

LETTER
FROM
THE SECRETARY OF WAR,
ACCOMPANYING

An engineer report of a reconnaissance of the Yellowstone River in 1871.

APRIL 18, 1872.—Referred to the Committee on Printing.

WAR DEPARTMENT, *April 17, 1872.*

The Secretary of War has the honor to submit to the United States Senate a report of a reconnaissance of the Yellowstone River, made in 1871, by Captains Barlow and Heap, Corps of Engineers, under orders of Lieutenant General Sheridan, and to suggest the publication of the same.

WM. W. BELKNAP,
Secretary of War.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., April 13, 1872.

SIR: I have respectfully to transmit herewith a report of a reconnaissance made during the summer of 1871, of the sources of the Yellowstone River, by Captain J. W. Barlow, assisted by Captain D. P. Heap, of the Corps of Engineers, under the orders of Lieutenant General P. H. Sheridan, commanding Military Division of the Missouri. A map of the region traversed accompanies the report, and it is suggested that they be transmitted to Congress with a view to their publication.

The map has been drawn upon stone, in this office, and should Congress direct the publication of a considerable number of copies, transfers can be readily prepared and furnished the Congressional Printer.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

The Hon. the SECRETARY OF WAR.

HEADQUARTERS, MILITARY DIVISION OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
Chicago, Illinois, February 28, 1872.

GENERAL: I have the honor to transmit a copy of my report of a reconnaissance to the sources of the Yellowstone River, made by myself, assisted by Captain D. P. Heap, Corps of Engineers, during the sum-

mer of 1871. Accompanying this is Captain Heap's report upon the manner of making the maps.

I transmit, also, a copy of a map prepared in this office, under my direction, from an outline furnished by Captain Heap.

Very respectfully, your obedient servant,

J. W. BARLOW,
Captain of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

REPORT OF A RECONNAISSANCE IN WYOMING AND MONTANA TERRITORIES, 1871, BY CAPTAIN J. W. BARLOW, ASSISTED BY CAPTAIN D. P. HEAP, CORPS OF ENGINEERS, UNITED STATES ARMY.

OFFICE OF CHIEF ENGINEER,
HEADQUARTERS MILITARY DIVISION OF THE MISSOURI,
Chicago, Illinois, December 8, 1871.

GENERAL: I have the honor to submit the following report of my reconnaissance through a portion of Montana and Wyoming Territories.

In presenting this report I feel constrained to offer a few words in explanation of its many palpable deficiencies, and also regarding the form in which it appears, viz, that of a journal.

Since my return, other duties, mainly growing out of the destruction of my office, have so constantly occupied my time and attention, that careful study and proper revision of my field-notes have been impossible. But knowing the desire of the Lieutenant General to be informed, at the earliest possible moment, upon the nature of the country examined by me, to save time I have found it necessary to retain the form in which my notes were originally taken, and in some instances to copy portions with little revision.

Under these circumstances the report is, perhaps, as accurate, though less satisfactory to the writer, than a more studied composition would have been.

A map of the route traveled, together with several charts of special points of interest, are being prepared as rapidly as possible, and will be presented as soon as they are finished.

Very respectfully, your obedient servant,

J. W. BARLOW,
Captain of Engineers, United States Army.

Lieutenant Colonel JAMES B. FRY,
Assistant Adjutant General, Military Division of the Missouri.

Orders and instructions.

[Special Orders No. 149.]

HEADQUARTERS MILITARY DIVISION OF THE MISSOURI,
Chicago, Illinois, July 1, 1871.

Captain J. W. Barlow, chief engineer Military Division of the Missouri, with two assistants, will proceed via Corinne, Utah, to Fort Ellis, Montana; from the last-named post he will make an exploration of the sources of the Yellowstone. Captain Barlow will be guided in his duties by the special instructions from the Lieutenant General, commanding.

The Quartermaster's Department will furnish the necessary transportation for this party, instruments, and baggage.

By command of Lieutenant General Sheridan.

JAMES W. FORSYTH,
Lieutenant Colonel, Aide-de-Camp, A. A. A. G.

HEADQUARTERS, MILITARY DIVISION OF THE MISSOURI,
Chicago, June 26, 1871.

SIR: Captain J. W. Barlow, chief engineer of the Military Division of the Missouri, accompanied by a small party, has been directed to proceed to the head-waters of the Yellowstone River, Montana Territory, and he is hereby authorized to call on you for, and you are hereby authorized to furnish him, thirteen riding-animals fully equipped, and fifteen pack-animals fully equipped; also such commissary supplies as he may need for this party.

Should you not have the pack-mules at your post, and they can be procured from Camp Baker, you are authorized to procure them from that post. If they cannot be obtained from Camp Baker, then Captain Barlow will make his own arrangements for the pack-mules.

It is Captain Barlow's intention to accompany the expedition of Professor Hayden, taking advantage of the escort ordered for him, but as he may desire at times to make side surveys you will furnish him with one non-commissioned officer and five mounted cavalrmen, to be under his special orders for the expedition.

Very respectfully, your obedient servant,

P. H. SHERIDAN,
Lieutenant General.

Captain D. P. HANCOCK,
Seventh United States Infantry, or Commanding Officer, Fort Ellis, Montana.

This reconnoissance was made during the months of July and August, 1871, for the purpose of examining the sources of the Yellowstone, Missouri, and Snake rivers, and the valley of the Yellowstone Lake. To assist me in this duty, Captain D. P. Heap, Corps of Engineers, engineer officer of the Department of Dakota, with his draughtsman, Mr. W. H. Wood, were ordered to report to me. I also employed Mr. H. G. Prout as assistant topographer and recorder. Mr. Thomas J. Hine accompanied the party as photographer. These gentlemen rendered efficient service, and I am greatly indebted to each of them, particularly to Captain Heap, for astronomical observations. The records of these observations, together with notes of the trail, were taken by Captain Heap to his office in Saint Paul, and thus, fortunately, escaped the conflagration of Chicago. The meteorological records were, however, less fortunate, having been destroyed in my office, together with the numerous and interesting specimens I had collected, and which had only arrived in Chicago just previous to the fire. The photographer, also, lost his negatives, consisting of nearly two hundred beautiful views of lake and mountain scenery, including photographs of some of the largest geysers, taken while in action. Sixteen prints were made the day previous to the fire, which Mr. Hine saved. These will but serve as a sample of those destroyed.

The party, as above enumerated, left Chicago on the 2d of July, and were provided with the following instruments for use in the field, viz: two sextants, one artificial horizon, one sidereal chronometer, one mean solar pocket chronometer, two mercurial cistern barometers, one thermometer, two aneroids, two prismatic compasses, three pocket compasses, one clinometer, two odometers, one pair odometer wheels, and a box of tools.

Leaving Chicago at 10.45 a. m., we were carried by the Chicago and Northwestern Railway over the prairies of Illinois and Iowa to the Missouri River, where we arrived on the following morning. After crossing the ferry in a drizzling rain, and calling at General Augur's headquarters, we proceeded on our journey, over the Union Pacific Railroad. Another expanse of prairie lay before us, with the broad and sluggish water of the Platte River on our left. After passing Cheyenne, the elevation rapidly increases, and the country becomes very barren. The soil, dry and parched from want of moisture, was in a condition closely approximating a desert, yielding sustenance only to the hardy sage-bush, which seems to grow almost literally without water.

We celebrated the 4th of July in crossing the main divide of the Rocky Mountains. Why these mountains are called *Rocky* is not evident until after reaching Sherman and commencing the descent toward the Salt Lake Valley. From this point, however, to the valley, no exception can be taken to the name, the descent being through Echo and Weber Cañons, with rocky gorges, whose walls, in many places, it is said, tower thousands of feet above the river's bed, retaining their snow covering even during this excessively hot July weather. Many of these prominent mountain tops still show evidence of Mormon efforts to resist General A. Sidney Johnston's march upon their territory in 1857. Rude walls occupy their almost inaccessible heights, from whence these people had intended to launch rock upon the advancing troops.

The descent from Sherman to Great Salt Lake Valley is nearly 4,000 feet. On arriving at Ogden, we took the Utah Central Railroad for Salt Lake City, passing through the highly cultivated fields and gardens of the industrious Mormons, over a perfectly level stretch of country lying between the Wahsatch range of the Rocky Mountains on the left and the blue Salt Lake on the right.

After spending a part of the following day in this interesting, as well as beautiful, Mormon city, we returned to Ogden, and thence by the Central Pacific Railroad to Corinne, at which point we changed our mode of traveling for the Montana stage-line.

Another day's delay occurred owing to the difficulty in obtaining accommodation for the whole party and baggage. It was, therefore, on the morning of the 8th, after a refreshing rain of the night before, (very unusual in this region,) that we fairly began our stage ride to Fort Ellis. Two passengers besides my party, seven in all, with 800 pounds of baggage, made a heavy load, and occasioned loss of time during the whole stage-trip. A stage ride, at best, is a cheerless experience, but the Montana route particularly has usually been considered almost unendurable. The heat, the dust, the crowded condition of the stage, and above all the loss of sleep for three or four nights and days, it is said, reduces the traveler to a state bordering on insanity. We were more fortunate, perhaps, than others, inasmuch as our first day was cool, the air being purified by the rain and thunder of the previous night, and by occasional showers during the day.

The second day proved more tedious, our route dragging wearily across the large desert of Idaho, the only interesting occurrence being our arrivals at the successive post-stations at intervals of from twelve to twenty miles. On the third day we crossed the Montana line, in the morning, near Pleasant Valley, where we partook of the best meal upon the whole stage-route. During the day we crossed a divide, separating the tributaries of the Snake River from those of the Missouri. Passed on this day's route some bits of pretty scenery, the Red Rocks and Beaver Head Cañon being the most noteworthy.

After several changes of conveyances, generally for the worse, we were finally introduced, during the third night, to a "jerkey," a two-seated covered wagon drawn by a single pair of horses. At this point (Moore's Junction) Captain Heap and Mr. Wood separated from the party, taking the road to Helena, while the others, including myself, continued our course to Fort Ellis via Virginia City. Spending the remainder of the night and part of the next day in the "jerkey," we reached the latter town at 10 a. m.

Virginia City is situated in a mining gulch, and huddled together in a heap, with small houses and narrow, crooked streets—the people being American miners and Chinese in about equal proportions. The mines

here were formerly the richest ever discovered; they are now, however, much less so, and are worked principally by the Chinese, who are content to earn but a small proportion of what would satisfy the American miner.

The route from Virginia City to Bozeman, though generally good, crosses some exceedingly steep divides between the Jefferson, Madison, and Gallatin rivers. These valleys are all handsome, fertile regions, and will, without doubt, eventually be peopled by a thriving population. The valley of the West Gallatin is peculiarly inviting. Beautiful green foliage extends along the bank of the river, while majestic mountain ranges shut it in from the outer world, giving it an air of peaceful and home-like security. Already many farms have been cultivated in these valleys; and though irrigation is rendered necessary by the dryness of the climate to insure good crops, yet it is found that the added quality of the grain and the certainty of a good yield counterbalance the extra expense of irrigation. It is reported, also, by residents, that the rainfall is becoming yearly more abundant as new land is brought under cultivation. This being the fact, the necessity of irrigation will in time cease. The mountain slopes are usually well timbered with heavy pine forests.

Three days were occupied at Fort Ellis in active preparation for the field. Instruments were unpacked and put in order, camp-equipage and subsistence stores selected, and provision made for transportation upon pack-animals. It was ascertained that the quartermaster's and commissary departments could furnish nearly everything that was required, in addition to the articles I had brought with me. I increased my party to eleven persons by hiring three civilian packers, two laborers, and one cook. To mount this party I made requisition for twelve riding-animals. For conveying instruments, commissary stores, and other baggage, ten pack-animals were obtained.

Professor Hayden, in charge of a geological expedition, destined to the same field of operations as myself, had been at Fort Ellis for some days, organizing and equipping his party. His was a much larger party than mine, and a company of the Second Cavalry, from the fort, had been ordered to accompany it as an escort, under the protection of which my expedition was also to be made. A guard of one sergeant and five men were, however, assigned to me specially, in case I desired to leave the larger escort at any time for making side surveys. Dr. Hayden proposed to transport his material as far as possible on wagons, then dividing the stores, and leaving with his wagons a portion—to be sent for as might be required—to push on with pack-animals, carrying only the remainder and his other necessary baggage. This idea was good and I adopted it, estimating that ten pack-animals would carry thirty days' rations for my party, besides the other baggage required. This arrangement did not work well, however, when carried out, from the fact that the roads would not permit wagon-transportation sufficiently far, we being only able to reach Bottler's Ranch, on the Yellowstone, with our wagons, a distance of thirty-five miles from Fort Ellis. The passage of our heavily-laden wagons to this point was attended with much inconvenience and labor, and consumed three days' time.

Dr. Hayden was ready to start by the 15th of July, but owing to a delay in the arrival of a portion of my baggage from Virginia City I was unable to move until the morning of the 16th. The escort, company F, Second Cavalry, Captain Tyler and Lieutenant Grugan, also moved at the same time. With the exception of my special guard of six men, the escort took the advance and were soon out of sight, expecting to

reach a good camping-place, sixteen miles distant, before night. Owing to the hilly nature of the country, I soon found it necessary to devote the whole attention of my party to the wagons, assisting them over bad places and keeping them upright along many of the steep hill-sides. Notwithstanding our labors, one of the wagons was eventually upset, its contents having to be reloaded after righting and replacing the wagon upon the road. A still more serious accident happened a few miles farther on, in the breaking of the same wagon just at the foot of a steep acclivity, which rendered further progress impossible. Night now coming on, dark and rainy, I decided to go into camp at once, only eight miles from Fort Ellis, and to await the arrival of a new wagon-reach, for which I had sent back to the fort. Our cook having followed the escort to the camping-spot which we expected to make, some eight miles farther on, our chances for either dinner or supper were unfavorable. Improvising a lunch from what we could find, and stretching our tent-fly from one of the wagon-tops to the hillside beyond, we rolled ourselves in our blankets, and decided that our first day's march, owing to wagon incumbrance, was almost a failure.

