382. 9	4422	Do.
57	612. 5	4451. 1	Do.

Altitudes of stations above the sea-level—Continued.

No. of station.	Distance in feet from station to station.	Elevation above sea, in feet.	Remarks.
58	1785.8	4550.2	In Guadalupe Pass.
59	3210.7	4662.2	Do.
60	1581.7	4684.7	Do.
61	9247.8	4539.5	Do.
62	2117	4549.9	Do.
63	4592	4437.8	Do.
64	1416	4511.4	Do.
65	11224.8	4472.3	Do.
66	2143	4431.2	Foot of Cañon, Guadalupe Pass.
67	18929.2	5619.7	In Guadalupe Pass.
68	1339.4	5659	Do.
69	1951.6	5716.8	Summit of Pass.
70	3269.4	5573.3	In Guadalupe Pass.
71	15038.9	5553.3	Pinery.
72	31442.4	4777.8	Independence Spring.
73	73880.2	4256	
74	5268	4171.8	Head Springs of Delaware Creek.
75	50584.9	4421.3	On high land near Delaware Creek.
76	30847	4378.6	Do. do.
77	11794.8	4505.8	Do. do.
78	28457.6	4290.6	Do. do.
79	7615.1	4204.3	Do. do.
80	29040.3	4069.2	Pecos, mouth of Delaware Creek.
81	14533.3	4143.5	Llano Estacado.
82	12133.3	4222.5	Do.
83	10400	4273.3	Do.
84	22533.3	4432.3	Do.
85	57733.3	4599	Do.
86	56800	4706.9	Summit of Llano Estacado.
87	10000	4701.5	Llano Estacado.
88	31700	4612.3	Do.
89	36400	4543.2	Do.
90	27400	4483.7	Do.
91	49533.3	4564.3	Do.
92	27333.3	4654.7	Do.
93	9733.3	4665.2	Do.
94	17600	4627	Do.
95	46800	4563.5	Do.
96	42333.3	4540.6	Do.
97	28866.6	4509.3	Do.
98	14466.6	4485.8	Do.
99	27866.6	4463.2	Do.
100	32666.6	4418.9	Do.
101	16666.6	4409.9	Do.
102	20600	4443.4	Do.
103	23533.3	4430.2	Do.
104	18000	4277.3	Sulphur Springs of the Colorado.
105	15179.1	4343.5	
106	60461.3	4501.6	
107	9798.4	4530.3	
108	15370	4452.7	
109	22577.7	4419.9	Open plain.
110	37692.7	4387.1	
111	40522.3	4162.3	
112	30067	3988.9	Colorado river.
113	31002	4021.1	
114	13520.9	4013.4	
115	45920	4146.9	
116	30868.5	4236.6	Divide of Colorado and Brazos rivers

Altitudes of stations above the sea-level—Continued.

No. of station.	Distance in feet from station to station.	Elevation above sea, in feet.	Remarks.
117	29975.6	4149.5	
118	11734.9	3875.3	
119	24363.3	4023.5	Tributary of Double Mountain fork of the Brazos.
120	60206.2	3673.3	
121	55861.9	3543.3	
122	53073.6	3359.1	
123	42986.2	3170.6	
124	17985.5	3128.8	
125	15332.2	3021.8	
126	27284.1	2926.6	
127	38643.6	2881.7	
128	22334	2855.8	
129	15814.5	2819	
130	46366.4	2697.7	High lands west of Clear fork of the Brazos.
131	17207.3	2690	Do. do. do.
132	5740	2646.2	
133	34822	2119.5	Clear fork of the Brazos.
134	22672.2	2314.8	High lands east of Clear fork of the Brazos.
135	14987.6	2277.8	
136	23087.6	2173.8	
137	3316.4	2082.2	
138	22050.3	2091.9	
139	11403.5	2103.5	
140	11901	2046.4	
141	35804.8	1843.4	
142	21301.7	1716.4	High land west of Brazos river.
143	35205.4	1614.1	High land east of Brazos river.
144	3717.8	1611.5	
145	33626.4	1660.4	
146	17666.4	1706.6	Divide of Brazos and Trinity rivers.
147	35588	1524.5	West fork of Trinity.
148	10740	1652.7	
149	21416.6	1640.3	
150	19120.5	1573.6	
151	10003.2	1556.2	
152	8252.8	1539.4	
153	29348.5	1547.9	
154	8482.4	1555.2	
155	15944.4	1559.7	
156	47774.2	1475.9	
157	61170.2	1440.1	
158	18712.3	1434.8	
159	14605.2	1447.5	
160	82400.9	1782.9	East edge of Upper Cross Timbers.
161	38266.9	1716.2	
162	7485	1602.2	Elm fork of Trinity.
163	11507.8	1623.4	
164	42690	1369.6	Clear fork of Trinity.
165	49997.8	1461.7	Hill near Gainesville.
166	14987.8	1540.1	
167	28126	1425.6	
168	23215.1	1364.9	East edge of Lower Cross Timbers.
169	10557.6	1340.4	
170	39414	1227.9	Big Mineral.
171	21557.6	1205	
172	26595.4	1189	High land west of Red river.
173	30423.4	790.2	Preston.
174	-----	641	Red river.

Observations for determining profile from El Paso to Preston, on Red river.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ' "			
1.	B.....	2870	00 36 00	30.4	B. Back sights. F. Front sights.
	F.....	2334.3	00 54 30	37	
2.	B.....	1287.6	00 19 30	7	
	F.....	382.6	1 08 00	7.4	
3.	B.....	2793.5	00 19 30	15.4	
	F.....	1505.1	3 36 00	94.5	
4.	B.....	32616			
	F.....	472	00 39 30	5.4	
5.	B.....	9579			
	F.....	1097	00 35 00	11.1	
6.	B.....	3061.6			
	F.....	1620	00 29 30	13.9	
7.	B.....	35945.1	00 02 30	26.1	
	F.....	6709.3			
8.	B.....	2515.4			
	F.....	892.9			
9.	B.....	13890.8			
	F.....	3635.4	1 02 00	65.5	
10.	B.....	2015.5	00 59 00	34.5	
	F.....	1301.1	1 01 00	23	
11.	B.....	1262.8	00 54 00	19.8	
	F.....	684.7	00 45 00	8.9	
12.	B.....	2283.2	00 54 00	35.8	
	F.....	1773.1	2 11 00	67.5	
13.	B.....	994.9	3 01 00	54.9	
	F.....	1224.5	2 06 00	44.8	
14.	B.....	1989.8	9 40 00	334.1	
	F.....	1791.4	4 26 00	138.5	
15.	B.....	1530.7	1 51 00	49.4	
	F.....	4979.6	1 54 00	164.8	
16.	B.....	3826.7	00 56 00	62.3	
	F.....	6683.8	00 34 00	66.1	
17.	B.....	4757.8	00 34 00	47	
	F.....	1898.4	00 04 00	2.2	
18.	B.....	29784.8	00 05 00	43.3	
	F.....	48981.4	00 12 00	170.9	
19.	B.....	10765.7	00 26 00	81.4	
	F.....	8881.3	1 01 00	157.5	
20.	B.....	4234.8	00 53 00	65.2	
	F.....	9247.8	00 09 00	24.2	
21.	B.....	7053.9	1 24 00	172.3	
	F.....	3061.4			
22.	B.....	29312.3			
	F.....	29133.7			
23.	B.....	6518.1	00 51 00	96.9	
	F.....	4694.1	1 00 00	81.9	
24.	B.....	9617.7	1 20 00	223.8	
	F.....	19707.4			
25.	B.....	16234.1	00 40 00	188.8	
	F.....	7334.4	00 38 00	81	
26.	B.....	20472.7			
	F.....	38075.4			
27.	B.....	9617.7	00 59 00	165	
	F.....	3214.3	1 53 00	105.5	
28.	B.....	10382.9	1 24 00	253.5	
	F.....				