The following morning the march was resumed, but another misfortune occurred at the outset, in the sliding and almost upsetting of the wagon containing my baggage and instruments. It had finally to be unloaded, after numerous efforts to right it had been made without success. Our accidents were now happily over, the mules and drivers behaved better, and the road became less dangerous. At 3 p. m. we reached the point where the escort had awaited us since the day before. We had made but ten miles in two days. This being a fine camping-spot, I decided to remain here until morning, when, by making an early start—the animals rested—we would be able to push on to Bottler's Ranch in one day.

The country thus far passed over was wild and mountainous, generally well timbered, with plenty of good grass and water in the numerous valleys and ravines. A mine of bituminous coal has been opened a few miles from Fort Ellis on this route, and has already yielded a fair quantity of fuel of good quality, some of which has been used at the fort.

At this place we pitched our first camp, consisting of two "A" tents, and a wall-tent fly, with a third "A" tent for the cook and his stores. Our cooking utensils and mess furniture were simple, though sufficient, consisting of two camp-kettles, one bake-kettle, a frying-pan, and a broiler, for cooking; knives, forks, iron spoons, tin plates, and china cups, and a table, completed our mess equipments. The cups, however, became broken from time to time, until all finally disappeared. Here the photographer obtained his first view, with our camp in the foreground, and the thickly-wooded bank of Trail Creek, a beautiful trout stream, as a background.

Our general course to the Yellowstone River was now southeast, down the valley of Trail Creek, which we crossed and re-crossed several times, avoiding dangerous side-hills. The road, however, was generally good, with some sharp ascents, requiring the doubling of our teams. By allowing my horse to graze while waiting for the wagons to close up, the beast took advantage of his liberty, ran off, and followed the main escort, which, as usual, was some miles in advance. I saw no more of him until I had reached Bottler's Ranch.

At different points on the road from Fort Ellis, beautiful vistas of majestic ranges of mountains, lying to the east of the Yellowstone River, were obtained; and now, as we emerged from the winding valleys of

the mountain region through which we had been traveling for three days, these lofty peaks, from across the river, seemed almost directly above our heads. Conspicuous among them stands Emigrant Peak, near 11,000 feet above the sea, and about 6,000 above the valley. This peak is so named from the mining region lying near its base, called "Emigrant Gulch." The Yellowstone here is a broad, swift stream, some 300 feet wide, and not fordable.

Our course now lay up the west bank of the river, nearly due south. The road, following the nearly level river bottom, was good, except at the crossing of numerous streams flowing into the river at short intervals. These streams would afford convenient means of irrigation, should this valley ever become settled. Several antelope were seen as we came up this valley, none, however, sufficiently near to allow of their being shot.

Opposite Emigrant Peak, a thriving ranch has been established by two brothers, named Bottler, who have several fields already under cultivation. Their crops of wheat, potatoes, and many other vegetables yield an abundant harvest, while in the raising of stock and making of butter and cheese they have met with remarkable success. A ready market for their produce is found in the mining camps across the river. Above this point the valley becomes much narrower, rocky spurs shoot out from the mountain ranges on each side, rendering it impracticable to move with our wagons beyond Bottler's. Here it was therefore decided to leave the train with a portion of our supplies under a small guard, and with saddle-animals alone to continue our progress up the river.

Dr. Hayden had only arrived the day before, as much out of patience with the wagons as myself, and, like me, delighted with the idea of leaving them at this point. One day was spent in arranging materials for packing and taking astronomical observations. We suffered intensely from mosquitoes during our stay at this camp. The nights being warm, with occasional showers without wind, there seemed to be no way of avoiding their incessant annoyance.

We had located camp on the second terrace from the river—the broad stony plateau or table-land affording good grazing at this season, though yielding also an abundant crop of a small variety of a very prickly cactus. Stretched out below, the broad bottom-lands of the Yellowstone, with the river running near the foot of the hills on the east, present a wide view to the north, east, and south; while to the west were vast mountains forming a divide between this valley and that of the Gallatin. Our little camp, on the morning of the 20th, presented a scene of great activity. The wagon-mules were being taught another duty; many of them submitted with patience, while others became restive under their packs, and nearly unmanageable. Our pack-saddles did not prove to be just what we needed, being too narrow for the backs of the mules, and thereby greatly increasing their natural restiveness. The packing was eventually accomplished, each mule carrying about two hundred pounds. By 7 a. m. we had started just in advance of Dr. Hayden's party, which, however, came up soon, and traveled in company with mine. Our route lay up the valley of the Yellowstone, nearly due south, for ten miles over a good trail which could easily be made into a passable wagon-road, except at one or two points where some blasting and cutting would be required.

Some very picturesque rocks were passed, many of them standing out like turrets from the ruins of old castles. These rocks are generally volcanic; some fine specimens of basaltic columns were ob-

served. The river now bends to the eastward; a fine, rushing stream, called Trail Creek, joins the river from the west just at this curve, and caused some delay in crossing. The trail now enters the second or middle cañon of the Yellowstone, and becomes very rough, obstructed by masses of volcanic rock, in some places rendering the footing of the animals very insecure. One pack-animal, belonging to the general escort, made a misstep and rolled down the hill-side a distance of some 50 feet, completely demoralizing his pack, but without serious injury to himself. Just beyond this dangerous pass the cañon widens somewhat, disclosing a grassy valley of several acres, watered by a mountainous stream fed from melting snows above. We had marched but sixteen miles and it was now only 1 o'clock, but as the animals began to show signs of weariness and hunger, Dr. Hayden with the main escort decided to halt in the valley for the night. I was told by one of my packers that another valley, similar to this, with better grazing, would be found a mile and a half farther on. This information led me to proceed to that spot. A still more difficult and rocky pass than the one we had just encountered led to this valley, and I was therefore desirous to get through it while the animals were in good marching condition, and less restive than on first starting out in the morning. Here we found a valley as beautiful as the other, giving abundant pasturage for the animals, while a growth of cottonwood on the river's bank afforded a pleasant camping spot. The surrounding mountains shot up almost perpendicularly to the height of from two to three thousand feet; their lower slopes being wooded, while their peaks were usually bare. The formation here is principally granite rock, with a preponderance of feldspar. Here we caught trout by dozens and found them of excellent flavor and very large; they would bite at almost anything, taking the artificial fly with great activity. I enjoyed a bath in the river, but found the current so swift that I could make no headway against it in swimming, while in standing upright it would almost sweep me off my feet.

There are no practicable fords along this portion of the river except during seasons of low water, in the fall. The night passed at this camp was very refreshing; no mosquitoes nor other troublesome insects disturbed us, though a large rattlesnake was killed in camp soon after our arrival. Following up the Yellowstone Valley, tall mountain ranges continue on either side, the river falls off somewhat in width and depth, and, flowing near the eastern range, leaves a broad spread of rolling country on the right. Several rocky spurs intersected the trail, causing much inconvenience to the animals, and necessitating the dismounting of many of the horsemen. One mule met with a mishap and fell from a steep bank. The odometer wheels slipped at the same place, but without injury. These wheels are drawn by one of the saddle-horses; the saddle, taking the place of harness, supports the shafts, which are lashed thereto. The cart being very light, made of velocipede wheels, and weighing but thirty pounds, is no impediment to the horse or its rider, and can be taken wherever the other animals go. Two small and beautiful lakelets were passed soon after leaving camp, one bearing a perfect resemblance to the figure seven.

Some few miles further on a remarkable mountain, known as Cinnabar Mountain, also as "The Devil's Slide," was passed on the right. This is a curious and strange freak of nature. The upheaval had carried the strata of which the mountain is formed into a nearly vertical position, with their edges standing out toward the valley, a slight twist, or wrench, at the time of the upheaval, giving the strata a curved appear-

ance. Several stand out a hundred feet beyond the general face of the mountain, and extend, probably, a thousand feet upward, leaving rocky depressions between, and giving rise to the name of "The Devil's Siide." There is ample opportunity for him and all his attendants to find amusement here. A deep-red tinge, from salts of iron, distinguishes this mountain from all others in its vicinity.

On reaching the mouth of Gardner's River, or Warm-Stream Creek, as it is also called, coming in from the southwest and joining the Yellowstone fifteen miles above the middle cañon, we left the trail and followed this valley without crossing the stream.

A few miles above the mouth of this river, a boiling-hot torrent of water, some six feet wide, and a foot in depth, pours out of the hill-side, perfectly clear, though steaming hot. It is probably the outlet of a vast subterranean reservoir of hot water, which supplies the numerous boiling springs upon the mountain-sides above. Near this hot brook are several warm mineral springs, beside which a few invalids had formed a camp, for the purpose of testing their healing properties.

A system of hot springs of great beauty, flowing from the top and sides of a large hill of calcareous deposit, and called Soda Mountain, is found five miles up the left bank of Gardner's River. Here, at the foot of this curious white mountain, we encamped, and remained until the 24th, examining the wonderful spring formation of this region, and the country around it. The central point of interest is the Soda Mountain, occupying an area of a hundred acres, and rising like the successive steps of a cascade, to the height of over 200 feet above the plateau at its base. The upper surface is a plain, composed of many hot springs, constantly sending up volumes of vapor slightly impregnated with sulphurous fumes. The sides of the hill down which the waters of these hot springs flow have become terraced into steps of various heights and widths, some twelve inches in dimension, while others are as many feet. In each terrace there is generally a pool of water, standing in a scolloped basin of gypsum, deposited at the edges by the water as it becomes cooler. These basins are often tinged with pink, gray, and yellow colors, giving to the whole a very beautiful effect.

The rock in all directions has evidently been deposited in the same manner as the Soda Mountain is now being built up. When the formation ceases from a change in the course of the water, the rock becomes friable and disintegrates. After a time vegetation springs up and covers the surface. Many of the basins have the size and shape of bathtubs, and were used by members of the party for bathing purposes. The temperature varies in the different pools from fifty degrees all the way up to one hundred and eighty, so there is no difficulty in finding a bath of suitable temperature. A few of these springs are strongly mineral, though most of them are sufficiently pure for cooking and drinking purposes. Near the base of this hill a remarkable column of rock is seen standing 60 feet in height, and nearly vertical; this is probably a defunct geyser. In many places small upheavals have occurred, the rock has been rent open, allowing an escape of steam and gas jets, whose formations in the hot regions beneath can be heard through these openings. The action of these subterraneous waters has, of course, worn out caverns in the rocks beneath, leaving the crust sometimes thin and frail; caution should therefore be exercised in exploring these places. Numerous caves and holes were found in the adjacent hills. I penetrated to the depth of 50 feet in one of the former, and found myself in a vaulted dome 30 feet across and 40 feet high. On the far side was a deep well, dark and gloomy, into which I threw

masses of rock, but did not venture to explore it personally. The views from this camp are extremely picturesque, combining every variety of mountain scenery, having rocky gorges, in which are usually found mountain streams breaking into cascades and falls at frequent intervals. The opposite bank of Gardner's River is very steep, nearly precipitous, and surmounted by a wall of basaltic columns.

During our stay at this camp I made a circuit of the high red-topped mountain to the west of the springs, near which Mr. Everts, who was lost in the Yellowstone Basin the previous summer, was picked up by the men who went in search of him. The mountain stands in a fork of a branch of Gardner's River, having a cañon on two sides, through which these streams flow in beautiful cascades, with one or two considerable falls. I made this trip in company with Dr. Hayden and one or two others. Though our climbing over rocks and through thickets, and crossing mountain-torrents, proved very fatiguing, we felt well repaid for our labor in observing the grand scenery upon our route. Many fine specimens of geological formation were observed, one of the most beautiful being fan-shaped basaltic formations in great abundance. Skirting the cañon to the south of the mountain for two miles, we crossed, but found the ascent so steep that we were compelled to cling to projecting rocks in many places to prevent sliding back to the bottom. On reaching the plateau beyond, our breath and strength were nearly exhausted. We now ascended to the top of the mountain, leaving our horses about half way up, and continuing the journey on foot. Here a magnificent view of the Yellowstone Valley was obtained, with its mountain ranges stretching away in the distance, southward, to the limit of vision. Also of the country lying west toward the Gallatin River. In that direction is a valley almost level, slightly rising toward the mountains on either side, with a beautiful, clear stream winding through the center, whose current was so gentle that its direction could not, as yet, be determined. Grass and flowers covered the hill-side, interspersed with occasional groves of balsam, cedar, and spruce. High cones of volcanic origin rise here and there in all directions, some of them probably fifty miles distant. The lofty peaks directly west, beyond the valley just mentioned, were probably near the sources of the West Gallatin. This region appears almost inaccessible. Continuing the circuit of the mountain, we returned to camp by way of its north side. Here we encountered another cañon as wild and precipitous as the other, and affording still more beautiful scenery. A clear cut, hundreds of feet in depth, through the mountain's base, allowed the passage of a small stream, which about midway rolled down a slightly inclined and rocky slope, then spread out into a pretty cascade of a hundred feet in height. More desperate climbing followed, and we reached an elevated plateau whose side to the east had, at some time, dropped off, leaving a sheer precipice of seven or eight hundred feet in height upon which we were now standing. Passing further northward we encountered, previous to reaching camp, several spouting hot-springs, throwing up boiling water to the height of several inches.

On reaching camp I learned that one of the cistern barometers had broken while hanging upon a tree, without apparent cause. Toward evening I enjoyed a bath among the natural basins of Soda Mountain. The temperature was delightful, and could be regulated at pleasure by simply stepping from one basin to another. They were even quite luxurious, being lined with a spongy gypsum, soft and pleasant to the touch. I walked over a part of the hill by the faint light of the new moon, which gave to its deep-blue pools of steaming water a wild and

ghostly appearance. The photographer has taken numerous views of these springs and the country in their vicinity, which will serve to convey a much more definite idea of their beautiful formation than can be given by any written description. A special survey was made of this locality, and careful observations taken of its latitude and longitude.

While at this camp one of the men killed a large brown bear and three cubs. The latter were brought in and served our mess with delicious steak for several meals.

July 24.—Resumed the march, following up the southern branch of Gardner's River. The trail for the first four miles proved very rough, the sides of the valley coming down close to the stream, and very steep. At the end of this gorge a fine water-fall was discovered about 75 feet in height, beyond which the valley became less rocky. I ascended the ridge on the left, hoping to reach the summit of the divide overlooking the Yellowstone Valley several miles to the eastward. After reaching several summits I still discovered higher ones beyond, but finally ascended the last one, and was rewarded by a grand view of an immense extent of mountain scenery. In all directions were seen sharp basaltic peaks, beautifully set off with large fields of snow lying in their upper gorges; quiet, secluded valleys, well timbered hill sides, pretty lakes and mountain streams. Over the whole the sun was shining with great brilliancy, but never oppressively in these elevated regions.