Observations for determining profile from El Paso to Preston—Continued.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ' "			
32.	B..... 612.5	3 12 00	-----	34.1	
	F..... 1785.8	3 11 00	99.1		
33.	B..... 3210.7	2 00 00	-----	112	
	F..... 1581.7	00 49 00	22.5		
34.	B..... 9247.8	00 54 00	145.2		
	F..... 2117.0	00 17 00	10.4		
35.	B..... 4592.1	1 24 00	112.1		
	F..... 1416	2 59 00	73.6		
36.	B..... 11224.8	00 12 00	39.1		
	F..... 2143	1 06 00	-----	41.1	
37.	B..... 18929.2	3 36 00	-----	1,188.5	
	F..... 1339.4	1 41 00	39.3		
38.	B..... 1951.6	1 42 00	-----	57.8	
	F..... 3269.4	2 31 00	143.5		
39.	B..... 8342.2				
	F..... 4974.7				
40.	F..... 1722				
41.	B..... 31442.4	1 27 00	795.5		
42.	B..... 105322.6	00 43 00	1317.3		To the Pinery.
	F..... 5268	00 55 00	-----	84.2	
43.	B..... 161549.2	00 25 00	1174.7		To the Pinery.
44.	B..... 203897.6	00 18 00	1067.5		To the Pinery.
45.	B..... 2845.7	00 26 00	215.2		
	F..... 7615.1	00 39 00	-----	86.3	
46.	F..... 29040.3	00 16 00	-----	135.1	
47.	B..... 13564.4	00 04 00	15.7		
	F..... 11324.4	00 24 00	79		
48.	F..... 9706.7	00 18 00	50.8		
49.	F..... 21031	00 26 00	159		
50.	F..... 53384.4	00 10 00	156.7		
51.	F..... 53013.4	00 07 00	107.9		
52.	F..... 9333.6				
53.	F..... 29586.8	00 11 00	-----	94.6	
54.	F..... 33973.4	00 07 00	-----	69.1	
55.	F..... 25573.4	00 08 00	-----	59.5	
56.	F..... 46231.1	00 06 00	80.6		
57.	F..... 25511.1	00 13 00	96.4		
58.	F..... 9084.4	00 04 00	10.5		
59.	F..... 16426.8	00 08 00	-----	38.2	
60.	F..... 43680	00 05 00	-----	63.5	
61.	F..... 39511	00 02 00	-----	22.9	
62.	F..... 26942.2	00 04 00	-----	31.3	
63.	F..... 13501.6	00 06 00	-----	23.5	
64.	F..... 26007.9	00 03 00	-----	22.6	
65.	F..... 30490.2	00 05 00	-----	44.3	
66.	F..... 15555.6	00 02 00	-----	9	
67.	F..... 19226.7	00 06 00	33.5		
68.	F..... 21964.4				
69.	F..... 10800	00 34 00	-----	166.1	
70.	F..... 15179.1	00 15 00	66.2		
71.	F..... 60461.3	00 09 00	158.1		
72.	F..... 9798.4	00 10 00	28.7		
	B..... 37947.7	00 10 00	110.4		
73.	F..... 37692.7	00 03 00	-----	32.8	
74.	F..... 40522.3	00 19 00	-----	223.9	

Observations for determining profile from El Paso to Preston—Continued.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ' "			
75.	F..... 61069.1	00 08 00	.....	142.1	
76.	F..... 13520.9	00 02 00	.....	7.7	
77.	B..... 45920	00 10 00	.....	133.5	
	F..... 30868.5	00 10 00	89.7		
78.	F..... 29975.6	00 10 00	.....	87.1	
79.	F..... 36098.2	00 12 00	.....	126.1	
80.	F..... 60206.2	00 20 00	.....	350.2	
81.	F..... 55861.9	00 08 00	.....	130	
82.	B..... 53073.6	00 12 00	185.2		
	F..... 42986.2	00 15 00	.....	187.5	
83.	F..... 17985.5	00 08 00	.....	41.8	
84.	B..... 15332.2	00 24 00	107		
	F..... 27284.1	00 12 00	.....	95.2	
85.	F..... 38643.6	00 04 00	.....	44.9	
86.	F..... 22334	00 04 00	.....	25.9	
87.	F..... 15814.5	00 08 00	36.8		
88.	B..... 46366.4	00 09 00	121.3		
	F..... 17207.3				
89.	B..... 64224.2	00 20 30	382.9		
	F..... 14987.8	00 08 30	.....	37	
90.	B..... 23087.6	00 15 30	104		
	F..... 3316.4	00 09 30	.....	91.6	
91.	B..... 23050.3	00 01 30	.....	9.7	
92.	B..... 11403.5	00 03 30	.....	11.6	
93.	B..... 11901	00 16 30	57.1		
	F..... 35804.8	00 19 30	.....	20.3	
94.	B..... 21301.7	00 20 00	127		
95.	B..... 35205.4	00 10 00	102.3		
	F..... 3717.8	00 02 00	.....	2.6	
96.	B..... 33626.4	00 05 00	.....	48.9	
97.	B..... 17666.4	00 09 00	.....	46.2	
98.	B..... 46328.2	00 04 00	53.9		
	B..... 21416.6	00 02 00	12.4		
99.	F..... 19120.5	00 12 00	.....	66.7	
	F..... 10013.2	00 06 00	.....	17.4	
100.	B..... 8252.8	00 07 00	16.8		
102.	B..... 29248.5	00 01 00	.....	8.5	
	F..... 8482.4	00 03 00	7.3		
103.	B..... 15944.4	00 01 00	.....	4.5	
104.	B..... 47774.2	00 06 00	83.8		
	F..... 61170	00 02 00	.....	35.8	
105.	F..... 18712.3	00 01 00	.....	5.3	
106.	B..... 14605.2	00 03 00	.....	12.7	
107.	B..... 82400.9	00 14 00	335.4		
108.	B..... 38266.9	00 06 00	66.7		
	F..... 18992.8	00 15 00	.....	82.8	
109.	B..... 92687.8	00 06 00	161.7		
	F..... 14987.8	00 18 00	78.4		
110.	B..... 28126	00 14 00	114.5		
	F..... 23215.1	00 09 00	.....	60.7	
111.	F..... 10557.6	00 08 00	.....	24.5	
112.	B..... 60971.6	00 02 00	35.4		
113.	B..... 26595.4	00 15 00	116		
	F..... 30423.4	00 45 00	.....	398.2	

Observations for determining the profile from the emigrant crossing of the Pecos to the Big Springs of the Colorado.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ' "			
1.	B..... 48354.2	00 24 00	-----	337.4	B. Back sights. F. Front sights.
2.	B..... 18470.1	00 15 00	-----	80.5	
	F..... 93013.5	00 06 00	162.3	-----	
3.	B..... 19975.2	00 23 00	-----	133.6	
	F..... 16263.4	00 12 00	56.7	-----	
4.	F..... 5404	00 05 00	7.8	-----	
5.	B..... 5574.2	00 01 00	-----	1.6	
	F..... 11684.1				
6.	B..... 4974.6	00 39 00	-----	56.4	
	F..... 14235.2	00 01 00	4.1	-----	
7.	B..... 15574.6	00 10 00	-----	45.3	
	F..... 11350.3	00 27 00	89.1	-----	
8.	B..... 15434.2	00 19 00	85.3	-----	
	F..... 39236	00 19 00	-----	216.8	
9.	F..... 31442.4	00 07 00	-----	64	
10.	F..... 9882.4	00 12 00	-----	33.7	
11.	F..... 79722.2	00 03 00	-----	69.5	
12.	B..... 66752.6	00 08 00	155.3	-----	
	F..... 32812.4	00 11 00	-----	104.9	
13.	F..... 12398.4	00 16 00	-----	57.7	
14.	B..... 43795.9	00 01 00	-----	12.7	
	F..... 34006.3	00 06 00	-----	59.3	
15.	F..... 7015.6	00 45 00	-----	74.4	Big Springs of Colorado.

Observations for determining the profile through San Augustin Pass of the Organ mountains.

Observations.			Deduced results.		Remarks.
Number of station.	Distance, in feet.	Angle.	Elevation, in feet.	Depression, in feet.	
		° ' "			
1. {	B..... 8099.8	1 25 00	-----	200.2	B. Back sights. F. Front sights.
	F..... 1942.7	1 20 00	45.1	-----	
2. {	B..... 7653.8	0 50 00	-----	111.3	
	F..... 40574.8	0 26 00	306.9	-----	
3. {	B..... 4540.9	1 30 00	-----	118.7	
	F..... 5178.7	2 47 00	251.4	-----	
4. {	B..... 2104.7	3 57 00	-----	144.9	
	F..... 2296	4 37 00	185.2	-----	
5. {	B..... 1326.6	9 27 00	217.7	-----	
	F..... 1288.3	6 02 00	-----	145	
6. {	B..... 5612.4	4 25 00	422.3	-----	
	F..... 1466	3 10 00	-----	80.9	
7. {	B..... 1755.2	2 30 00	76.5	-----	
	F..... 8176.3	1 00 00	-----	142.7	
8. {	B..... 1657.9	1 27 00	41.3	-----	
	F..... 2580.1	1 17 00	-----	48.7	
9. {	B..... 4490	1 20 00	104.3	-----	
	F..... 4400.8	0 37 00	47.3	-----	
10. {	B..... 11161				
	F..... 5982.4	0 52 00	-----	90.4	
11. {	B..... 2576.6	1 25 00	63.6	-----	
	F..... 1520	1 11 00	-----	31.3	
12. {	B..... 2357.8	0 24 00	16.4	-----	
	F..... 2946.6	0 22 00	-----	18.8	Ojo de la Soledad.