I fell in with Dr. Hayden, whom I found examining this ridge, and together we continued in a southeasterly direction parallel with the valley below, through which our trains were moving. We had proposed ascending this valley as far as practicable, then to strike across the country and meet the Yellowstone opposite the mouth of the East Fork. While we were pursuing our investigations, one of the doctor's assistants came up and reported that his train, with the general escort, had gone into camp some two miles south of the point where he found us, but that my train had not come up. I went to the doctor's camp and learned that none of my party had arrived except Captain Heap and Mr. Hine, who had followed the trail of the doctor's party. A messenger sent by Captain Tyler came back, finding no traces where my party had left the trail. I then decided to go myself in search of them. After considerable examination it was discovered that they had obeyed their instructions, deviated from the direction taken by the doctor's party and followed the course of Black-tail Deer Creek to the eastward, and had struck across toward the valley of the Yellowstone. It would appear to be an easy matter to find where a train as large as mine had departed from the main trail, but in this case no tracks were left in the prairie grass to indicate the point, and it was only after an hour's search that the spot was discovered. Following the trail was in many places difficult, the country being intersected at various intervals by ravines and water-courses, with here and there a meadow, over which the animals had apparently become so scattered that all traces of their footsteps were lost. The country, until we near the river, consists of rolling prairie, dotted with groves of spruce and pine, and well watered with numerous cool streams finding their way northward into Black-tail Deer Creek. The ridges are unusually stony, limestone rock cropping out at their summits. Continuing eastward and passing into a small cañon, rendered gloomy by approaching night-fall, and following over a divide for a few miles, we emerged upon a height overlooking the valley of the Yellowstone. A plain though rough trail led down the mountain-side. The descent was steep and long, through groves of poplars and other small trees, along a nearly vertical hill-side, apparently over frightful

chasms, rendered wierd and gloomy by approaching darkness. We began to despair, almost, of ever finding the camp, and felt there might be a possibility that we were following a fresh Indian trail. We were soon set at rest, however, as a short time after dark we reached the foot of the mountain and found camp located in a pretty meadow, with a clear stream running through it. The river was about a mile and a half distant. I had ridden thirty miles though the train had marched but seventeen.

The next day was spent in a trip across the Yellowstone, by way of a pack-train bridge recently constructed for the accommodation of parties visiting some new mines about forty miles to the east of this point, on the head-waters of Clark's Fork. The banks of the river here are one hundred feet apart, while a pier resting upon a ledge of rock jutting out from the west side divides the bridge into two spans, the main one being about sixty feet, and composed of heavy pine timbers of that length. A path on either side has been graded down to the bridge, that on the opposite side having been cut from the face of the cliff, the rock of which is composed of soft, shelly, and partially disintegrated slate. The bridge is located just above the mouth of East Fork, a considerable stream, and in seasons of high water is not far below the magnitude of the main river. It finds its sources many miles to the east and south-east, among some of the loftiest peaks of the Rocky Mountain range, and drains, with its numerous tributaries, a vast extent of country. From its extreme source to its mouth, it is probably fifty miles in length. An elevated, rolling country, several miles in extent, lies in the angle of the two rivers. It is intersected by numerous streams fed from the melting snow in the mountains above. In this area were three or four small lakes or ponds literally covered with ducks. Near its center stands a mountain of remarkable appearance, nearly square, with precipitous sides, known as the "Square Butte." I crossed the river, and, passing south along its bank, obtained a view of the cañon of the Yellowstone, which here is very beautiful. Its walls are composed of volcanic conglomerate capped with basaltic columns. Many of the pinnacles remain, towering hundreds of feet in height, having about the proportions of an ordinary sewing-needle. In many places below are observed steam-jets rising from near the river's edge, while indications of sulphur deposit are very numerous. Farther up, I was able to descend to the river's bed opposite the mouth of Tower Creek, coming in from the west. This stream is named from numerous tower-like pinnacles reaching up many feet above its bank. Here were some fine specimens of brimstone deposit from hot sulphur jets along the banks of the river. On the other side were numerous warm springs, which I did not visit.

The trout in this part of the river are exceedingly fine and added much to the variety of our mess. Back from the river to the east the country rises rapidly and soon becomes extremely rugged. High barren peaks are seen rising one above the other, far off to the east and south. I ascended the range to the height of 3,000 feet above the river, and judged that many of the peaks beyond were a thousand or 1,500 feet higher. On these mountains I picked up numerous specimens of petrifications and some fine pieces of agates and rock crystal. On returning to camp I learned that the other party had passed during the day and had proceeded on as far as Tower Creek, some four miles above.

I broke camp on the morning of the 26th at half-past 7; sent the train over the trail taken the day before by Dr. Hayden, and then, in company with Captain Heap, I made an examination of the river's bank

and the falls of Tower Creek. The views from the bank of the river on this side were even more interesting than those obtained yesterday. The fall is exceedingly picturesque, and, when seen from below, the stream appears to drop from among a number of tower-like rocks, some of them extending upward more than a hundred feet above the crest of the falls. The fall itself is a sheer descent of 156 feet into a shallow basin. The water then rushes away through a rocky and rapidly descending channel, forming numerous cascades in its course to the river below.

A thick growth of pine and hemlock covers the sides of this gorge. Regaining the trail, which led through moderately open timber, Captain Heap and I pushed on as rapidly as possible, but soon losing all signs of the advance party, Captain Heap returned to pick up the trail; I went forward and soon regained it. I then continued over a beautifully undulating country covered with rich verdure and decked with wild flowers of every hue, many of them unknown in the Eastern States. Yet the elevation here is so great (7,000 feet) that frosts occur every night during the year. The vegetation does not seem to suffer from these summer frosts, the effect upon grass and flowers being apparently but that of dew. The path led to still higher elevations and eventually crossed a mountain range called the "Elephant's Back," forming a part of the rim of the Yellowstone Lake basin. It is this ridge which, cut through by the Yellowstone below the great falls, forms that stupendous cañon, 2,000 feet in depth. A road could easily be constructed through some one of the numerous passes in this range, avoiding the severe climbing necessary by this route. Much timber would have to be removed, however, from these passes before even pack-animals could get through. On this expedition the most annoying and sometimes insurmountable obstacles met with were masses of fallen timber. The trail led within a mile of the highest peak of this range, called Mount Washburne. I wished to obtain a view from this eminence, and with some difficulty succeeded in leading my horse to its extreme top. The summit is composed of broken masses of volcanic rock, literally smoothed or leveled off by the force of the wind, which sweeps with terrible violence over these elevated regions. I had observed large areas of snow several hundred feet below the summit of this ridge, but, upon the peak, I doubt if, even in winter, the wind will permit snow to remain.

From this point mountain peaks were observed in all directions, while the Yellowstone Lake, though twenty miles distant, seemed to lie at my feet. The valley of the river can be seen following the general direction of the mountain-chain to the east, a stern volcanic range of sharp peaks, many of them having the form of the Egyptian pyramids, though, of course, of much greater magnitude. One large mountain of this range had been a landmark for two days, bearing a strange resemblance to a human profile turned toward the zenith. I named it "Giant's Face."

The summit of Mount Washburne is 9,000 feet above the sea, while many of those to the east of the Yellowstone are apparently 2,000 feet higher. I intended making a sketch of the horizon line of country, as seen from this mountain, but so fierce a gale was blowing at the time that I found it utterly impossible to use my drawing materials.

I descended by the opposite side into a precipitous gorge or cañon a thousand feet deep, having to drag my horse down some of the worst places. There was no vegetation, no soil, nothing but volcanic rock, in some places solid, but much of it loose and broken, affording no footing whatever, and compelling the horse to slide for several yards at a time. On one occasion I discovered that I was following the trail of a bear to his den. Soon after emerging from this cañon I became engulfed in an

immense pine forest which seemed interminable. In this forest were many open glades covered with grass and flowers. In one of these, quietly reposing, I discovered three fine elk, which, upon my approach, disappeared into the thick underbrush before I could bring my carbine to bear upon them. I had descended the mountain far to the east of the trail, and now taking the direction of the sun I succeeded in traversing the forest and regaining the trail which I had no difficulty in following. A ride of some five miles soon brought me to camp. While in the forest I came upon a valley of chalk-white rock, evidently an old system of warm springs; several small ones were still in operation, giving a perceptible warmth to a small stream flowing through the valley and filling the atmosphere with an intense odor of sulphur.

We had now reached the vicinity of the great falls of the Yellowstone, which should be classed among the most interesting and beautiful of the earth. Lieutenant Doane minutely and graphically describes them in his report, and compares them most favorably with all others on this continent. I viewed them both by moonlight after arriving at camp, and on the following morning. I should describe the upper fall as the embodiment of beauty, the lower one that of grandeur: At the crest of each the river narrows to less than a hundred feet, while its depth correspondingly increases. Above the upper fall the river rapidly descends over a series of cascades, gaining great velocity, whence, upon reaching the brink of the precipice, the whole volume is thrown outward and divided almost at once into drops which aggregate into conical shapes, their apexes projecting forward, not unlike an array of comets. These soon lose their individuality and gradually blend together, forming a dense white mass, which descends in a fall of 115 feet, spreading out at the bottom with the grace and beauty of a lady's ball-room costume. A point of rocks jutting out just in front of and slightly below the crest of the fall, affords a convenient spot for observation, whence the whole beauty of the scene can be taken in at a glance. Here the cañon of the Yellowstone finds its beginning in a beautifully wooded gorge between two and three hundred feet in depth, through which the river flows swiftly, though smoothly, over its rocky bottom, to the crest of the lower fall half a mile below; the river then emerges from between its rocky banks and makes its prodigious leap of 350 feet into the depth of the great cañon. It is no small undertaking to descend the steep and slippery side of the cañon, even to the crest of the fall, while the yellow, volcanic and nearly vertical walls of the gorge beneath bid defiance to the most expert climber. The depths below are filled with hot springs; the rock is soft and crumbling, affording no secure footing, while the river rushes away in a perfect torrent over innumerable cascades and ripples, causing eddies and whirlpools which would dash to atoms any unlucky adventurer who should be so unfortunate as to find himself engulfed in its waters.

About 400 yards below the lower fall a fine view is obtained from a high projecting promontory. Coming in from the west between the upper and lower falls a small stream flows over several ledges of rocks, giving rise to a number of beautiful cascades, from which the creek derives its name. These are extremely beautiful, though insignificant in comparison with the greater wonders so near at hand. One of these little falls drops into a cavern nearly concealed by overhanging cliffs, thence descending from a low ridge of rocks into a pool of great depth. A portion of the water passes through a crevice, or small tunnel, and darts out through the main fall of the cascade below, giving it a most singular appearance.

After regaining the trail I hurried on up the river to overtake the train on its way to the Mud Volcano, some ten miles above. I soon came to the wreck of a pack-mule, which had made a false step in getting over a fallen tree, and had rolled, end over end, down the hill. His pack, consisting of the photographer's apparatus, escaped without serious injury. The scenery along the river above the falls is quite tame, compared with the wildness and grandness of the regions I had just left. The river, a broad, smooth stream, flows over a sandy bed, with gently sloping banks, generally well wooded. No noisy cataracts break the Sabbath-stillness of this region. No volcanic agencies seem to have been at work here. One would expect to find farm-houses and hamlets in so quiet and peaceful a valley.

Many small streams, coming in from the distant mountains, and a rolling prairie of several miles extent, was crossed during this day's march. I discovered a hillock composed of pebbles of obsidian, somewhat resembling coal-cinders. Toward the western verge of this prairie a hill of white rock was discovered which, upon investigation, proved to be another of the "soda mountains," as they are called by the hunters. Approaching nearer, I found jets of smoke and steam issuing from the face of the hill, while its other side was hollowed out into a sort of amphitheater, whose sides were steaming with sulphur fumes, the ground hot and parched with internal fires. Acre after acre of this hot volcanic surface lay before me, having numerous cracks and small apertures at intervals of a few feet, from whence were expelled, sometimes in steady, continuous streams, sometimes in puffs like those from an engine, jets of vapor more or less impregnated with mineral substances. I ascended the hill, leaving my horse below, fearful that he might break through the thin rock-crust, which in many places gave way beneath the tread, revealing caverns of pure, crystalized sulphur, from which hot fumes were sure to issue. These crystals were very fine, but too frail to transport without the greatest care. A large boiling spring, emitting strong fumes of sulphur and sulphureted hydrogen, not at all agreeable, was also found here. The water from this spring, over-running its basin, trickled down the hill-side, leaving a highly-colored trace in the chalky rock. Upon the opposite side was found a number of larger springs. One, from its size and the power it displayed in throwing water to the height of several feet above the surface, was worthy of notice. Near this was a spring having regular pulsations, like a steam-engine; giving off large quantities of steam, which would issue forth with the roar of a hurricane. This was, in reality, a steam volcano; deep vibrations in the subterraneous caverns extending far away beneath the hill could be distinctly heard. In searching through the thick mass of timber west of this region for other curiosities, Captain Heap and I became almost locked up in a labyrinth of fallen timber, so dense, and so inextricably interlaced, that it was with the greatest difficulty we finally found our way out again. The country, from this point to the Mud Volcano, was mostly rolling prairie, intersected with several streams flowing into the river, some of them having wide estuaries and adjacent swampy flats covered with thick marsh-grass in abundance. Ducks are usually found in these sluggish streams, as well as in the little lakes so numerous throughout this whole region. We camped on the bank of the river, in the immediate vicinity of the mud geysers. These being the first specimens of the true geyser yet seen, we examined them with much curiosity.

July 28.—Remained at this camp throughout the day examining the springs, and crossing the river on a raft for the purpose of ascertaining

if the same phenomena existed on the opposite side, several steam-jets being visible among the hills beyond.