CHAPTER XIV.—BOTANICAL REPORT.*

Catalogue of Plants collected on the expedition: By Dr. John Torrey.

[Full botanical report to be made hereafter.]

RANUNCULACEÆ.

CLEMATIS DRUMMONDII, *Torr. and Gray, Fl. 1, p. 9.* On the Upper Colorado, Texas; April.

ANEMONE CAROLINIANA, *Walt.; Torr. and Gray, Fl. 1, p. 12.* *Torr. in Marcy's Rep., t. 1.* Delaware creek, to the Sacramento, the Pecos, and the Colorado; March, April.

MYONERUS MINIMUS, *Linn.* Head of the Colorado; April.

DELPHINIUM AZUREUM, *Michx.; Fl. 1, p. 314.* Western Texas; April. Broad-leaved varieties.

BERBERIDACEÆ.

BERBERIS TRIFOLIOLATA, *Moricand; Gray, Pl. Lindh. 2, p. 142.* Base of the Guadalupe mountains, New Mexico; March.

PAPAVERACEÆ AND FUMARIACEÆ.

ARGEMONE MEXICANA, *Linn.* Western Texas; April.

CORYDALIS AUREA, *Willd.* Delaware creek to the Sacramento and Pecos; March.

CRUCIFERÆ.

STREPTANTHUS PETIOLARIS, *Gray, Pl. Fendl., p. 7.* On the Upper Colorado, Texas.

STREPTANTHUS CARINATUS, *Wright. in Gray, Pl. Wright. 2, p. 11.* Rocky hills on the Pecos, New Mexico; March. Smaller specimens than Wright's, and, like those, in flower only.

GREGGIA CAMPORUM, *Gray, Pl. Wright. 1, p. 9, t. 1.* On the Pecos, &c.; March. In flower only.

SISYMBRIUM CANESCENS, *Nutt.* Delaware creek to the Colorado; March, April.

ERYSIMUM ASPERUM, *DC. Torr. and Gray, Fl. 1, p. 95.* On the Pecos, Llano Estacado, and Upper Colorado; March, April.

DITHYREA WISLIZENI, *Engelm., in Wisl. N. Mex., p. 11; Torr. in Marcy's Rep., t. 2.* On the Pecos, Llano Estacado, &c.

VESICARIA GRACILIS, *Hook. Bot. Mag., t. 35, 33; Gray, Pl. Lindh. 2, p. 148.* On the Pecos, Llano Estacado, and Upper Colorado; March, April. Except by its not stipitate silicles, *V. angustifolia* (*Nutt.*) is apparently undistinguishable from *V. gracilis*; and there is some reason to fear that the difference is not constant.

VESICARIA GORDONI, *Gray, l. c., p. 149.* Llano Estacado; April. There is reason to fear that this also passes into the foregoing.

* Omitted in its appropriate place, on page 128.

VESICARIA ARGYRÆA, Gray, *Pl. Lindh.* 2, p. 146. Between Delaware creek and the Pecos; March. Not yet in flower.

VESICARIA FENDLERI, Gray, *Pl. Fendl.*, p. 9. *V. stenophylla*, Gray, *Pl. Lindh.* 2, p. 149. Everywhere on Delaware creek, the Pecos, Llano Estacado, &c.; March, April. To this, it is now evident, belongs the *V. stenophylla*; and the species exhibits great diversities in its mode of growth and foliage, as also in the size and even the shape of its pods. The name *V. Fendleri* is the older one; that of *V. stenophylla* is applicable only to some of the forms which the species assumes.

VESICARIA LUDOVICIANA, DC. *Syst.*, 2, p. 297. On the Pecos; March. Not in flower.

DRABA CUNEIFOLIA, Nutt. in Torr. and Gray, *Fl.* 1, p. 108. Delaware creek to the Colorado.

SELENIA DISSECTA, (n. sp.) Leaves bipinnately divided, the segments linear; style not longer than the ovary; valves of the pod imperfectly one-nerved; seeds on short and thick funiculi. In sandy or gravelly soil, from Delaware springs to the Llano Estacado; March and April. In flower, and with some mature fruit. This second species of Nuttall's genus *Selenia* is perhaps the most interesting plant of the present collection. It is a sort of biennial—like so many of this region—the plant having grown from the seed the preceding autumn, and begun to flower early in the following spring. The earliest flowers, borne on slender peduncles, spring directly from the crown, among the tufted radical leaves. Later, an ascending, sparsely leafy stem rises to the height of from three to six inches, and bears a raceme of leafy-bracted flowers, in the manner of *S. aurea*. The blossoms appear to be considerably larger than those of *S. aurea*, at least the earlier ones, the petals being fully half an inch long; but their form, and apparently their color, is the same. The leaves are all pinnately divided, with their primary divisions pinnately 3-9 parted. The anthers are linear, rather than oblong. The style, although slender, is hardly as long as the ovary; stigma rather large, depressed. The silicle is elliptical, slightly inclined to obovate, very flat, seven to eight lines long, scarcely stipulate, rounded at the summit, and abruptly tipped with the comparatively short style; valves minutely reticulate, veiny; a mid-nerve is usually evident from the base to the middle, or sometimes even to the summit. Septum complete in the specimens examined; obscurely two-nerved in the middle; the areolæ large, and nearly as in *S. aurea*. The seeds resemble those of that species, but are borne on short and thick funiculi, the base of which is somewhat adnate to the margin of the septum, and the cœcal pouch at the hilum is small, or indistinct. Cotyledons orbicular, accumbent against the ascending radicle, which is on the side remote from the placenta. As already shown, (in *Gen. Ill.* 1, p. 158,) the genus belongs to the Abyssinææ.

LIPIDIUM ABYSSOIDES, Gray, *Pl. Fendl.*, p. 10. Llano Estacado; April.

LIPIDIUM WRIGHTII, Gray, *Pl. Wright.* 2, p. 15. On the Pecos, Colorado, &c.

LIPIDIUM INTERMEDIUM, Gray, l. c. Near Fort Washita, April.

CISTACEÆ.

LECHEA MINOR, *Lam.*; *Torr. and Gray, Fl. 1, p. 153.* On the Llano Estacado; March. Without flowers or fruit.

CARYOPHYLLACEÆ.

SILENE ANTIRRHINA, *Linn.* On the Upper Colorado, Texas; April.

PARONYCHIA JAMESII, *Torr. and Gray, Fl. 1, p. 170.* Gaudalupe mountains, New Mexico. Without flowers.

MALVACEÆ.

CALLIRRHÆE DIGITATA, *Nutt.*; *Gray, Pl. Fendl., p. 17.* On the Upper Colorado, Texas; April.

CALLIRRHÆE INVOLUCRATA, *Gray, l. c.* A small variety. On the Upper Colorado; April.

MALVASTRUM COCCINEUM, *Gray, Pl. Fendl., p. 21.* Every where between the Rio Grande and the Colorado; March, April.

SPHERALCEA HASTULATA, *Gray, Pl. Wright. 1, p. 17.* On the Pecos and Colorado.

SPHERALCEA AUGUSTIFOLIA, *Spach.*; the small-flowered variety, *S. stellata, Torr.* Pecos to Llano Estacado; March.

SPHERALCEA FENDLERI, *Gray, Pl. Wright. 1, p. 21.* Cotton-wood Springs, New Mexico. Fruit only, without foliage.

GERANIACEÆ.

GERANIUM CAROLINIANUM, *Linn.* From Llano Estacado to the Colorado, &c.

ERODIUM TEXANUM, *Gray, Pl. Lindh. 2, p. 157, and Gen. Ill., t. 151.* From the Pecos to the Colorado; March, April.

OXALIDACEÆ.

OXALIS WRIGHTII, *Gray, Pl. Wright. 1, p. 27.* On the Pecos; March.

LINACEÆ.

LINUM RIGIDUM, *Pursh, Fl. 1, p. 210.* On the Pecos, Llano Estacado, and Upper Colorado; March, April.

LINUM MULTICAULE, *Hook. in Torr. and Gray, Fl. 1, p. 678.* Llano Estacado; April; Mr. Garrard.

LINUM PERENNE, *Linn.* From New Mexico to the Colorado; March, April.

ZYGOPHYLLACEÆ.

LARREA MEXICANA, *Moricaud*; *Torr. in Emory's Rep., p. 137, t. 3.* From the Rio Grande to Llano Estacado, &c. Not yet in flower.

RUTACEÆ.

ZANTHOXYLUM CAROLINIANUM, *Lam.; Torr. and Gray, Fl. 1, p. 214.* Western Texas; April. The variety characterized in *Pl. Wright. 1, p. 31.*

RUTOSMA TEXANUM, *Gray, Gen. Ill. 2, p. 144, t. 155.* On the Pecos, &c.; March.

RUTACEA? In the Organ mountains, New Mexico, Captain Pope gathered, as — — and Mr. Wright had previously done, a sterile branch of a remarkable, probably rutaceous, shrub, with digitate leaves of numerous linear leaflets, which, with the petioles and the branchlets, are tuberculate with great glands. The flowers and fruit are a desideratum.

ANACARDIACEÆ.

RHUS GLABRA, *Linn.* Near Fort Washita; April.

RHUS TRILOBATA, *Nutt. in Torr. and Gray, Fl. 1, p. 219.* On the Upper Colorado, Texas; April.

RHUS MICROPHYLLA, *Engelm. in Pl. Wright. 1, p. 31.* With the preceding species.

VITACEÆ.

VITIS RUPESTRIS, *Scheele in Linnæa, 21, p. 591.* Western Texas; April 21; in flower.

RHAMNACEÆ.

CEANOTHUS OVATIES, *Desf. (C. ovalis, Bigelow.)* Near Fort Chadbourne; also, a downy variety on the Colorado, Texas.

ZIZYPHUS LYCIOIDES, *Gray, Pl. Lindh. 2, p. 168.* Western Texas; April.

MICRORHAMNUS ERICOIDES, *Gray, Pl. Wright. 1, p. 34.* Near Delaware springs, &c.; March.

SAPINDACEÆ.

SAPINDUS MARGINATUS, *Willd.; Gray, Gen. Ill. 2, t. 180.* Pecos and Llano Estacado.

UNGUADIA SPECIOSA, *Endl.; Gray, Gen. Ill. 2, t. 178, 179.* Big Springs of the Colorado and elsewhere; April.

POLYGALACEÆ.

POLYGALA ALBA, *Nutt. Gen. 2, p. 87.* Llano Estacado, Colorado, &c.

POLYGALA MACRADENIA, *Gray, Pl. Wright. 1, p. 38.* On the Pecos; March.

KRAMERIA LANCEOLATA, *Torr.; Gray, Gen. Ill., t. 187, 188.* Western Texas; April.

LEGUMINOSÆ.

VICIA LEAVENWORTHII, *Torr. and Gray, Fl. 1, p. 271.* On the Upper Colorado, Texas; April.

VICIA EXIGUA, *Nutt. in Torr. and Gray, l. c.; Gray, Pl. Wright. 2, p. 32.* Llano Estacado; March, April.

TEPHROSIA VIRGINIANA, *Pers. Syn. 2, p. 328.* Western Texas; May.

AMORPHA FRUTICOSA, *Linn. Var.* On the Upper Colorado; April.

PSORALEA ESCULENTA, *Pursh, Fl. 2, p. 475, t. 22.* On the Colorado, Western Texas; April.

PSORALEA OBTUSILOBA, *Torr. and Gray, Fl. 1, p. 300.* Western Texas; May.

PSORALEA FLORIBUNDA, *Nutt. in Torr. and Gray, Fl., l. c.* Western Texas; May.

PSORALEA CUSPIDATA, *Pursh, Fl. 2, p. 741.* Western Texas; April.

PSORALEA DIGITATA, *Nutt. in Torr. and Gray, l. c.* Western Texas; April.

DALEA FORMOSA, *Torr. in Long's Exped. and Emory's Rep., t. 1.* Everywhere between the Rio Grande and Western Texas.

PETALOSTEMON VIOLACEUM, *Michx.* Near Fort Washita.

PETALOSTEMON CANDIDUM, *Michx.* Near Fort Washita.

ASTRAGALUS MOLLISSIMUS, *Torr. in Ann. Lyc., New York, 2, p. 178; Gray, Pl. Wright. 1, p. 53.* On the Llano Estacado, in sandy soil; March, April. Plant sometimes considerably caulescent, and a foot high.

ASTRAGALUS SUCCUMBENS, *Dougl. in Hook. Fl. Bor. Am., 1, p. 151.* On the Pecos, Llano Estacado, &c.; March, April. The specimens are only in flower; in which state they very well accord with Douglas's plant. Mr. Gordon also gathered it in flower on the Raton mountains.

ASTRAGALUS PAUCIFLORUS, *Hook. Fl. Bor. Am. 1, p. 129.* High grounds at the headwaters of the Colorado, Texas; April.

ASTRAGALUS MISSOURIENSIS, *Nutt. Gen. 2, p. 99.* Guadalupe mountains to the Colorado; March, April.

ASTRAGALUS CYANENS, *Gray, Pl. Fendl., p. 34.* Between the Pecos and Llano Estacado. Probably too near the preceding species.

ASTRAGALUS NUTTALLIANUS, *DC., var. trichocarpus and canescens, Gray, Pl. Wright.* From the Pecos to the Colorado; March, April.

ASTRAGALUS LINDHEIMERI, *Gray, Pl. Wright. 1, p. 52.* On the Upper Colorado; April.

ASTRAGALUS CANADENSIS, *Linn.* Near Fort Washita; April.

ASTRAGALUS, n. sp.? In flower only. High ground, on the eastern border of the Llano Estacado; April.

OXYTROPIS LAMBERTI, *Pursh, Fl. 2, p. 740.* Western Texas; May.

STYLORANTHES ELATIOR, *Swartz.; DC. Prodr. 2, p. 318.* Western Texas; May.

DESMODIUM CANESCENS, *DC. Prodr. 2, p. 238.* Near Fort Washita.

LESPEDERA STUVEL, *Nutt. Gen. 2, p. 107.* Near Fort Washita.

SOPHORA SERICEA, *Nutt. Gen. 1, p. 280.* Western Texas; April.

CERCIS OCCIDENTALIS, Torr. in *Pl. Lindh.* 2, p. 177. Near Fort Chadbourne; May.

HOFFMANSEGGIA STRICTA, var. *DEMISSA*, Benth. in *Pl. Wright.* 1, p. 56. Llano Estacado to the Colorado; April. In flower.

HOFFMANSEGGIA DREPANOCARPA, Gray, *Pl. Wright.* 1, p. 58. On the Pecos.

HOFFMANSEGGIA BRACHYCARPA, Gray, l. c. On the Pecos.

HOFFMANSEGGIA JAMESII, Torr. and Gray, *Fl.* 1, p. 393. Llano Estacado.

CASSIA PUMILIO, Gray, *Pl. Lindh.* 2, p. 180, and *Pl. Wright.* 1, p. 59. Llano Estacado, &c.; April.

CASSIA BAUHINIOIDES, Gray, l. c. Llano Estacado; April.

CASSIA ROEMERIANA, Scheele; Gray, *Pl. Lindh.* 2, p. 179. Western Texas; April.

STROMBOCARPA PUBESCENS, Gray, *Pl. Wright.* 1, p. 60. (*Prosopis*, Benth.) Near Doña Ana. The fruit only: called *Tornio*, or Screw-tree.

ALGAROBIA GLANDILOSA, Torr. and Gray, *Fl.* 1, p. 399. Headquarters of the Colorado, Texas; April.

DESMANTHUS JAMESII, Torr. and Gray, *Fl.* 1, p. 402. Llano Estacado, &c. Foliage only.

SCHRANKIA PLATYCARPA, Gray, *Pl. Lindh.* 2, p. 183. Western Texas; April.

MIMOSA BOREALIS, Gray, *Pl. Fendl.*, p. 39. On the Upper Colorado, and near Fort Chadbourne; April, May.

ACACIA HISTA, Nutt. in Torr. and Gray, *Fl.* 1, p. 404. Western Texas; April.

ACACIA TEXENSIS, Torr. and Gray, l. c. (Probably the *A. cuspidata*, Schlecht.) Near Fort Washita.

ROSACEÆ.

PRUNUS AMERICANA, Marsh; Torr. and Gray, *Fl.* 1, p. 407. Big Springs of the Colorado; April.

PRUNUS CHICASA, Michx.; Torr. and Gray, l. c. On the Colorado; April.

CERCOCARPUS PARVIFOLIUS, Nutt. in Torr. and Gray, *Fl.* 1, p. 427. Doña Ana, New Mexico; February. Foliage only.

GEUM VIRGINIANUM, Linn. Western Texas; May.

ROSA SETIGERA, Michx.; Torr. and Gray, *Fl.* 1, p. 457. Fort Washita; April.

RUBUS TRIVIALIS, Michx., *Fl.* 1, p. 296. Near Fort Washita.