The central point of interest here is the Mud Volcano, which has broken out from the side of a well timbered hill. It has a crater 25 feet across at the top, gradually sloping inward to the bottom, where it becomes about half this diameter. Its depth is about 30 feet; the deposit is gray mud, nearly a pure alumina, and has been thrown up by the action of the volcano at no very distant period. The rim of the crater on the down-hill side is some 10 feet in height, and trees 50 feet high and 100 feet distant are loaded with mud thrown from this volcano. The surface of the bottom is in a constant state of ebullition, puffing and throwing up masses of boiling mud, and sending forth dense columns of steam several hundred feet above the surrounding forests. This column of steam can be seen for many miles in all directions. Some 400 yards from this crater are three large hot springs of muddy water, one of which proved to be a geyser having periods of active eruption about every six hours. The phenomena attending these eruptions are as follows: Soon after the violent period passes, the water in the pool gradually subsides through the orifice in the center, the surface falling several feet. The water almost entirely disappears from sight, when it gradually rises again until the former level is reached, during which occasional ebullitions of greater or lesser magnitude occur; great agitation now ensues; pulsations at regular intervals of a few seconds take place, at each of which the water in the crater is elevated higher and higher until finally, after ten minutes, a column is forced up to the height of 30 or 40 feet. During this period waves dash against the sides of the surrounding basin; vast clouds of steam escape; a noise like the rumbling of an earthquake takes place; suddenly, after about fifteen minutes of this commotion, the waves recede, quiet is restored, and the waters sink gradually to their lowest limits. They soon rise again and repeat the same operation. The water from this geyser does not flow away, as the spring occupies the center of a basin 60 yards in diameter and 12 feet in depth; a channel from this basin, however, serves to conduct off any excess of surface-water that may flow in from the hill-side above.

The supply of water is diminished by a constant loss of vapor, and, if not re-supplied, the spring in time dies out. Evidences of extinct springs are quite numerous in this vicinity. Close by are a great many very small boiling-mud pits, a plastic material resembling mortar in color and consistency, worked smooth by constant mixings which it has received for an indefinite period. To the north of the geyser are numerous sulphur jets, small rills from which were depositing a sulphurous slime along their channels. The warmth and mineral properties of this material give rise to a rank vegetation.

At the head of a small ravine still further to the northward is a cavern extending fifteen feet into the side of a hill, and about six feet across at the opening. It is lined with variegated colors deposited from the vapor constantly issuing from its extreme depths, while the channel of the small stream leading down the ravine is also colored by a similar deposit from the escaping waters. The amount of steam forced out from this cavern was immense, causing great agitation of the water within, and giving rise to a roaring and splashing sound as of heavy waves breaking upon a rocky shore.

There are many ponds, varying in size from an ordinary sitting-room to a half acre in extent, all warm or hot, some of them boiling and giving off dense masses of steam, usually in regular pulsations. I enjoyed

a steam bath at the mouth of the cavern-spring. The water was much too hot for bathing, and the stones upon which I stood would have burnt my feet but for the precaution of keeping on my shoes.

A slight pungent odor, not strong enough to be offensive, pervades this entire region. I found little of interest to repay me for the labor of crossing the river. The raft was swept rapidly down the current, and soon got beyond the depth of our poles, and only by dint of severe paddling were we able to cross and return. Captain Heap and myself were the only persons who ventured upon the raft, and upon our return no one followed our example. Four or five small mud-craters were discovered giving off steam and occasionally sending up small quantities of thick mud, some of which was sufficiently pure and fine to serve for the manufacture of porcelain or china ware.

July 29.—Sounds resembling a human voice calling for help were heard at intervals through the night; it is supposed they proceeded from the throat of a species of panther, called the American lion. I saw the skin and claws of one of these animals at Bottler's Ranch, which had belonged to a formidable specimen of this genus. I judged that an encounter with one would not be altogether safe. In size it must have been somewhat under that of the lions usually seen in menageries, though from the appearance of its head and claws it must have nearly equaled them in strength and fierceness.

After witnessing the morning eruption of the mud-geyser, which occurred at 6 o'clock and lasted nine minutes, attended with the usual phenomena, we continued our march to the Yellowstone Lake, about eight miles distant. The trail proved generally easy, skirting the river, which now becomes much broader, with gently sloping banks and broad grassy meadows. It seemed almost incredible that so tame and quiet a scene could be found in the midst of a region usually so wild and terrible. Just before reaching the lake we crossed a broad prairie extending several miles to the northward, and a continuation of the one met with on our march from the falls to the mud-springs. We crossed this prairie after emerging from a fine grove near the river, and found ourselves near the beach of the Yellowstone Lake. A beautiful picture is this clear blue sheet of water nestling among the snow-peaks of the highest mountain-range on our continent. The rim of this lake-basin is composed of a mountain range varying from nine to eleven thousand feet in height above the sea, and inclosing an area of about one thousand four hundred square miles. Beyond this rim the water-slopes descend in all directions, and furnish the sources of the principal rivers of the continent. Four of the most important tributaries of the Missouri, viz, the Big Horn, the Yellowstone, the Madison, and the Gallatin, carry the melting snows from these mountains northward, and then through the Mississippi Valley to the Gulf of Mexico, more than three thousand five hundred miles. The Snake River, having its sources actually interlaced with those of the Yellowstone and Madison, traverses in its westward course nearly a thousand miles before it mingles its waters with those of the Columbia on its way to the Pacific Ocean.

Again, the Green River, rising but a few miles from the sources of the others, seeks the deserts of Colorado, and after innumerable windings in those deep cañons, at length, after a course of one thousand five hundred miles, reaches the Pacific through the waters of the Gulf of California.

The dividing point in this central region of the continent is Union

Peak, situated south of the Yellowstone Lake, its extreme height being nearly 14,000 feet above the sea.

We located our camp at the edge of the bluff, some 20 feet above the beach below. A cold stream furnished us with water, and numerous fallen trees afforded us plenty of wood, while the fine meadows of the adjacent prairie supplied excellent grazing for the animals. The lake is very irregular in outline, and about twenty miles across. Several high promontories project from the southern and western shores far out into the lake, greatly diminishing its apparent extent, and forming several large bays and inlets. With the exception of the northeastern angle, heavy masses of timber cover the lake shores quite down to the water's edge, rendering its circuit attended with great difficulty. On the eastern and southern sides the mountain ranges are continuous, while to the southwest and west breaks appear, through which issue many of the sources of the Snake River. In the latter direction, some ten miles from the lake, stands a very conspicuous peak, its outlines sharp and conical, and at this distance appearing almost covered with snow. This proved to be, upon subsequent investigation, 10,500 feet in height.

The water of the lake is cool and tolerably pure at this point, but, being somewhat impregnated with vegetable matter, we preferred the mountain stream for drinking and cooking. The fish found in the lake above the falls are very numerous; all of the same variety, namely, a fine large species of trout; but as many of them have long white worms in their flesh, we discontinued catching them. The fish did not seem to suffer from the effect of the worms, whose existence was probably due to the influence of warm or chemical springs found in many parts of the lake.

July 30.—The party remained in camp at the lake. I attempted to cross with a small force to the opposite side of the river for the purpose of examining the eastern shore of the lake, and had a small raft constructed of pine logs sufficiently buoyant to sustain four men and as many horse-equipments. The horses were expected to swim. The river here at the outlet of the lake was deep, 400 yards wide, and the current swift. After several ineffectual attempts to get the animals across, the exploration was made on foot, the raft answering its purpose very well. We went as far south as Pelican Creek, about one mile from the mouth of the river. A long sand-bar here reaches out into the lake, the resort of numerous water-fowls. A large portion of the side of the mountain to the east is composed of white rock, evidently another vast warm-spring formation. One of our horses was taken sick to-day, with indications of poisoning. The attack, however, did not prove to be fatal.

The nights are beautiful in this valley. This evening's full moon, as it rose above the mountains beyond the lake, was reflected across to my camp in a broad belt of golden light as brilliant as the moon itself.

The thermometer descends from six to ten degrees below the freezing point, and yet the morning's sun melts the frost-work on the most delicate flowers without causing their bloom to fade or their leaves to wither.

July 31.—I started to-day at 8 a. m. for the valley of the Madison, to examine the basin of the great geysers. From the representations of one of my packers I had determined to retrace my steps on the trail, back toward the Mud Springs about five miles, and then crossing the open prairie ten miles to the west, and after examining a system of boiling springs on its western verge, to strike directly over the dividing ridge, and through the unknown forest lying beyond. By this route I

would have open country more than half the way, while by taking a more direct course the route would be through dense forests the entire distance. Dr. Hayden, with two or three of his party, proposed to accompany me, but, just before starting, changed his mind, and, piloted by two hunters whom we had met the previous day, and who were journeying towards the head-waters of the Madison upon a trapping expedition, started an hour before I was ready, by what they supposed to be a shorter route, entering the woods at once. On leaving the trail along the river's bank, I crossed a low ridge and entered upon a broad, smooth valley, leading nearly due west. This valley was occasionally intersected by ravines, in which were usually found cold mountain-streams of pure water. It was covered with grass and wild flowers in great profusion. Twenty-seven varieties of the latter have been already counted. Ten miles west of the river we came upon a very hot stream, formed from the overflow of a large system of springs in some respects more interesting than any we had yet encountered. One, with a curious crater, was constantly throwing up boiling water to the height of several feet. The crater is of calcareous rock, 6 feet in diameter, and bears a strong resemblance to a human ear. A beautiful branch joins this stream from the northwest, cool, and highly impregnated with alum. The water from these springs is remarkably clear and colorless, except that from a single one which had the bright color of gamboge. On both sides of the hot stream the ground is a soft, hot marsh, very dangerous to examine, and it is only in the immediate vicinity of the largest springs, where a rocky deposit has been formed, that one is entirely safe. A steam-jet flowing beneath the surface of the water into the stream, at one point presented a very interesting appearance and gave off a very novel sound, something like that made by the spindle of a spinning-machine.

Beyond these springs our course lay through a small but wild and pretty cañon, having five gates fifty feet in height, at intervals of about one hundred feet. Continuing two miles further up this winding ravine we reached a forest, where we encountered some difficulty from undergrowth and masses of fallen timber. For the first three miles, however, the wood was comparatively open and our progress easy. Then we came upon an immense area covered with sulphur-vents, each hill-side containing thousands of these little crystal chambers, which, upon being broken into, sent forth quantities of sulphurous steam. In passing through the orifice from below, this vapor had been sublimated into beautiful crystals of pure sulphur, varying in dimensions from the size of a needle to the thickness of the finger, while some were even larger. The country presented the appearance of a vast lime-kiln in active combustion. The crust of soft white rock was exceedingly thin, requiring great caution in picking a route for the animals. We were soon on the crest of the divide between the waters of the Yellowstone and the Madison, and it became necessary to push on in order to reach water and grass before night-fall. The thick underbrush and fallen timber now became almost impassable, while the rough surface of the mountain, cut into sharp gorges, with rugged, precipitous sides, rendered anything like a straight course out of the question. The pack-animals suffered terribly; their packs were constantly disarranged and frequently torn open from severe contact with trees, and it often became necessary to cut our way through some of the worst places. Toiling on in this manner for five miles, but still making some progress toward the Madison Valley, we were overtaken by Dr. Hayden. In company we descended the mountain and eventually reached a branch of the Madison, where

we camped for the night. This stream, we afterward ascertained, joins the Firehole River—the main eastern fork of the Madison—some eight miles further down. It is here fifteen feet wide and four feet in depth. The divide crossed to-day was not high—only about a thousand feet above the valley on either side. The distance was twenty-five miles.

August 1.—We discovered a brimstone valley about two miles up the stream, in which were a great many hot springs flowing into and raising the temperature of the creek. There are many of these brimstone basins, their general characteristics being about the same. I took the temperatures of many of the springs in this one, which were recorded as follows: Small white sulphur spring, temperature 128°; another, 5 feet across, with black deposit, 172°; a small bubbling spring, 179°; the hottest found in this basin, 199°. One beautiful spring, with light yellow deposit, 182°. These were the principal springs found in this basin. In addition to the springs, and covering the side of the valley, were numerous steam-jets issuing from little apertures, which were always found to contain beautiful specimens of crystallized sulphur.

I moved camp in the afternoon at half-past 4 o'clock, following the course of the stream in a southwesterly direction, passing numerous hot springs from 140° to 190° of temperature, impregnated with various mineral salts, principally iron, alum, and sulphur.

A mile from camp we passed two very large springs, 20 and 40 feet across respectively. Another mile brought us to a warm creek, which I followed up, thinking there might be geysers towards its source, but found only another of the numerous brimstone basins. We soon struck a good trail, which led down the stream, crossing and recrossing as the necessity of the country demanded, and finally passed through a deep cañon with steep rocky walls on either side. After traveling about eight miles we came to the junction of the valley with that of another stream coming in from the south, which subsequent investigation proved to be the Firehole, or, more properly, the river of the geysers. Near the junction of the two valleys was a sharp conical butte, evidently of spring formation, as were also the extreme heights of the ridges between which we had been traveling.

Just beyond this butte the nearly level valley of the Firehole River appears some two miles across and three miles in length. At the southern extremity of this plain a high terraced hill was seen throwing up vast clouds of steam with occasional jets of water, while in many other directions, among the trees and on the sides of the valley, numerous steam columns were visible. The plain was covered with a whitish spongy soil, checked into squares in drying, showing evidences of having been recently overflowed. As it appeared boggy we passed around it to the eastward and ascended the large white hill composed of calcareous deposit, our horses occasionally breaking through its thin covering.

In returning to the point from which we entered this valley we rode directly across the plain, and found that it was marshy only in appearance. Half a mile back from the valley I found the train just unpacking in a beautiful park of firs with a broad meadow just in front. No artificial arrangement of trees could have been more perfect. I learned that one of the escort, (Private Canter,) had not come in with the rest and was probably lost. As I had given instructions to the whole party that, in case any one lost his way, he should return to the previous camp and there wait to be sent for, I did not feel very anxious regarding him. I gave the sergeant directions to return at daylight to the previous camp, where the man would undoubtedly be found.

August 2.—Canter did not come in during the night; Sergeant Blade and Private McConnel went in search of him at daylight, and found him at the old camp.