FALLUGIA PARADOXA, Torr. in Emory's Rep., t. 2. Guadalupe Mountains, New Mexico. Foliage only.

ONAGRACEÆ.

ENOTHERA LAVANDULÆFOLIA, Torr. and Gray, *Fl.* 1, p. 501. Llano Estacado; April.

ENOTHERA HARTWEGI, Benth., *Pl. Hartw.*, p. 1; the var. answering to *E. Fendleri*; Gray, *Pl. Fendl.* On the Pecos, Llano Estacado, and Colorado.

ŒNOTHERA TUBICULA, Gray, *Pl. Wright.* 1, p. 71. On the Pecos and Llano Estacado.

ŒNOTHERA ALBICAULIS, Nutt. *Gen.* 1, p. 245; Gray, *Pl. Wright.* 1, p. 69. On the Pecos.

ŒNOTHERA TRILOBA, Nutt. *Gen.*, l. c. On the Pecos.

ŒNOTHERA SERRULATA, Nutt., l. c. Big Springs of the Colorado to Fort Washita, &c.; April.

ŒNOTHERA SINUATA, Linn. Near Fort Washita; April. Western Texas; May.

ŒNOTHERA WRIGHTII, Gray, *Pl. Wright.* 2, p. 57. On the Llano Estacado; April. In flower.

ŒNOTHERA MISSOURIENSIS, Sims, *Bot. Mag.*, t. 1592. Western Texas; May.

ŒNOTHERA SPECIOSA, Nutt.; Torr. and Gray, *Fl.* 1, p. 496. Western Texas; April.

ŒNOTHERA SPACHIANA, Torr. and Gray, *Fl.* 1, p. 498. Western Texas; May.

GAURA PARVI FLORA, Dougl.; Torr. and Gray, *Fl.* 1, p. 519. Llano Estacado and Western Texas.

GAURA SUFFULTA, Engelm., in *Pl. Lindh.* 2, p. 190. Western Texas; April.

GAURA COCCINEA, Nutt.; Torr. and Gray, *Fl.* 1, p. 518. Llano Estacado.

GAURA SINUATA, Nutt.; Torr. and Gray, i. c. Western Texas; April.

CUCURBITACEÆ.

SICYDIUM LINDHEIMERI, Gray, *Pl. Lindh.* 2, p. 194. On the Pecos; also Western Texas; March, April.

CUCURBITA PERENNIS, Gray, l. c. Western Texas; April. Foliage only.

PASSIFLORACEÆ.

PASSIFLORA INCARNATA, Linn.; Torr. and Gray, *Fl.* 1, p. 538. Western Texas; May.

GROSSULACEÆ.

RIBES AUREUM, Pursh. Big Springs of the Colorado, &c.; April.

CACTACEÆ.

CEREUS CÆSPITOSUS, *ECHINOCACTUS TEXENSIS*, and *OPUNTIA FRUTESCENS*, Engelm., occur in the collection, either the branches or separate flowers.

UMBELLIFERÆ.

CYMOPTERUS MONTANUS, Nutt. in Torr. and Gray, *Fl.* 1, p. 624; Gray, *Pl. Fendl.*, p. 56, and *Pl. Wright.* 1, p. 79. Eastern part of the Llano Estacado, and on the Upper Colorado; April.

POLYTAENIA NUTTALLII, DC. *Prodr.* 4, p. 196. On the Colorado, Texas; April. In flower.

DAUCUS PUSILLUS, Michx., *Fl.* 1, p. 164. On the Colorado, Texas; April.

MUSENIUM? (n. s.) Formerly got by Wright, but not noticed; description to be given. On the Llano Estacado and Big Springs of the Colorado; April.

RUBIACEÆ.

OLDENLANDIA (HOUSTONIA) HUMIFUSA, Gray, *Pl. Wright.* 2, p. 68. On the Pecos and Llano Estacado; March. A vernal state.

OLDENLANDIA AUGUSTIFOLIA, Gray, l. c. Fort Washita and Western Texas; April, May.

GALIUM APANNE, Linn. On the Colorado; April. Not in flower.

VALERIANACEÆ.

FEDIA AMARELLA, Lindh. in *Pl. Lindh.* 2, p. 217. On the Colorado, &c., Texas; April, May.

COMPOSITÆ.

MACHERANTHERA TANACETIFOLIA, Nees; Gray, *Pl. Wright.* 1, p. 90. Llano Estacado and Western Texas; March to May.

ERIGERON STRIGORUM, Muhl.; Torr. and Gray, *Fl.* 2, p. 176. Near Fort Washita; April.

ERIGERON DIVERGENS, Torr. and Gray, l. c.; Gray, *Pl. Wright.* 1, p. 91. From the Pecos to the Colorado, Texas. Various forms.

DIPLOPAPPUS ERICOIDES, Torr. and Gray, *Fl.* 2, p. 182. New Mexico to the Colorado; March, April. Various forms.

TOWNSENDIA SERICEA, Hook. *Fl. Bor. Am.* 2, p. 16, t. 119. Guadalupe mountains, New Mexico; March.

CHETOPAPPA ASTEROIDES, DC. *Prodr.* p. 5, 301. Western Texas; April, May.

APHANOSTEPHUS RAMOSISSIMUS, DC. *Prodr.* 5, p. 310; Gray, *Pl. Wright.* 1, p. 93. Big Springs of the Colorado; April.

APHANOSTEPHUS ARKANSANUS, Gray, l. c. Western Texas; May.

BELLIS INTEGRIFOLIA, Michx. *Fl.* 2, p. 131. Western Texas; May.

APLOPAPPUS SPINULOSUS, DC. *Prodr.* 5, p. 345. From the Pecos to the Colorado, Texas.

XANTHISMA TEXANUM, DC. *Prodr.* 5, p. 94; Gray, *Pl. Wright.* 1, p. 98. Western Texas; May.

SOLIDAGO CANADENSIS, Linn. Near Fort Washita; April. Not in flower.

CALYMMANDRA CANDIDA, Torr. and Gray, *Fl.* 2, p. 262. Western Texas, on the Upper Colorado; April. This has scarcely been collected since it was gathered by Drummond.

FILAGINOPSIS MULTICAULIS, Torr. and Gray, *Fl.* 2, p. 263. On the Pecos and Llano Estacado; March. Western Texas; April. Sterile

corollas naked at the summit, but bearing a few long, woolly hairs near the base.

PARTHENIUM HYSTEROPHORUS, *Linn.* Pecos and Llano Estacado.

MELAMPODIUM CINEREUM, *DC. Prodr. 5, p. 518.* Banks of the Pecos to the Colorado; March to May.

BULANDIERA LYRATA, *Benth.; Gray, Pl. Fendl., p. 78.* Llano Estacado; March.

ENGELMANNIA PINNATIFIDA, *Torr. and Gray, in Trans. Amer. Phil. Soc. and Fl. 2, p. 283.* Western Texas to the head of the Colorado; April, May.

LINDEHEIMERIA TEXANA, *Gray and Engelm., Pl. Lindh. 2, p. 225.* Western Texas; April.

ZINNIA MULTIFLORA, *Linn.* Near Fort Chadbourne, Texas.

ECHINACEA ANGUSTIFOLIA, *DC. Prodr. 5, p. 554.* Var. Western Texas; April.

SIMSIA (BARRATTIA) CALVA, *Gray, Pl. Lindh. 2, p. 228.* On the Upper Colorado; April.

DRACOPIS AMPLEXICAULIS, *Cass.; DC. Prodr. 5, p. 558.* Near Fort Washita; April.

ACTINOMERIS HELIANTHOIDES, *Nutt. Gen. 2, p. 181.* Near Fort Washita; April.

THELESERMA FILIFOLIA, *Gray, in Hook. Ken. Jour. Bot. 1, p. 252, and Pl. Wright. 1, p. 109.* Headwaters of the Colorado; April. Also probably *T. GRACILIS*; but not yet in flower.

COREOPSIS GRANDIFLORA, *Nutt.; Torr. and Gray, Fl. 2, p. 345.* On the Colorado; April.

COREOPSIS TINCTORIA, *Nutt.* Near Fort Washita; April.

CHRYSACTINIA MEXICANA, *Gray, Pl. Fendl., p. 93.* Near Independence spring; March. Without flowers.

HYMENATHERUM (ACIPHYLLÆA) ACERORUM, *Gray, Pl. Wright. 1, p. 115.* On the Pecos and Llano Estacado; March, April.

HYMENATHERUM PENTACHÆTUM, *DC. Prodr. 5, p. 642.* On the Pecos; March.

AGASSIZIA SUAVIS, *Gray and Engelm., Pl. Lindh. 2, p. 229.* Western Texas; April.