The group of hot springs or geysers forming the terraced hills of the south is very interesting, consisting of a large number of springs, ranging in size from a mere point to a hundred feet in diameter. Some are geysers having regular periods of activity, throwing up columns of water to the height, in some cases, of 30 or 40 feet. Many of the small ones seemed constantly active, but eject water only a few feet above the surface. One small geyser has periods of action every fifteen minutes, throwing a column of water 30 feet high. Another, with an irregular but beautifully formed crater, gave off occasional bursts of steam and water, shooting the latter to the height of 20 feet. The whole system, however, furnish at this date but a small quantity of water, forming a stream only 2 feet wide and 3 inches deep. A beautiful feature near this hill is a mud-spring, 150 feet across, containing about a thousand little jets of steam, each shooting up minute particles of fine, soft clay, worked ready for the molder. This clay was pure white, and capable of producing the finest porcelain. The clay of several other springs near by was beautifully tinted in pink and orange colors. The water from the geysers is nearly pure, though holding in solution silicates of lime and magnesia, which are slowly deposited at the craters in beautiful bead-like drops of infinite shape and variety. The craters are all low, showing their recent origin, being elevated but from 2 to 6 feet above their orifices, though the hill, which has been formed by the united efforts of all, rises 100 feet above the plain below. There are about a hundred thermal springs in this system, the largest being at the extreme height of the elevation. It is of a bright-blue color, 30 feet in depth, with rocky caverns beneath, the temperature being nearly up to the boiling-point. This is a geyser, having periods of action every twelve hours. Previous to an eruption the surface of the spring gradually rises about six inches, and expands over an adjacent pool, the whole covering about half an acre. Steam-bubbles issue from the caverns beneath, the temperature rises, larger jets of steam escape, accompanied with the bubbling up of the water. After an hour's preparation of this character a sudden rush of an immense and powerful mass of steam occurs, which carries with it a column of water to the height of 30 to 60 feet, spouting out in all directions, and descending in a shower upon the surrounding rock to the distance of 30 or 40 feet from the crater. The eruption lasts three-quarters of an hour, and a large quantity of water is discharged.

Between the present camp and the Firehole Valley is a group of beautiful springs, which in a country where these curiosities are not so common would receive much attention. One 4 by 5 feet in diameter, and 50 feet deep, is surrounded with a hard rocky rim. The water was a clear blue, whose temperature was 190°. Close by was a large spring, 10 by 20 feet across, having a soft slimy deposit impregnated with salts of iron, its temperature 126°; another, having a similar deposit, but formed in large sheets resembling raw hides in a vat. Across the plain to the west were found several mud-springs in a ravine near a small pond. Here tracks of deer, elk, and buffalo in great abundance were seen. Farther to the north was found another system of hot springs, shooting up plastic mud of a light gray color, having the consistency of thick cream. One of these springs was 100 feet across and contained ten craters, which threw up mud 8 feet high. The Firehole River at this point is a broad shallow stream from 100 to 200 feet in width, and about 2 feet deep. The bottom is hard lava, through which boiling springs

bubble up in many places. The banks are often swampy, though in many places covered with calcareous rock deposited from warm springs. The creek upon which I encamped makes a bend to the north and enters the river a mile below. I descended the river six miles to ascertain at what point another branch, supposed to come in from the west, joins it. I found no streams entering this river from either side in that distance. The valley gradually contracts, and, after four miles, becomes a cañon difficult of passage. I was now satisfied that I had entered the Fire-hole Valley below or to the north of the great geysers, and decided to move to the south in search of them. Leaving directions for camp to move across the plain about two and a half miles and locate near the geyser-hill before mentioned, I ascended the river a distance of a mile further, and came upon another group of interesting springs, in some respects more beautiful than any yet discovered. A hill, sloping 50 feet up from the river's bank, down which five streams of boiling water in porcelain channels of variegated colors, varying from bright saffron to a deep vermilion, rippled over cascades worn in the terrace formation of the rock. Upon the crest of this hill, from which the rock sloped in all directions, was found a spring or small lake just even with the crest, 200 yards in diameter and nearly an exact circle. The middle waters were deep ultramarine blue, while its concentric rings varied through nearly all the colors of the rainbow, being green, yellow, orange, and red. The edges for some distance down the slope were a bright vermilion. Masses of vapor were constantly rising from the surface of this lake. Between this large spring and the river a huge chasm in the rock was found 100 feet long and 30 feet broad, revealing another spring of most astonishing beauty. The rock had evidently fallen in and disappeared in a cavity of great depth, as the sides of the chasm, some 15 feet high, were rough and ragged, showing quite a recent fracture. The depth of this spring was immense toward the center. The waters were as clear as crystal, and the color of turquois. The caverns seemed lined with silver, and these extended in several directions beneath the hill. From the surface of the water a vast cloud of steam was constantly rising, producing an effect upon the mind of something terrible and unreal, and at the same time very fascinating. Another large spring, of a clear green color, and several smaller ones, were found in this group.

August 3.—About ten miles west of our camp, beyond the river, and across several open patches of meadow containing numerous hot springs, where the water in many places spreads over low sunken ground, causing deep and dangerous warm marshes, stands a singular pair of buttes, almost identical in size and general appearance. A narrow ridge rising half way to their tops connects these mountains together. They are called the "Twin Buttes." In company with Dr. Hayden I ascended to the top of the first one, from which a fine view of the surrounding valley was obtained. These mountains are volcanic in their origin. An orifice at the base of a huge rock near the crest of the one I ascended still ejects a current of hot vapor, with a loud, hissing sound. The top of this butte was found to be 600 feet above the plain. I was disappointed in not obtaining a more extended view to the west, the trees in that direction growing quite to the top of the butte, allowing but a glimpse of the mountain range beyond. The west branch of the Madison is undoubtedly just over that range, a high, precipitous, and densely wooded ridge 1,500 feet in height, and very difficult of passage. To the east the view was less obstructed, and I was able to take in at a glance nearly the whole of the lower geyser basin, with its hundreds of boiling springs scattered through the valley, over an area of four miles in length.

by about two and a half in width. A steep precipice was observed to the south, its face looking exactly north, from whose crest a tiny stream descended in a narrow and graceful fall. I determined to visit this fall, and after a great deal of rough climbing over rocks, through deep and thickly wooded ravines, reached its foot. Here were some of the largest pines I had seen, towering upward a hundred feet, as though ambitious to reach the crest far above. The fall proved upon measurement to be a clean descent of 250 feet, and dropped into a shallow and pretty basin at the foot by the cliff. I named this fall the "Fairy." On climbing to the crest I picked up some beautiful specimens of jasper and agate, and plucked some lovely flowers of an unknown variety on the brink above. I had a severe climb up a nearly vertical rock, and on reaching the top was completely exhausted. I found a more easy point by which to descend. A very pretty cascade was discovered a few yards above the brink of the fall.

August 4.—It rained last night, which is very unusual. The shower, however, was only a slight one, accompanied with a good deal of wind. A dense fog lay on the ground early this morning, but was soon dispelled by the rising sun. I sent the train up the river, with directions to proceed six or eight miles and go into camp, thus giving me an opportunity to explore the adjacent country for other thermal phenomena. A ravine to the southeast of the geyser-hill valley contains several large springs, which I had not yet examined. I took them in my route.

A lake of hot water, 100 by 200 feet in extent, was discovered; also a fine geyser, throwing water to the height of 50 feet. Beyond, was a vast hot marsh, which I was obliged to skirt for a long distance, it being too soft to bear the weight of a horse. Here was discovered a very beautiful spring, having a scalloped curbing of rock 12 feet across, and surrounded by numerous pockets, in which were deposited a quantity of little pebbles as smooth as polished marble. I procured quite a number of these; also some other specimens of deposit, enameled with silica. In the center of this plat, about two miles in area, stands a crater 15 feet high, upon a basin of about the same height. This is an interesting crater, throwing a small stream to the height of about 6 feet. It is rapidly going to decay, the supply of deposit not equaling the amount expoliated by the action of the elements. It is soft and crumbling, and steam issues from its sides in many places. Around this plain the trees have been killed by the action of hot water, often overflowing the basin. Their trunks, for several feet from the ground, are denuded of bark, and are crusted with a white deposit of silicious rock. Continuing on to the southwest, through thickly timbered and broken country, Captain Heap and I reached the river at the site of the beautiful group of springs seen two days before. From this point onward, the mountains, from 800 to 1,200 feet in height, close in near the river, narrowing the valley to about a quarter of a mile, many beautiful and curious springs and small geysers were found at frequent intervals all along the banks of the river. Any one of these would be a study in itself, was there none other to demand attention. A pair of twin geysers was particularly noticeable, one throwing out sudden gusts of steam, the other responding regularly with a spout of water, 20 feet in height, at an oblique angle. Following the trail of the party in advance, occasionally losing it in the marshes and fallen timber, we hurried on, crossing and re-crossing the river in several places. The stream here has a fine rushing current, from 6 inches to 3 feet in depth, 50 yards wide, and flowing over a smooth, rocky bottom. The valley is well wooded with

spruce, pine, and cedar, and is intersected by several cold streams as well as numerous warm ones.

Three miles beyond the twin geysers was found a system of hot springs and geysers, extending across the river and covering an area of several hundred acres. One of the most interesting of this group is a minute geyser emitting jets of water at intervals of every three minutes, in two or three convulsive puffs, to the height of 30 feet. The peculiarities of this crater are very marked, it having an entanglement of roots just at its opening. These have become incrustated and partially petrified with silicious deposit, causing them to resemble frosted silver. At the west side of this river at this point are ten large springs, three or more geysers, and numerous smaller springs, some of which are probably geysers. One of the large springs was exceedingly beautiful, being 15 by 18 feet across and gradually decreasing in diameter toward the bottom. The transparency of the water, though of a deep-blue color, rendered every outline of its sides as clear as if it contained but air. At the center the depth must have been 40 feet or more. Around and near this spring were dozens of little springs sputtering and hissing upon their own individual account. One hundred yards south of this transparent pool is a remarkably fantastic crater, consisting of a huge fissure in the rock, around which has been formed by deposits a most curiously wrought net work of white mineral, resembling delicate tracing of frost-work. The river flows to the east, across which can be seen numerous steam-jets, while on this side are more than twenty between the large spring and the river. Many of the springs have double or twin craters. The rock in many places is thin and friable, and, upon being broken through, dark, smoking holes filled with boiling water or mud are revealed. It is not unusual to find springs within a few feet of each other, standing at a great difference of level; where both are boiling this is very remarkable. A triple geyser constantly in action deposits a substance resembling sponge, both in color and texture. Continuing up the stream we passed many single springs with lovely blue depths, also many steam-jets. In one large spring a pine tree had fallen, its whole top being submerged; the branches, cones, and needles were all completely incrustated with a rich coating of mineral, like frosted silver. It was fast becoming petrified, the wood already having partially changed into stone, being yet soft, having about the consistency of lard.

The valley now becomes wider, and soon another basin, containing an immense system of geysers, was entered. From their number and magnitude it seems probable that we had reached the Firehole basin, described by Lieutenant Doane. Subsequent investigation proved this to be the case. This basin is two miles in length by about one-half mile in width, the river traversing it in a winding course, whose general direction is from southeast to northwest. The stream is very rapid, having a smooth bed of lava; is about 30 yards in width and from 6 inches to 3 feet in depth. The hills on either side are rocky and heavily wooded, rising from seven to twelve hundred feet above the valley, and nearly inclosing it. The scene, as we entered from below, was grand and imposing. Along both banks, and extending back into the forest, were numerous steam-jets rising in soft masses of cloudy vapor to the altitude of several hundred feet, while dotted over the whole extent of the basin were seen numerous columns of water in the form of fountains playing at various heights.

I found the camp located on the east side of the river, near a small pine grove, with good grass in the bottom. Soon after arriving a shout was heard near the hill-side, a hundred yards distant, and upon rushing

out in that direction a huge mass of steam was seen issuing from a crater at the base of the hill, accompanied by a column of water rising to a height far exceeding that of any geyser I had yet seen. This grand fountain continued to play for several minutes, when dying down, I approached to obtain a closer view of the aperture whence had issued such a powerful stream. A sudden gush of steam drove me away, following which the water was again impelled upward and upward, far above the steam, till it seemed to have lost the controlling force of gravity, and that it would never cease to rise. The roar was like the sound of a tornado, but there was no apparent effort; a steady stream, very graceful, and perfectly vertical, except as a slight breeze may have waved it to and fro. Strong and smooth it continued to ascend like the stream from a powerful steam fire-engine. We were all lost in astonishment at the sudden and marvelous spectacle. The proportions of the fountain were perfect. The enthusiasm of the party was manifested in shouts of delight. Under the excitement of the moment it was estimated to be from three to five hundred feet in height. Comparing it with the Fairy Falls, seen the day before, which measured 250 feet, I have no hesitancy in stating that this geyser played to the height of over 200 feet. It commenced at 5 p. m., and continued twenty minutes. Three days were devoted to the examination of the springs in this basin, viz, the 5th, 6th, and 7th of August, during which period a special survey of the valley was made, and the height of some of the important geysers measured.

The longer I remained the more firmly I became convinced that a thorough solution of the wonders of this valley can only be obtained by long and patient investigation during the whole season, by a corps of observers stationed at several points in the basin, whose duty it shall be to accurately record every phenomenon attending each spring. During my stay I was only able to study the most general features of a very few. There may be many geysers, some perhaps more powerful than those I saw, whose period of action failed to occur while my party were in the basin. Indeed, the "Giantess," described by Lieutenant Doane as being the most wonderful geyser in the basin, was not seen to play by any of my party; while the fine geyser near my camp, named by me the "Comet," was entirely unnoticed by the party visiting the valley last summer. I made careful preparations to measure the height of the latter should it play again, but though I remained three days, principally for that purpose, the following displays occurred in the night, the intervals of rest being about twenty-eight or thirty hours.

GENERAL DESCRIPTION OF THE GREAT GEYSER BASIN.

Entering the basin from the north and following the bank of the stream, whose direction is about northeast, a series of rapids near together is encountered where the river makes a sharp bend to the southwest, at which point is found a small steam-jet upon the right. A warm stream comes in from the left, falling over a bank 10 feet in height. A short distance beyond a second rapid is found, and then another about 100 yards farther on, where the gate of the geyser basin is entered. Here, on either side of the river, are two lively geysers, called the "Sentinels." The one on the left is in constant agitation, its waters revolving horizontally with great violence, and occasionally spouting upward to the height of 20 feet. Enormous masses of steam are ejected. The crater of this geyser is 3 feet by 10. The opposite "Sentinel" is not so constantly active, and is smaller. The rapids here are 200 yards in

length, with a fall of 30 feet, following the bank of the river, whose general course is from the southeast, though with many windings. Two hundred and fifty yards from the gate we reach three geysers acting in concert. When in full action the display from them is very fine. The waters spread out in the shape of a fan, in consequence of which they have been named the "Fan" geysers. A plateau opposite the latter contains fifteen hot springs, of various characteristics. Some are of a deep-blue color, from sulphate of copper held in solution, and have fanciful caverns, distinctly visible below the surface of the water. The openings at the surface are often beautifully edged with delicately wrought figures of scalloped rock. One variety deposits a red or brown leathery substance, partially adhering to the sides and bottom of the cavern, and waving to and fro in the water like plank. The size of these springs varies from 5 to 40 feet in diameter. One hundred yards farther up the east side of the stream is found a double geyser. A stream from one of its orifices plays to the height of 80 or 90 feet, emitting large volumes of steam. From the formation of its crater it was named the "Well" geyser. Above is a fine swamp of cold water, opposite which, and just above the plateau previously mentioned, is found some of the most interesting and beautiful geysers of the whole basin. First we came upon two small geysers near a large spring of blue water, while a few yards beyond is seen the walls and arches of the "Grotto." This is an exceedingly intricate formation, 8 feet in height and 90 in circumference. It is hollowed into fantastic arches, with pillars and walls of almost indescribable variety. This geyser plays to the height of 60 feet several times during twenty-four hours. The water as it issues from its numerous apertures has a very striking and picturesque effect. Near the "Grotto" is a large crater, elevated 4 feet above the surface of the hill, having a rough-shaped opening, measuring 2 by 10½ feet. Two hundred yards farther up are two very fine, large geysers, between which and the "Grotto" are two boiling springs. Proceeding a hundred and fifty yards farther, and passing two hot springs, a remarkable group of geysers is discovered. One of these has a large crater, 5 feet in diameter, shaped something like the base of a horn, one side broken down, the highest point being 15 feet above the mound on which it stands. This proved to be a tremendous geyser, and has been called the "Giant." It throws a column of water the size of the opening to the measured altitude of 130 feet, and continues the display for an hour and a half. The amount of water discharged was immense—about equal in quantity to that in the river—the volume of which during the eruption was doubled. But one eruption of this geyser was observed; its periodic times were not, therefore, determined. Another large crater close by has several orifices, and, with ten small jets surrounding it, formed, probably, one connected system. The hill built up by this group covers an acre of ground, and is 30 feet in height. Five hundred yards to the right, and partially concealed by an intervening growth of pines, stands a cone of white rock 40 feet high, which sends forth puffs of steam from a small orifice at its apex. It has probably been a splendid geyser, but now nearly extinct.

The deposits constantly forming at the mouth of the craters must eventually close the opening, necessitating the discharge of the water at some other point, and the geyser then becomes either a warm spring or a steam fountain.

From the cone a valley radiates westward, in which a number of interesting springs are found, one having a beautiful curbing of rock, built up in delicate scollops of a perfect pattern. Another has a basin

15 feet deep, its sides covered with obsidian pebbles, while a third has its cavity extending beneath the surface of the ground in the form of a cavern. In the timber between the latter springs and the river are found numerous evidences of extinct geysers. The rock is of the same formation, and broken here and there into sharp ravines and fissures, from whence steam and heated gases are constantly issuing. Two hundred yards above the "Giant," and near the river bank, is found a fine hot spring of deep water, 15 by 25 feet in diameter. Between the latter and the river are six small steam jets, with bubbling water beneath. Immediately opposite, on the east bank, is a broad plateau containing five large and small springs, and two boiling springs, one of the latter 40 feet in length. This throws a fountain from one end to the height of 60 feet, at irregular intervals, for the space of ten minutes. Just above the latter, on the edge of the river's bank, are three minute springs, furnishing pretty rills a few inches wide, rippling in tiny cascades through tinted channels down to the river, some 5 or 6 feet below. A hundred and fifty yards west of this are seven hot springs, from 10 to 20 feet across. In the river at this point is a small island, 100 feet in length, with a few pine trees at either end. Between the foot of the mountain and the river the east plateau widens out to 600 yards. Near the large bend in the river, on this plateau, sheltered by a small grove of pine, our camp was located. To the east is situated a very large blue spring, deep and clear, and in the vicinity are found numerous small holes, some bubbling, many discharging steam, and others quiescent. At the base of the mountain, farther south, is situated the "Comet" geyser, which gave us the grand display soon after reaching the basin. The crater of this geyser is very beautiful, though but slightly elevated above the general slope of the plateau; it might easily be overlooked, should it not happen to play during the visit of an examining party. There are three openings, all of which are apparently connected with the reservoir below. One, a very small aperture, emits puffs of steam similar to the exhaust-pipe of a steam-engine. The large one, in the center, 6 feet across, boils violently during an explosion, but does not throw water to a great height.

The third opening is the geyser proper, from which a towering column ascends to the astonishing height of 200 feet. It is 12 by 18 inches in diameter, somewhat narrowed as it descends, and is of great depth, smooth and straight. These cavities are all lined with delicate deposit of rock, beautifully enameled with silica, in appearance as delicate as frost-work, but hard and strong, requiring the assistance of a hammer to detach fragments obtained as specimens. This deposit usually assumes a spherical form, the outer surface being incrustated with minute beads. Just south of this geyser are three large hot springs nearly in the same line. Near the river's bank, on this part of the plateau, are found eight hot or boiling springs, differing in temperature and appearance. One of these occupies the extreme point of a projecting promontory, and is in a state of constant ebullition. It deposits a saffron-colored crater 6 feet in diameter, of rare intricacy and beauty. A small one close by, 6 inches across, bears a strong resemblance to a shell. Opposite the latter is a small pearly-gray spring, 4 feet in diameter. Above the promontory the river flows to the northwest for 300 yards, above which point it again changes its course. The second point is marked by an old water-worn cone, fast crumbling away. Between camp and the large blue spring to the eastward is a curious mud-spring, the surface of which is 4 feet below the ground. It is 4 by 6 feet in diameter. The mud is a fine variety of blue clay, boiling-hot. A

curious system of steam jets issues from the marshy ground just beyond. Directly opposite this and across the river is a violent little boiler, constantly shooting up water to the height of from 3 to 6 feet. Between the two angles of the river, deep, wide channels are being worn in the surface of the rock by streams of hot water flowing from the "Comet" geyser above. The second angle is also a promontory, and contains two geysers near its extreme point; also two large boiling springs, having saffron-colored curbs, rising several inches above the surrounding rocks.

Covering an acre and a half between the "Comet" and the river is a system of fifteen geysers and eight hot springs, varying from 6 inches to 6 feet in diameter; one of which is usually in action, there being scarcely a moment when all are quiet. Two or three of them are very beautiful fountains, with perfect basins of pure white rock, almost as fine as alabaster, while graceful jets of water shoot from their centers, 20 to 60 feet in height. A yellow stream from one flows through a golden-colored channel, from its orifice to the river. Exactly opposite the second promontory a small cone, 5 feet high and 6 feet in diameter, emits a steady flow of steam. Across the river, and 10 feet from its edge, an active geyser is seen, its crater 3 feet by 6 at the surface, and lined with a saffron-colored deposit. One hundred and fifty yards west of this spring, situated upon the crest of a hill, 40 feet above the river, is located the largest and most imposing crater in the basin. Its resemblance to a ruined castle or tower is wonderfully striking. In ascending this hill to the castle-crater the surface of the rock is found to be much broken, crumbling away and worn into channels by the water flowing from the geyser during its periods of action. The base of the castle-crater, on the east side, is 20 feet above the slope of the hill, and, on the west, it is even with it. It is 325 feet in circumference, and composed of partially disintegrated strata of calcareous rock.

The turret on the tower is 125 feet in circumference, and rises 20 feet above the base. Broken and crumbling masses of rock at the top give a good idea of the battlement turret. The whole structure is graceful in its proportions and details, resembling an old castle somewhat dilapidated. Even the appearance of port-holes is given by small apertures at several points in the turret and base. This geyser has frequent periods of eruption, throwing off a large quantity of steam. The discharge of water is not great, being but a small stream rising to the height of about 60 feet.

At the base is another crater, 8 feet across, having a probable connection with the main vent, and serving to decrease its force. Another small jet is found about 10 feet distant. Fifty yards east of the castle-crater is a beautiful deep spring of very hot water, of great depth, having a raised and scalloped rim a few inches in height, and 20 feet in diameter. This cavity contains perfectly transparent water, though of a blue color, and appears to be a hundred feet in depth. A sounding-line was found to descend 45 feet. Several small steam vents are found near this spring. To the eastward, and lying between the castle and the extreme end of the valley, the ground is swampy and incloses a lake nearly 75 yards in length. The plateau on the eastern side of the river rapidly converges to a point between the river and the timbered hill-side. Here a small stream comes in, fed from a large spring in the mountain-side a half mile to the east. Crossing the stream, another large geyser system is found, and consists of a hill 50 feet high, deposited from the waters of four geysers, situated close together upon its conical apex. These craters are elevated a few feet above the general surface of the

crest, and are in a constant state of ebullition, sending forth clouds of steam, and, occasionally, jets of boiling water. One hundred yards to the south is a small hill, containing but one crater at its summit, very irregular and intricate, and leading to an immense cavern beneath the hill. The waters below are quiet. This spring has probably undergone a change from a geyser to a simple hot spring. In time the dome above will crumble and fall in, revealing one of those deep-blue hot springs so numerous in the geyser basins.

Between the two large hills are three small active hot springs, or geysers, from 1 to 3 feet in diameter. Fifty yards beyond bubble and sputter five or six others of about the same magnitude. In this part of the basin new springs are apparently forming; the crust is thin and brittle, rendering investigation somewhat difficult. Here is a large spring of very irregular shape, about 60 feet in diameter, with a thin crust extending several feet over its edge. Passing east and leaving the river 200 yards to the right, several small bubbling springs are found, while upon the crest of the next hillock, 150 yards distant from the group of four geysers called the Chimneys, is another dead geyser, having a high dome and crater, which covers a quiet spring below. Continuing east, over a thin treacherous crust, a fine boiling spring is found on the left, and on the crest of another elevation; fifty yards farther is an active boiler, 6 by 10 feet across, with a curbing 1 foot high and 3 feet thick built around it. On the same hill, and forming with this geyser the angle of a triangle, are two other deep springs, with craters, one 5 by 12 feet, the other 20 by 30 feet. One of these three is the Giantess, described by Lieutenant Doane as the most astonishing geyser in the basin. It did not play during either of the three days my party was in the valley, although it may have done so in the night. I am almost certain it played the last night of my stay, as I was awakened by the eruption of the "Comet," and heard, during its action, heavy concussions accompanied by vast bodies of steam rising from some point in its direction. Although the rock about this spring shows none of the bead-like deposit that is usually found at the geyser craters, yet from deep and wide channels reaching off to the river it may be inferred that heavy streams must at times flow down its surface. Eighty yards east of this group is a deep spring, 6 by 8 feet at the opening, filling a rocky cone 20 feet high and 400 feet in circumference. This has been a violent geyser, but seems to be so no longer. The cavity beneath is very wide, extending in all directions. The covering is of rock, a thin surface, in the form of a dome. There are a great many other springs in this part of the valley, a description of which would be nearly a repetition of what I have said regarding others. No two, however, are exactly alike. One large spring has a natural bridge across it in the center, the rock on either side having broken through.

The banks of the river here are steep and high, and have been elevated by the deposits from several springs still flowing, the water from which trickles down the sides in pretty rills of variegated colors. Upon the opposite, or western, side of the river, some three hundred yards from its bank, stands one of the most interesting craters of the entire basin. This magnificent geyser is the last of the system on leaving the valley to the south, and is situated upon a high eminence overlooking nearly its whole extent. The hill has been built up nearly a hundred feet above the river. The crater is a wonder of beautiful formation, rising by successive steps, or terraces, from its base, 480 feet in circumference, to a central apex 18 feet higher, where a huge fissure in the rock, 2 feet by 7, allows the escape of steam and hot water in a jet of grand

and beautiful proportions. The formation of the surface of the upper part of the hill is a net-work of beads deposited upon curved surfaces of intricate design and beautiful coloring. The lace-maker might here find designs for his most exquisite fabrics in the delicate tracing formed round the edges of numerous pools of hot water, renewed every fifty minutes by the action of the fountain. These little pools are but a few inches in depth, are of various sizes, and lined with delicate gray on saffron-tinted porcelain. Around their edges are wrought shell-shaped scollops, which project over the water, having usually a contrasting color with the lining of the cells beneath. This deposit, so delicate and frail in appearance, is really as hard and strong as marble, and can be walked upon without injury. The opening of the crater is also very beautiful, formed of spherical masses of beads cemented together, and having the color of ashes of roses. These beautiful incrustations, from 12 inches to 4 feet in diameter, half way surround the crater, presenting a very beautiful aspect. The continuation of the aperture may be traced for 20 yards along the crest of the ridge, eastward, although now almost entirely closed up. Between its periods of action the crater remains empty for some time, but emits quantities of steam, with a rumbling and hissing sound. Just before the display occurs the water rises in the crater, a few convulsive gushes of water are thrown out, when, with an exhibition of mighty power, a column of water the size of the orifice majestically rises to the height of 138 feet. I obtained this measurement during one of its periods of action, though perhaps not its highest. The display lasts for five or six minutes, when the column becomes gradually shorter until it sinks entirely away, leaving a flood of hot water flowing down the hill-side to the river. Near by are two extinct geysers, their cones dilapidated and decaying under the influences of the climate, being no longer renewed by the hot-water deposits; one is entirely dead, while the other still emits some traces of steam from a small aperture at its apex. These cones are 250 feet in circumference and 10 feet high. Looking down the valley to the west, from the crater of "Old Faithful," the view is superbly beautiful, and covers nearly the whole area of the geyser basin, with its thousand steam-jets and graceful fountains scattered so lavishly along both sides of the river, and surrounded with high inclosing hills clothed with rich foliage. No other locality, I think, can be found which combines so many attractions, both of climate and scenery. To the southward is another small valley, through which flows a stream one-half as large as the Fire-hole River, and which it joins two miles below. In this valley are also found numerous hot springs. These are not so remarkable as those already described. Among the most noticeable is a group of eight beautiful springs inclosed in a single rim of scolloped work 140 feet in length. The interior of this basin is lined with a rose-colored deposit. They are found upon the crest of an eminence, the sides of which have become incrustated with rocky deposits in all directions, and extending off into the adjacent forest, whose dead and withered trees bear evidence of the deadly effect of the hot water which has flowed among them.