GAILLARDIA AMBLYODON, *Gay; Torr. and Gray, Fl. 2, p. 267; Gray, Chl. Bor. Am., t. 4.* Western Texas; April.

GAILLARDIA PINNATIFIDA, *Torr. in Long's Exped.; Torr. and Gray, Fl. 2, p. 366.* Llano Estacado to the Colorado; March, April.

GAILLARDIA PULCHELLA, *Fongereux; Torr. and Gray, l. c.* Western Texas; April.

HYMENOPAPPUS CORYMBOSUS, *Torr. and Gray, Fl. 2, p. 272.* On the Colorado, &c.; April.

BAHIA ABSINTHIFOLIA, *Benth.* Var. *DEALBATA*, *Gray, Pl. Wright. 1, p. 121.* On the Pecos; March.

RIDDELLIA TAGETINA, *Nutt.; Torr. and Gray, Fl. 2, p. 262.* Llano Estacado; March.

AMBLYOLEPIS SETIGERA, *DC. Prodr. 5, p. 568; Gray, Pl. Wright. 1, p. 121.* From the Llano Estacado to the Lower Colorado; March, April.

ACTINELLA SCAPORA, *Nutt.*; *Torr. and Gray, Fl. 2, p. 382.* On the Pecos and Llano Estacado; March.

ACTINELLA LINEARIFOLIA, *Nutt.*; *Torr. and Gray, l. c.* On the Pecos.

ACTINELLA RICHARDSONII, *Nutt.* *Picradenia Richardsonii, Hook.* Near the Pecos; March.

HELENIUM TENNIFOLIUM, *Nutt.*; *Torr. and Gray, Fl. 2, p. 385.* Western Texas; April.

MARSHALLIA CÆSPITOSA, *Nutt. in DC. Prodr. 5. p. 680.* On the Upper Colorado; April.

ACHILLEA MILLEFOLIUM, *Linn.* Near Fort Washita, and on the Colorado.

ARTEMISIA DRACUNCULOIDES, *Pursh*; *Torr. and Gray, Fl. 2, p. 216.* Sacramento river, to Llano Estacado; March.

ARTEMISIA LEWISII, *Torr. and Gray, Fl. 2, p. 217.* Pecos to Llano Estacado; March.

ARTEMISIA LUDOVICIANA, *Nutt.*; *Torr. and Gray, Fl. 2, p. 420.* Cotton-wood Springs, New Mexico, &c.; March.

GNAPHALIUM LUTEO-ALBUM, *Linn.* New Mexico and Western Texas.

SENECIO FILIFOLIUS, *Nutt.*, var. *JAMESII, Torr. and Gray, Fl. 2, p. 444.* On the Pecos and Upper Colorado.

SENECIO LOBATUS, *Pers.*; *Torr. and Gray, l. c.* Western Texas; April.

CIRSIUM VIRGINIANUM, *Michx.*, *Fl. 2, p. 90.* Western Texas; April.

CIRSIUM UNDULATUM, *Spreng.*; *DC. Prodr. 6, p. 651.* Llano Estacado, &c.

CENTAUREA AMERICANA, *Nutt.* Near Fort Washita; April.

PEREZIA NANA, *Gray, Pl. Fendl., p. 111.* On the Pecos; March. Foliage only.

APOGON HUMILIS, *Ell. Sk. 2, p. 267.* Western Texas; May.

KRIGIA OCCIDENTALIS, *Nutt.*; *Torr. and Gray, Fl. 2, p. 467.* Western Texas; May.

PINAROPAPPUS ROSENS, *Less.*; *DC. Prodr. 7, p. 99.* Western Texas; April.

LYGODESMIA APHYLLA, *DC.*, var. *TEXANA, Torr. and Gray, Fl. 2, p. 484.* Western Texas; April.

PYRRHOPAPPUS CAROLINIANUS, *DC. Prodr. 7, p. 144.* Upper Colorado, Texas; April.

PYRRHOPAPPUS GRANDIFLORUS, *Nutt.*; *Torr. and Gray, Fl. 2, p. 495.* Big Springs of the Colorado, &c.; April.

PRIMULACEÆ.

DODECATHEON MEADIA, *Linn.* Western Texas; May.

PLANTAGINACEÆ.

PLANTAGO VIRGINICA, *Linn.* Llano Estacado, and on the Colorado; March, April.

PLANTAGO GNAPHALOIDES, *Nutt. Gen.* 1, p. 100. On the Pecos; March.

APOCYNACEÆ.

AMSONIA CILIATA, *Walt. Fl. Car.*, p. 98. On the Upper Colorado; April.

CONVOLVULACEÆ.

EVOLVULUS ARGENTEUS, *Pursh, Fl.* 1, p. 187. On the Upper Colorado, Texas; April.

CONVOLVULUS LOBATUS, *Engelm. and Gray, Pl. Lindh.* 1, p. 44. On the Colorado, Texas; April.

HYDROPHYLLACEÆ.

PHACELIA INTEGRIFOLIA, *Torr. in Ann. Lyc., New York*, 2, p. 222, t. 3. Delaware creek to the Pecos; March. Barely commencing to flower.

PHACELIA, n. sp., apparently; characters to be given. Pecos, Llano Estacado, and Upper Colorado; March, April.

POLEMONIACEÆ.

GILIA LONGIFLORA, *Don.*; *Torr. in Sitgreaves' Exped.*, t. 7. On the Pecos and Llano Estacado; March.

GILIA RIGIDULA, *Benth. in DC. Prodr.* 9, p. 312. Llano Estacado and Upper Colorado; April.

GILIA CORONOPIFOLIA, *Pers.*; *Benth. in DC.*, l. c. Llano Estacado, and near Fort Washita; March, April.

PHLOX DRUMMONDII, *Hook. Bot. Mag. t.*, 3441; *Benth. l. c.* Western Texas; May.

PHLOX PILOSA, *Linn.*; *Benth. l. c.* Western Texas; May.

GENTIANACEÆ.

SABBATIA CAMPESTRIS, *Nutt. in Trans. Amer. Phil. Soc.*; *DC. Prodr.* 9, p. 50. Near Fort Washita; April.

JASMINACEÆ.

MENODORA HETEROPHYLLA, *Moricand, in DC. Prodr.* 8, p. 316; *Gray in Sill. Jour.* 14, 1852. Western Texas; April. This is doubtless the Bolivaria Grisebachiiis, *Scheele in Linnæa*, 25, p. 254.

ACANTHACEÆ.

STENANDRIUM BARBATUM, (n. sp.) dwarf, multicapital, bearded all over with long and shaggy white hairs; scape at first shorter than the ob-lanceolate or narrowly spatulate, entire, and scarcely petioled radical leaves; bracts oblong-lanceolate, acute, entire, nearly equalling the corolla; anthers bearded on the back and tip; stigma funnel-form, its oblong margin not ciliate; capsule oblong, four-seeded. On the Pecos;

March. First collected by Mr. Wright, on a lower part of the same river. It is No. —, of his distributed collection.

DIPTERACANTHUS STREPENS, *Nees, in DC. Prodr.* 11, p. 121. Western Texas; April, May.

CALOPHANES OBLONGIFOLIUS, *Don.; Nees, in DC. Prodr.* 11, p. 107, and var. TEXENSIS, *Nees.* Western Texas; April, May.

SCROPHULARIACEÆ.

LINARIA CANADENSIS, *Dum.* On the Pecos, Llano Estacado, and Western Texas; March to May.

VERONICA PEREGRINA, *Linn.* Llano Estacado, &c.; March.

PENTSTEMON COBEA, *Nutt.; Benth. in DC. Prodr.* 10, p. 326. Western Texas; April, May.

PENTSTEMON GRANDIFLORUS, *Nutt. in Fras. Cat.; Benth. in DC. l. c.* Near Fort Chadbourne; May.

PENTSTEMON ALBIDUS, *Nutt., Gen.* 2, p. 53. Upper Colorado, Texas; April.

PENTSTEMON FENDLERI, (n. sp.) erect, glabrous throughout, glaucous; leaves coriaceous, entire, the radical ones ovate or obovate and tapering into a short petiole, the cauline ovate or oblong and closely sessile; flowers cymulose, or sometimes subsolitary in the axils of the upper leaves, and of ovate bracts, forming a strict internipid panicle, or series of apparent verticils; segments of the calyx ovate, with scarious margins; corolla (blue or purple) funnel-form, scarcely bilabiate, sparsely bearded or smooth in the throat; sterile filament dilated and densely (yellow) bearded at the summit. On the Pecos and Llano Estacado; March, April. A species which occurs in all the collections made in this region, considerably variable in size, foliage, the number of the flowers, (which are handsome, and 8 or 10 lines long,) the size of the bracts, &c. It is most nearly related to *P. acuminatus* and *P. nitidus*, especially to the latter.