Lieutenant Doane, from Fort Ellis, overtook my party while in this valley, bringing orders for the return of the general escort, except the six men previously detailed to accompany me, and six others, with Lieutenant Doane in command, who were to remain with Dr. Hayden's party. As we had seen no signs of Indians, this escort was considered quite sufficient. I had remained a day longer in this basin than I had at first intended, hoping to again witness a display of the Comet geyser and to obtain a photograph of this wonder, and also its exact height. I was

disappointed, however, as the periods of action, after the first, occurred in the night-time. "Old Faithful" and the "Giant" were both measured and photographed while in action. By comparing these with the "Comet" the height of the latter can be approximately estimated, and was, undoubtedly, 200 feet.

On the morning of the 8th I resumed the journey up the valley of the Firehole River, intending to reach the Yellowstone Lake and join Dr. Hayden, who had started the day before. The route above the geyser basin soon became very rough; the banks of the river converged to a cañon whose sides were nearly precipitous, and covered with a dense growth of pine springing from among masses of rock. As we were leaving the valley "Old Faithful" gave us a splendid display by way of a parting salute. We followed the eastern bank of the river, as it seemed less densely wooded, for three miles along the edge of a steep, rocky, and entangled cañon. We now came upon two lovely cascades flowing through a wild cut in the mountain. From a projecting rock Mr. Hine obtained a view of this beautiful gorge and cataract. The country gradually becomes elevated as we advance, and thickly timbered with pine and spruce, intersected with mountain streams of pure cold water. About mid-day we passed a pretty little lake, 500 yards long and 150 yards wide, surrounded with high overhanging hills, their wooded slopes extending down to the water's edge. We found game and Indian trails during a part of the way, but as they usually bore too much to the westward we had to select our route across the country by the compass alone. At one time we ascended the back-bone of a sharp ridge, covered with small obsidian pebbles. From the crest of this ridge a magnificent view of the surrounding country was obtained. The summit was 9,500 feet above the sea, and 800 feet above the valley below. Into the valley beyond we now descended, and soon reached the shore of a lake, probably the Madison, some six miles in length by four in width. We followed the stony and narrow beach about two miles, as far as it afforded a practicable footing for the animals. The rocky mountain-side now coming quite down into the lake itself, necessitated our leaving the shore and ascending the mountain to the eastward. After severe climbing, the height was finally gained, and proved to be of about the same elevation as the ridge crossed just before entering the lake valley. After a tedious and weary march, or rather scramble, through thick forests, over rocky ridges and swampy ravines, our course usually to the eastward, we finally reached a more open valley, leading toward the lake. Upon following this for five miles we were gladdened by a glimpse of the lake through an opening between the hills. Night-fall now approaching, the sight of the lake was very grateful. Pushing on with renewed energy we soon heard two shots, somewhat to the left of our route. We changed our course to that direction, and, crossing a spur of hills, came out at Dr. Hayden's camp, near a group of warm springs on the Yellowstone Lake. We had traveled twenty-five miles in the mountains, probably ten miles farther than the direct distance. Here we found some letters, brought by Lieutenant Doane from Fort Ellis.

August 9.—I sent one of the packers and a member of my escort back to Bottler's Ranch this morning, with three pack-mules, for the remainder of our provisions left there on our way up. These men are to return by the eastern shore and meet me in the Upper Valley of the Yellowstone, south of the lake. We are camped at the lake's southwest angle, near a large system of warm springs, and find an abundance of trout in the lake, which, like those previously taken in its waters, contain large white worms, rendering them unfit for eating. The hot

springs here cover an area of forty or fifty acres, and extend 400 yards along the lake shore. They are similar in appearance to those heretofore described, though, in point of magnitude and number, generally inferior to those found in the Firehole basin. Their waters contain salts of iron and silica. One large spring, with an opening 5 feet by 7, is seen beneath the surface of the lake, near the shore, affording an opportunity for warm baths, which some of the party enjoyed. A small boiling spring near the shore is remarkable in having a bar across its opening, dividing the aperture into four equal parts. This arrangement served as a convenient clothes-boiler; the soiled articles being carried under the bar on one side, would come out washed at the other. One hundred yards back from the lake is an exceedingly interesting and intricate system of mud-springs, similar to those found in the Firehole basin. There are twelve or more craters, formed from the deposit of mud, varying in color from that of cream to light pink, the consistency of which is about that of soft putty. On exposure to the air the clay soon becomes as hard as chalk. It seems to be nearly pure alumina, containing small crystals of silver. Besides the active springs, there are found numerous hot-mud pools. There is great variety in the color and temperature of the warm springs forming the same group. This is general in all systems. The iron springs often deposit a reddish-brown substance, in flat sheets, floating on the water, and are generally less warm than the clear blue ones. The lake shore opposite the springs is composed of calcareous rock, brittle and easily acted upon by the waves, which have worn out deep caverns into which the rock is constantly crumbling. Few of the springs in this valley are now boiling, and no geysers are seen, though, from the appearance of several cones, I am led to believe that a number existed here at some previous time. The morning was rainy and clouds prevented astronomical observations at noon. Soon after the weather became clear, and I decided to move camp across the next peninsula and reach before night the rim of the lake beyond. Following the beach three and a half miles and fording two small inlets, the water of which reached the sides of the animals, we left the lake and struck across to the southeast through the forest, finding the timber quite open. We encountered two parallel ridges, between which was a system of small lily-ponds very difficult to cross. They are probably connected with a long, narrow lake still further toward the end of the peninsula. Near these ponds I found Dr. Hayden's trail, who left the previous camp early in the day. The country now became much rougher and obstructed with fallen timber. The slope leading to the lake on the opposite side of the peninsula was found to be very abrupt and the descent somewhat difficult. It was accomplished in safety, and we found ourselves in a charming valley at the head of a sharp arm of the lake, several miles in length, and bounded by high, rocky bluffs on either side, the one beyond rising in a yellow volcanic ridge, fifteen hundred feet above the valley, the upper portion to the north being a sheer precipice.

August 10.—The weather last night was intensely cold, the mercury falling to 26°. The sun coming up bright and warm soon rendered the temperature agreeable. Dr. Hayden and I decided to separate here for a few days, he to take the line of the lake shore, while I purposed moving farther to the west, then following a course fifteen or twenty miles south of the lake, to meet him in the valley of the Upper Yellowstone.

To obtain a view of the country I was about to investigate, I determined to ascend the Yellow Mountain, towering immediately above our

heads. Leaving Captain Heap to move the train in a southwesterly direction up the valley, and with directions to camp on the shore of a small lake supposed to lie about ten miles away in that direction, I, in company with Mr. Wood, set out to ascend the Yellow Ridge. The attempt was made from the north, and proved laborious, owing to the broken nature of the surface of the mountain, and the thick timber growing upon its lower slopes. It required two hours of tedious climbing to reach the summit, which was found to be 1,500 feet above the lake. A fine view, of many miles in extent, to the north and west, was obtained. This mountain forms a portion of one of several promontories jutting out into the lake. The great basin of the Yellowstone Lake lay spread out before me. Several other lakes, three or four miles in diameter, were observed to the west and southwest. There were four of these in sight from this mountain.

I now formed the opinion, which subsequent investigation strengthened, that all these small lakes are tributary to the Snake River, which drains the territory lying southwest of the Yellowstone Lake nearly up to its verge. To the southwest is a very conspicuous mountain, a sharp, bold peak, rising far above all others in its vicinity, its sides whitened with numerous fields of snow, while immediately at its base lies one of the pretty lakes just mentioned. The Yellowstone Lake, with its many indentations and its several islands, was spread out at my feet. The lofty volcanic range of mountains bordering its eastern shore rose almost from its waters, while the valley of the river stretched far away to the north, disappearing behind the "Elephant's Back," forty miles distant. Immediately beneath the mountain was the long narrow arm of the lake, at whose extreme point we had camped the night before, while just beyond lay the broad peninsula which we had so recently crossed; its two ridges and the inclosed lake and ponds were plainly visible. The descent to the southwest was difficult, over masses and fragments of volcanic rock, sharp and in some places treacherous to the tread, greatly demoralizing the horses, which were of course led and sometimes driven down the worst places. Before reaching the trail of the party we encountered, in the valley below, dense masses of fallen timber. It was near this valley, last year, that Mr. Everts became bewildered on losing his horse, and wandered for thirty-eight days in the great basin before being picked up, subsisting upon roots and insects. The trail, after it was found, was not very plain, being so greatly scattered in some places that it was almost impossible to trace it. It led over a low divide, separating a small stream upon which we had camped, and which flows into the Yellowstone Lake, from the valley, descending towards the south, and whose waters flow into the Snake River. This valley eventually joins another coming in from the northwest, through which flows a warm creek supplied from a large group of springs along its borders. This stream is 20 feet across, 18 inches in depth, and empties into the small lake at the base of the high snow-covered mountain seen in the morning. The lake is about five miles in length and three in breadth; and from its shape is called "Heart Lake." Here I found the remainder of my party except Mr. Hine the photographer, and one enlisted man. These two had gone back upon the trail of the previous day to find the tripod of the camera, which was missed on arriving in camp.

August 11.—Mr. Hine did not come in during the night. I fear that he was unable to follow the trail and has therefore returned to the lake. I directed one of the best men of the party to go back there and show him the way to this camp. Taking Mr. Prout with me, I climbed

the mountain near whose base we were encamped. Just at the foot of this mountain, near the lake shore, are four or five boiling springs, one of which is a geyser of considerable importance, throwing jets of water, at frequent intervals, to the height of 15 feet. The mountain is well timbered about half way to its top, the remaining portion of its slopes being bare, broken masses of rock, in many places rising in vertical walls of several hundred feet. We succeeded in taking our horses 1,600 feet above the lake; then leaving them at the base of a nearly precipitous ascent, several hundred feet in height, climbed to the summit without their assistance. Soon after leaving the horses I was obliged to abandon my carbine; the steepness of the acclivity requiring the aid of both hands. The rock of which this part of the mountain is composed was constantly disintegrating and sliding away in avalanches to the valley below. Immense fields of snow filled the gorges of the mountain, from which flowed icy-cold streams in torrents through the lower ravines. In reaching the summit, which was 3,000 feet above our camp, a wide stretch of country was visible in every direction. This mountain occupies about the center of the great basin. On the opposite side of the crest is a line of peaks, forming with this one nearly a circle round an immense conical valley, having the appearance of an extinct volcano.

The most striking object seen from this point of observation was the Teton range of mountains to the southwest, about sixty miles distant. This range rises high above the broad extent of intermediate country, which is drained by the numerous tributaries of the Snake and the Madison, and extends southward in an almost unbroken wall of steep and rocky cliffs, terminating in three sharp spires, so tall and slender that one is reminded of the mast of a ship. To the north the Yellowstone Lake, the mountain ascended yesterday, and the valley at its foot, were all distinctly visible. The outlets of the numerous small lakes in this portion of the great basin seemed to flow to the southward into the Snake River. The geology of this region is volcanic.

I gathered several specimens of rocks from this peak to take back with me. The western slope of this mountain is wooded with a scraggy growth of dwarf pines, bent nearly to the ground by the force of the west winds, and extending up the slope to near the crest, terminate in a line exactly parallel therewith. I passed westward along the connecting ridge to the nearest adjacent peak, where additional observations were taken. A fierce storm was now gathering among the peaks of the Tetons, which would probably soon cross the valley in this direction. I therefore determined to return to camp, descending obliquely across the face of the mountain, over immense tracts of snow, lying in some instances 1,500 feet below the summit. These snow-fields do not probably entirely disappear during the summer, and are replenished again early in September. This mountain I have named Mount Sheridan.

Aner, the man sent in quest of Mr. Hine and private Lemans, returned without finding any traces of them. I was now a good deal alarmed for their safety, and determined to dispatch the whole available party early in the morning in search of them. The night came on wet and gloomy, an unpleasant prospect for men lost in the forest.

August 12.—After a stormy night, the morning proved wet, cold, and dreary, with torrents of rain still falling. The day was spent in an organized search for the two lost members of our party. Captain Heap, with two men, went back upon the trail to the old camp, with directions to follow their tracks, if possible, until they came up with the men. With

two others I took a northwesterly course across the country, hoping to find their trail, on the supposition that they had gone to one of the lakes in that direction. I followed the valley of the warm creek flowing into the lake near our camp. This stream has a rapid descent for two miles, and is fed by hundreds of hot and boiling springs of the same general character as those previously described.

I saw some traces of sulphur, and also indications of geysers, though none were playing. Through the day we had cold and sleety rains with occasional squalls of snow or hail. Continuing round the mountain to the lake lying at the foot of its westerly slope, I examined the beach carefully for signs of the lost people, but found none. This lake is about four miles in length, north and south, and two in breadth; is pear-shaped, with an outlet at its southern extremity. After continuing the search until near night, without finding any traces whatever of the lost men, it became evident that they could not have wandered so far away from the previous camp, and that the other party would probably find them. This supposition proved correct, as upon returning to the camp I was greatly relieved to find the whole party assembled again; the lost men having been recovered by Captain Heap's party at the other camp, to which they had just returned, after wandering two days in the woods. They had suffered very little, having killed a deer the second morning, which supplied their immediate necessities.

The following four days were occupied in making a circuit from this point around to the valley of the Upper Yellowstone. During this journey the route lay entirely among the various tributaries of Snake River. The ridges were invariably timbered, except the highest peaks, which were bare and rocky. The valleys, in many places, spread out into fine meadows, but were often contracted to narrow cañons, with steep and rocky walls, rendering their exploration difficult and often impossible. The first day but eight miles were made and our camp located at the confluence of two fine branches of Snake River, their united currents flowing to the southwest. This was a trout stream, the fish being very excellent, though shy and difficult to catch.

A broad swampy flat, covered with willows, extends across the angle formed by the two streams, with very little good grazing. The next day we followed down the stream to the southwest for about three miles, to its junction with another branch joining it from the east. We then followed up the valley of the latter, which led in the direction of a prominent mountain, from whose summit I obtained an extensive view of the country far to the eastward. To the north of this mountain lay a sharp ravine, from which ran the branch of Snake River which we had left that morning, and flowing nearly due west at this point. Farther up, to the eastward, the valley of the stream widened out into a beautiful meadow, which point I proposed reaching that afternoon. While I was making these observations, however, the train passed directly across the ridge into the valley below, where it went into camp for the night. This was a mistake, by which I lost the trail and nearly cost me the unpleasant experience of spending a night alone on the mountain, for, upon descending from the summit, and after searching for the trail in the direction I supposed the train had taken, and finding no traces of it, I was beginning to realize that either the train or I had become lost. Just then I observed a light smoke curling upward from the deep ravine three miles below. This served to guide me to the camp.