PENTSTEMON PUBESCENS, *Soland.; DC. Prodr.* 10, p. 327. Western Texas; May.

CASTILLEJA PURPUREA, *Don.; DC. Prodr.* 10, p. 531. Llano Estacado and Western Texas; March, April.

SOLANACEÆ.

SOLANUM ELÆAGNIFOLIUM, *Car. Sc., t.* 243; *Dunal, in DC. Prodr.* 13, p. 290; *S. Texense, Engelm. and Gray, Pl. Lindh.* 1, p. 19; *S. Roemerianum, Scheele in Linnæa* 21, p. 767; *S. flavidum, Torr. in Am. Lyc., New York,* 1, p. 227. Western Texas; April, May.

SOLANUM ———, the *S. mammosum, Engelm. and Gray, Pl. Lindh. l. c.*, and the *S. platyphyllum, Torr. in Ann. Lyc.?* Western Texas; April. Not yet identified with any in *DC. Prodr.*

SOLANUM ROSTRATUM, *Dunal, Solan., t.* 24, and in *DC. Prodr.* 13, p. 329; *S. heterandrum, Pursh, Fl.* 2, p. 731, t. 7. Western Texas; May.

PHYSALIS LOBATA, *Torr. in Ann. Lyc., New York,* 1, p. 226. On the Pecos and Llano Estacado; March, April. Several forms, inclu

ding, probably, more than one species. They are not true species of *Physalis*. I know not what Dunal has done with them; but he must have seen specimens in Berlandier's and other collections. There is also a genuine *Physalis* from Upper Texas, but not in condition to name.

NICOTIANA RUSTICA, *Linn.*? Upper Colorado, Texas; April.

VERBENACEÆ.

VERBENA BIPINNATIFIDA, *Engelm. and Gray, Pl. Lindh. 1, p. 49; Schauer in DC. Prodr. 11, p. 553.* *Glandularia bipinnatifida*, *Nutt.* Delaware creek to the Colorado; March, April.

VERBENA AUBLETIA, *Linn.* Upper Texas, &c.; April.

VERBENA BRACTEOSA, *Michx. Fl. 2, p. 14.* On the Pecos and Llano Estacado; March.

VERBENA OFFICINALIS, *Linn.* *V. spuria*, *Linn.*, etc. Western Texas; April, May.

NYCTAGINEÆ.

ABRONIA CYCLOPTERA, *Gray, in Sill. Jour., (n. ser.) 15; Torr. in Marcy's Rep., t. 18.* Llano Estacado to Fort Chadbourne; April, May. In flower only.

OXYBAPHUS ANGUSTIFOLIUS, *Torr. in Ann. Lyc., New York, 2, p. 237.* On the Upper Colorado; April.

OXYBAPHUS HIRSUTUS, *Sweet; Hook. Fl. Bor. Am. 2, 124.* On the Colorado; April.

ACLEISANTHES BERLANDIERI, *Gray, in Sill. Jour., l. c.* On the Pecos; March. Foliage only.

PHYTOLACCA DECANDRA, *Linn.* Near Fort Washita; April.

PARIETARIA PENNSYLVANICA, *Willd.?* Delaware creek to the Pecos; March.

CELTIS RETICULATA, *Torr. in Ann. Lyc., New York, 2, p. 247.* Upper Colorado, Texas; April.

PLANERA RICHARDI, *Michx. Fl. 2, p. 248.* Western Texas; April.

MORUS RUBRA, *Linn.?* Near Fort Washita; April.

CAMPANULACEÆ.

DYSMICODON OVATUM, *Nutt. in Trans. Amer. Phil. Soc. (n. ser.) 8, p. 256.* *Speculariæ*, sp. *Torr. Mss.* Western Texas; April to May.

D. PERFOLIATUM, *Nutt. l. c.* *Campanula perfoliata*, *Linn.* *Specularia perfoliata*, *Alph. DC. Prodr. 7, pars. 2, p. 490* (in part;) with the preceding.

APOCYNACEÆ.

AMSONIA SALICIFOLIA, *Pursh, Fl. 1, p. 184.* On the Pecos; only the broad-leaved form was in the collection.

ASCLEPIADACEÆ.

ASCLEPIAS TUBEROSA, *Linn.; Michx. Fl. 1, p. 117; var. angustifolia.* Western Texas; May 10.

ACERATES PANICULATA, *Decaisne in DC. Prodr.* 8, p. 521. *Anantherix peniculatus*, *Nutt.* Sandy soil, headwaters of the Colorado; April. This is the snake-weed of the Camanche Indians.

A. VIRIDIFLORA, *Ell. Sk.* 1, p. 317. *Var.* 1. Leaves broadly ovate, mucronate, somewhat fleshy, smoothish. *Var.* 2. Leaves narrowly ovate, acute, somewhat hoary pubescent. Llano Estacado.

A. LONGIFOLIA, *Ell. l. c.*, *Decaisne, l. c.* Big Springs of the Colorado and Llano Estacado, in gravelly soil; April.

GONOLOBUS BIFLORUS, *Nutt. in herb, DC.* *Chthamalia biflora, DC. l. c.*, p. 605; with the preceding.

LABIATÆ.

SALVIA FARINOSA, *Benth. Lab.*, p. 274. On the Colorado; April. Probably not distinct from *S. Pitcheri, Torr.*

SALVIASTRUM TEXANUM, *Scheele in Linnæa* 22, p. 584. Gravelly soils, Llano Estacado; April. A common plant in Texas and New Mexico.

SCUTELLARIA RESINOSA, *Torr. in Annal. Lyc. N. York*, 2, p. 232. On the Pecos and the headwaters of the Colorado; April.

TEUCRIUM CANADENSE, *Linn.; Benth. in DC. Prodr.* 12, p. 581. Near Fort Washita.

T. CUBENSE, *Linn.; Benth. l. c.; Torr. in Marcy's Report*, p. 293. On the Pecos, &c.; April.

MONARDA ARISTATA, *Nutt. in Trans. Amer. Phil. Soc. (n. ser.)* 5, p. 186. In clayey soil; western Texas.

M. MOLLIS, *Nutt. l. c.* Near Fort Washita. Seems to be distinct from *M. fistulosa*.

BORAGINACEÆ.

EHRETIA? HISPIDA, *Torr. herb. Pl. Wright. No.* 485. This is probably a distinct genus, and will be fully described in the final report. On the Pecos; March.

HELIOTROPIMUM CURASSAVICUM, *Linn.; DC. Prodr.* 9, p. 538. Pecos to Llano Estacado; March to April.

ONOSMODIUM BEJARIENSE, *DC. Prodr.* 10, p. 70. Western Texas; May.

PENTALOPHUS LONGIFLORUS, *Alph. DC. Prodr.* 10, p. 86. *Batschia longiflora, Nutt. Gen.* 1, p. 114. Gravelly soil, Llano Estacado, &c.; March to April.

STEGNOCARPUS? CIOGARYA, *Torr. in Emory's Rep. of Bound. Comm. ined.* In decomposing gypseous gravel, on the Pecos; March. Differs from *Coldenia* § *Stegnocarpus* in the stamina being near the base, not at the summit of the tube of the corollex, and the nutlets are neither acuminate nor pubescent. It was first discovered by Dr. Edwards at Monterey, and is the same as No. 1554-1856 of Wright's New Mexican collection.

LITHOSPERMUM BRËVIFLORUM, *Engelm. and Gray, Pl. Lindheim, part* 2, No. 278. Gravelly soil, on the Pecos; April.

ERITRICHEUM CRASSISEPALUM, *n. sp.* With the preceding. A common species in Western Texas and New Mexico, but not hitherto described.

E. JAMESII, *Torr. in Marcy's Report*, p. 294. *Myosotis suffortitosa*, *Torr. in Ann. Lyc. N. York*, 2, p. 225. Sandy soil, Llano Estacado; March.

E. MULTICAULE, *Torr. in Marcy's Report*, l. c. On the Pecos; March.

ECHINOSPERMUM PATULUM, *Lehm.; DC. Prodr.* 10, p. 137.

E. STRICTUM, *Nees in Prince Maximill. Trav. App.* *Cynoglossum pilosum*, *Nutt. Gen.* 1, p. 114. Llano Estacado; March to April. The nutlets are armed with 6-8 strong short prickles, on each side of an obtuse border surrounding a deep open cavity in front of the nutlets. Sometimes one of the nutlets is of a different form from the others.

EUPHORBIACEÆ.

TRAGIA RAMOSA, *Torr. in Ann. Lyc., N. York*, 2, p. 245. Gravelly soils; March.

CNIDOSCOLUS STIMULOSUS, *Engelm. and Gray, Pl. Lindh., part 1*, p. 26. Sand-hills of Llano Estacado and Western Texas; March to May. Flowers larger than in the eastern plant.

STILLINGIA LANCEOLATA, *Nutt. in Trans. Amer. Phil. Soc., (n. ser.)* 5, p. 176. Sandy soil; April to May.

HENDECANDRA CROTONOIDES, *Hook. and Am. Bot. Beech., p.* 388. This is the same as No. 1800 *Pl. Wright*. It was found also by Frémont on the Gila. It is quite a distinct species from *H. procumbens*. The Mexicans call it *Yerba del Gato*, and use it as a purgative.

EUPHORBIA ARKANSANA, *Engelm. and Gray, l. c. No.* 303. Intermediate between *E. platyphylla* and *E. Stelioscopia*. Sandy soil. Collected in a journey to Fort Chadbourne, and on the headwaters of the Colorado.

E. GEYERI, *Engelm. mst.* Western Texas; May.

E. WRIGHTII, *n. sp., No.* 1827, *Pl. Wright*. Headwaters of the Colorado; April.

E. DILATATA, *n. sp., 1841, Pl. Wright*. With the preceding.

E. ALBOMARGINATE, *n. sp.* In red sand and clay. With the preceding.

E. FENDLERI, *n. sp., 800, Pl. Fendl.* Big Springs of the Colorado; April.

SANTALACEÆ.

COMANDRA UMBELLATA, *Nutt. Gen.* 1, p. 157. Gravelly soil. Big Springs of the Colorado, &c., Texas; April 1-13.

SALICACEÆ.

SALIX. Two undetermined species were found in the sand-hills of Llano Estacado.

POLYGONACEÆ.

POLYGONUM LAPATHIFOLIUM, *Linn., Willd. Sp. pl. 2, p. 442.* Near Fort Washita. Perhaps not distinct from *P. Persicaria*.

ERIOGONUM LONGIFOLIUM, *Nutt. in Trans. Amer. Phil. Soc. (n. ser.) 5, p. 164.* E. Texanum, *Scheele.* Gravelly soil, on the Pecos; April.

E. CERNUUM, *Nutt. in Pl. Gambel.?* Llano Estacado; sandy soil. It differs in the pubescence of the leaves being rougher and more persistent.

RUMEX VENOSUS, *Pursh, Fl. supp. 2, p. 733.* Delaware creek and along the Pecos; March.

R. ACETOSELLA, *Linn.; Pursh, Fl. 1, p. 249.* Western Texas; probably introduced.

CHENOPODIACEÆ.

OBIONE CANESCENS, *Moq. Chenop., p. 74.* *Atriplex canescens, Nutt. Gen. 1, p. 197.* Messilla valley, and from Delaware creek to Sacramento river; March.

O. CONFERTIFLORA, *Torr. and Frem., in Frem. second Report, p. 318.* Gravelly soil, headwaters of the Colorado.

O. ARGENTEA, *Moq. Chenop., p. 76.* *Atriplex argentea, Nutt. Gen. 1, p. 198.* Llano Estacado.

ARTHROCNEMUM FRUTICOSUM, *Moq. Chenop., p. 111; and in DC. Prodr. 11, p. 151?; Torr. in Stansb. Rep., p. 394.* In a saline decomposed gypseous soil; also on the borders of a salt lake on the Guadalupe mountains.

CUPULIFERÆ.

QUERCUS UNDULATA, *Torr. in Ann. Lyc., New York, 2, p. 248, t. 4.* Headwaters of the Colorado and Llano Estacado; in sandy soil. In flower April 12.

Q. PALUSTRIS, *Du Roi.* Trip to Fort Chadbourne, Texas.

CONIFERÆ.

EPHEDRA ANTISIPHITITICA, *Berland.; Endl. Conif., p. 263.* High rocky and sandy places; Llano Estacado and on the Pecos. The fertile aments are 1-2 flowered, but usually perfect but one seed, which, in that case, is triangular. When two seeds ripen they are less angular, and the opposite faces are flat. The scales of the ament become fleshy at maturity.

JUNIPERUS VIRGINIANA, *Linn.; Michx. f. Sylv. 2, p. 253, t. 155.* Headwaters of the Colorado and in various parts of Western Texas.

SMILACEÆ.

SMILAX HASTATA, *Willd. Sp. 4, p. 782; Elliot, Sk. 2, p. 696.* High plains, Llano Estacado.

COMMELYNACEÆ.

TRADESCANTIA VIRGINIANA, *Linn., Kunth, Enum.* 4, p. 81. Headwaters of the Colorado and on the Pecos; March and April. Very variable as to size, pubescence, and breadth of the leaves.

COMMELYNA ANGUSTIFOLIA, *Michx. Fl.* 1, p. 24. Near Fort Washita

IRIDACEÆ.

SISYRINCHIUM BERMUDIANA, *Linn., var. anceps.* *S. anceps, Cav.* Dry soils, Llano Estacado.

SILIACEÆ.

CAMASSIA GAWLERI, *Torr. in Whipple's Report, in ed. Scilla esculenta; Gawl. in Bot. Mag., t. 1574; (excl. syn. Pursh.)* *angusta.* *S. angusta, Engelm. and Gray, Pl. Lindheim., part 1, No. 198.* Western Texas.

ALLIUM MUTABILE, *Michx. Fl.* 1, p. 195. On the Pecos and the headwaters of the Colorado; March to April. Flowers varying from deep rose-red to nearly white.

PSEUDOSCORDUM STRIATUM, *Herb. Nothoscordum striatum, Kunth, Enum.* 4, p. 458. *Allium striatum, Jacq.*

YUCCA ANGUSTIFOLIA, *Pursh, Fl.* 1, p. 227. On the Pecos; April. Flowers in a long, narrow raceme, as large as in *Y. filamentosa*; greenish yellow, mixed with purple.

JUNCACEÆ.

JUNCUS TENIUS, *Willd.; Torr. Fl., New Ygrk,* 2, p. 329. Low grounds, Waco Tanks.

NAIADACEÆ.

POTAMOGETON PRÆLONGUS, *Wulf.; Gray, Bot. North. States,* p. 456. Western Texas.

CYPERACEÆ.

SCIRPUS LACUSTRIS, *Linn.; Torr. Cyp.,* p. 321. In water; Llano Estacado; March.

ELEOCHARIS OBTUSA, *Schultes; Torr. l. c.,* p. 302. With the preceding.

GRAMINEÆ.

CERATOCHLOA UNIOLOIDES, *Beauv. Agrost.,* p. 75, t. 15, f. 7. *Bromus Willdenovii, Kunth, Enum.* 1, p. 416. Headwaters of the Colorado; April.

TRIPSACUM DACTYLOIDES, *Linn. fl. Decad.* 17, t. 9. *Stend. Pl. Glum,* p. 362. Llano Estacado. A tall rank grass, affording good fodder.

CHLORIS VERTICILLATA, *Nutt. in Trans. Amer. Phil. Soc. (n. ser.)* 5, p. 143. Sandy plains northeast of the Pecos; April.

PANICUM PAUCIFLORUM, *Ell. sh.* 1, p. 120? On the Pecos; April.

PHALARIS ANGUSTA, *Nees; Trin. Ic. Gram.,* t. 78. Headwaters of the Colorado.

POA ARACHNIFERA, *Torr. in Marcy's Report*, p. 301. Headwaters of the Colorado; April 13.

β *Torr. l. c.* With the preceding, and Big Springs of the Colorado.

FESTUCA TENELLA, *Willd. Enum.* 1, p. 116. High sandy plains northeast of the Pecos, and headwaters of the Colorado; March to April.

F. MACROSTACHYA, (n. sp.) On the Pecos. This is one of numerous grama-grasses of Texas and New Mexico.

HORDEUM PUSILLUM, *Nutt. Gen.* 1, p. 87; *Kunth, Enum.* 1, p. 457. Sandy soil, Llano Estacado; March.

ELYMUS CANADENSIS, *Linn.*; *Kunth, Enum.* 1, p. 457. Near Fort Washita.

FILICES.

ADIANTUM CAPILLUS-VENERIS, *Linn.* Big Springs of the Colorado. We follow Hooker in this and several other allied forms of *Adiantum* to *A. Capillus-Veneris*.

NOTHOCHLÆNA SINUATA, *Kaulf.* Between the Rio Grande and Llano Estacado.

GYMNOGRAMMA TARTAREA, *Desv.* With the preceding.

CHEILANTHES. 2126 of *Wright's* New Mexican collection. With the preceding.

One or two other ferns, as yet undetermined, will be noticed in the final report.