While upon the summit of the mountain, which I named Mount Hancock, I enjoyed an unparalleled view of a vast extent of country, bounded by the Gallatin Mountains and "Elephant's Back" on the

north, the Yellowstone range on the east, the Wind River range on south, and the Tetons on the west. Thus the whole of the great basin was in view from the same point. The summit of the mountain, which is 10,400 feet above the sea, is composed of large masses of lava, as sharp as though just broken, and showing no signs of disintegration.

From our camp, at the bottom of the ravine, we proceeded up the narrow valley of the creek upon the following morning, finding the trail exceedingly rough, winding over projecting mountain-spurs and frequently disappearing in the forests. We were often obliged to follow low the rugged bed of the stream at places where the nearly vertical walls of the cañon were inaccessible. The bed-rock of this stream is fine gray sandstone, and resembles the Ohio building-stone. The stream is one of the principal branches of Snake River, has a rapid current, and is subject to severe freshets. At this season it was about 200 feet broad, and generally about 12 inches deep. The banks are from 1,000 to 1,500 feet in height and densely wooded, principally with spruce and pine. Traces of bituminous coal were found along this stream. Six miles of rough traveling brought us to a much higher elevation, where the ravine widened out into a fine valley, the same that I had seen from the top of the mountain the previous day.

From the ridge upon the left I obtained a view of the Yellowstone Lake. This ridge seemed to be the divide between the waters of the Yellowstone and those of the Snake. A small pond which I observed upon the ridge, when full to overflowing, would probably furnish water to both rivers. This ridge is about 1,500 feet above the lake and twelve miles distant to its nearest point. A column of smoke was observed several miles to the northeast arising from burning forests, showing the whereabouts of Dr. Hayden's party.

The animals of my train, particularly the horses, were now becoming a good deal worn, showing signs of breaking down, while the mules were severely afflicted with saddle-galls. The condition of the animals made short daily marches necessary, though the grass was generally good and water abundant. Continuing eastward we crossed some very fine valleys on the 16th, and began the descent of the mountain range separating the waters of the Snake from those of the Upper Yellowstone. This range, upon its lower slopes, is thickly timbered, though by following the crests of radiating ridges less timber was encountered than in the ravine. Glimpses of the Tetons were observed to the southwest from time to time, though until the crest of the ridge was reached but little of the surrounding country could be examined, owing to the intervening timber. On reaching the summit, however, some 1,100 feet above the last camp, the view in all directions was grander and more impressive than any I had before seen. I was completely surrounded with wild mountains, whose sides were precipitous rocks 1,500 to 2,000 feet in height. The valleys were cañons. The summits of the mountains spread out into rolling prairies in many places, bearing grass and flowers. Small lakes were seen at frequent intervals, their waters supplied from immense fields of snow, which undoubtedly remain during the entire summer. Signs of game abound, among which were found tracks of the grizzly and the black bear, mountain-sheep, elk, and deer.

Descending the valley to the east we found a small cold stream flowing northeast, which joins the Upper Yellowstone a few miles below. Here we went into camp, and with Mr. Prout I ascended the opposite mountain on foot. This proved to be a spur from a vast plateau reaching back to the south, between two branches of the Upper Yellowstone. From this plateau the Teton range to the southwest was distinctly

visible, also a high basaltic wall on the south and east. To the northwest a distant view of the Yellowstone Lake was obtained, through a gap in the mountains. To the northeast stood a remarkable tower, crowning the crest of a very high mountain and bearing a striking resemblance to a castle. The valley to the north is a broad open plain, nearly level with the Yellowstone River, winding among masses of dense willows. A small sheet of water, which is called Lake Bridjer on the old maps, was seen in this valley. Returning to the camp across the plateau we encountered a large grizzly bear and cub. Not being armed or mounted we made a safe detour of the monster, and returned to camp.

On the 17th we moved down the valley, over a swampy and difficult country. The stream rapidly descends over a rocky bed, and finally plunges through a cañon, by which it enters the valley of the main river below. Passing to the left of this cañon, and descending a steep but thickly wooded terrace, we entered the valley of the Upper Yellowstone. This valley is nearly level, surrounded by conglomerate rock, so worn by the elements as to give them the appearance of basaltic formation. From this point to the Yellowstone Lake the distance is about eighteen miles, the valley being two and a half to three miles in breadth. The river here is, however, half as large as the Yellowstone below the lake, and is formed by the junction of five streams, which unite their waters near this point.

This part of the valley I named Five Forks. Between these streams are radiating mountain spurs rising 2,000 feet above the valley, adorned with upright columns and projecting terraces of great architectural beauty. Crossing the valley are several broad trails, which, it is said, were formerly used by the Indians in passing from the head-waters of Clark's Fork, on the Stinking River, to the valley of Snake River. It was my intention to have explored at least the principal branch of the Upper Yellowstone as far as practicable, but the condition of the animals was now such that I feared they could do little more than make the return march to Fort Ellis. Our provisions were just exhausted, but the arrival at this point of fresh supplies, sent for from the west side of the lake on the 9th instant, relieved my anxiety in that respect. These stores would, however, be no more than sufficient to last us to Fort Ellis, traveling as slowly as the poor condition of the animals rendered necessary.

From observations on the march through these mountains, and from information derived from the packers who accompanied me, I am led to believe that a practicable road possibly a railway can be constructed from the Yellowstone Lake south to Snake River on the direction of the Tetons. The connection, however, of the valley of the Upper Yellowstone with that of the Wind River would be attended with great difficulties. An attempt to follow the Yellowstone to its source, then to cross the lofty range of mountains separating it from the Wind River, would, I think, with pack-animals in good condition, be attended with success; and although no pass through this range in this vicinity has yet been discovered, it is possible that a narrow one may exist. A glance at the map will show a natural route for a railroad, connecting the Pacific lines, by way of Wind River, to the Yellowstone, were it not for the difficulties to be met at this one point.

The 18th and 19th were passed in marching from the valley of Five Forks down the Upper Yellowstone to its mouth at the lake. This valley becomes wider as we descend, and continues nearly level, the river winding from side to side among dense willows and swamps, and rendering it necessary in traveling to keep along the base of the mountain

The hills and the mountain-slopes above are all thickly clothed with timber. The small streams flowing into the river were invariably obstructed with numerous beaver-dams, which form a continuous chain of ponds through the smaller valleys. About half way down the valley I descended the ridge to the east, crowned by the castle-topped summit above mentioned. The walls of this rock were about 400 feet in height, vertical, and in some places inclining outward. I spent an hour trying to find a fissure through which I could ascend to its top, but without success. The elevation of the mountain at the base of the tower is 2,000 feet above the valley. The height of the loftiest pinnacle of the tower is probably 10,500 feet above the sea. The rock is composed, for a distance of 20 feet above its base, of conglomerate, the same as the material of the ridge below, while farther above are strata of fine hard sandstone, the extreme top being of lava. In the east side were two large caverns with arches supported by a pier of fine proportions. A rain-storm now coming on, I descended the mountain (this mountain was named Mount Humphreys) and encountered a small lake on the way. The storm increased, rendering the passage through thick undergrowth anything but pleasant. I finally reached camp on the lake-shore just beyond the mouth of the river, thoroughly drenched.

August 20.—We experienced last night the singular sensation of an earthquake. There were two shocks, the first one being quite severe, accompanied by a rumbling and rushing sound. The morning broke clear and bright. I was anxious to overtake the other party, which had already moved northward. I learned from Barouch, who brought up my supplies, that the doctor's party were now probably near the outlet of the lake, twenty miles beyond. As this distance would be a long day's march in the present state of the animals, I concluded to divide it into two marches, and started at 1 o'clock with the intention of moving about eight miles on that day. Leaving the train in Captain Heap's charge, to be conducted along the shore of the lake, I ascended the mountain-slope rising to the east. Upon this slope I found numerous evidences of warm sulphur-springs, though none which were particularly noteworthy. In overtaking the train six miles from camp, I learned that the party were laboring under great excitement regarding Indians, the feeling being that a considerable party were in our vicinity, but were concealed in the forests awaiting a favorable opportunity to attack us. Although I had little apprehension on that score, having seen no evidence of Indians whatever, I deemed it prudent to continue the march along the lake-shore, and make a junction with the other party as soon as possible. This march was made hurriedly. The country was not, however, remarkable, being thickly timbered and rising rapidly from the lake to the mountain range beyond. Several streams, of no great magnitude, rising in the mountain range, were crossed during this day's march. We found the doctor's camp within four miles of the outlet of the lake, situated near a small rocky promontory called "Steamboat Point." This name is derived from a large and violent steam-vent, throwing out a vast volume of steam in heavy and regular concussions.

August 21.—Remained in this camp during the day, allowing the animals to rest after their hard march of the day before. A small party returned upon the trail to recover a mule which had strayed from the train yesterday. In this search they were successful, and returned with the mule toward night. Besides the large steam-vent, which is the distinguishing feature of this locality, there are many smaller ones and several sulphur springs. The rock is of volcanic origin, immense

masses of which are distributed in wild confusion along the shore. Frequent earthquake-shocks were felt by the party while at this camp. At such times the large steam-vent became more active, sending forth increased masses of steam with the roar of a cataract.

On the 22d I left Dr. Hayden's party continuing their geological investigations at Steamboat Point, and moved down the east bank of the Yellowstone as far as the falls. The course lay along the lake beach for about two miles, upon which I gathered several interesting specimens of mineral. Leaving the beach, we crossed a small prairie to the northwest, and entered a dense wood. Here the fallen timber delayed our march about ten hours. Beyond this we crossed Pelican Creek, a small stream coming in from the northeast. Beyond this stream I found the country more open, with occasional groves and parks of meadow-land. On reaching the bank of the Yellowstone a fine broad trail was found, upon which, through shady avenues of pines, our train traveled without difficulty. About 1 p. m. we arrived opposite the mud-springs and volcano, seen on our route up the river. The volcano was still sending forth its vast columns of steam far above the surrounding hills. Here on this side were several small rills of icy cold water, pouring from the side of the mountain in rapid streams as from a hydrant. On reaching the falls we went into camp on a small grassy plateau, fifty yards from the brink of the upper fall, and immediately above the rapids. Just below the fall I descended to the bottom of the cañon, 200 feet in depth. In this little cañon, just between the upper and lower falls, were caught some very fine specimens of trout. During the night the concussion caused by the falling water reminded me of the earthquakes felt on the lakes a few nights previous.

August 23.—I determined to remain over here to-day for the purpose of exploring the grand cañon below the lower falls. I expected this to be an undertaking of great difficulty, and attended with some danger; but entering a sharp and narrow gorge or fissure in the side of the cañon, immediately below the great fall, I found the descent much easier than was anticipated. It proved to be very steep; but the rock being solid, with projecting angles, there was little danger to a careful climber. A slope of loose and finely broken rock, a hundred feet in height, moist from the falling spray, terminated the descent. Sliding to the bottom of this slope, I stood on the foot of the great fall, 350 feet below its crest, the walls of the cañon rising 700 feet. My first impression on beholding this fall from below was one of disappointment; it did not appear as high as I expected. The fall, however, was grand, and presented a symmetrical and unbroken sheet of white foam, set in dark masses of rock, while rainbows were formed in the spray from almost every point of view. The steep rocks near the falls, constantly wet with rising mist, were covered with vegetation of an intensely green color. The river below runs with the velocity of a torrent, rushing down declivities, spinning round sharp angles, and dashing itself into spray at every turn. The walls of the cañon are composed of soft disintegrating rock, the prominent color being yellow, intermixed with various shades of gray and red. The rocks are constantly crumbling down, leaving steep ridges and sharp pinnacles hundreds of feet in height, standing out from the walls. I found it impossible to follow the bed of the stream, the steep and slippery side affording no footing whatever, and crumbling at the slightest touch. A view of the cañon from any point is very impressive, particularly so from the foot of the great fall. After ascending from the cañon I followed its eastern crest several miles down, finding that the depth increased rapidly, owing to the rising ground on approaching the cut through the "Elephant's Back,"

and also to the descent of the river, down numerous cascades along its channel. The views at all times were grand and magnificent.

August 24.—We have suffered a few days past from the buffalo gnat, a small fly, which attacks men and horses, causing severe swelling and itching. We encountered them in the greatest numbers near the outlet of the lake, and brought some of them with us to this camp. They are the first insects that have given us serious annoyance.

From our camp at the falls we struck across to the northeast toward the valley of the East Fork, making only nine miles the first day, owing partly to a late start, caused by the straying of several animals just before packing. Our course was along the valley of "Sour Creek," so named from its perceptibly acid taste. The country was at first generally open, though soon after passing a ridge and valley covered with steam jets the hills become more heavily timbered. On reaching a fine valley with cold streams coming in from the southeast, I went into camp for the night, and early on the morning of the 25th resumed the march toward the East Fork, continuing in a northeasterly direction. Very little was known of the intervening country, though it was generally understood that a high mountain range would have to be crossed; that there were deep and rugged ravines, with masses of heavy timber to be passed through. The animals were nearly worn out, and I almost regretted this detour from a straight line to Fort Ellis. We followed up for two miles a branch of the creek on which we had encamped, through groves of spruce, with open parks at intervals. The whole region is filled with signs of warm-spring formation and brimstone basins, with occasional swamps of volcanic mud. On leaving the open valley the wood abounded with game-tracks, several elk and deer being seen just in advance of our train. We now entered a forest of fallen timber, and ascended a high ridge about 800 feet in elevation, thence across a swift stream flowing over a bed of yellow lava.

Beyond the next ridge was found another pretty stream, having a white chalky bottom. Both flow into the grand cañon of the Yellowstone. Steaming sulphur-jets were discovered on the banks of White Creek. We now began the ascent of the mountain-chain, following up the valley of a small cold stream coming in from the east. The banks on either side of this valley are 800 feet in height. This ravine led far up the ridge, where, after climbing a short steep ascent, we found ourselves on the crest of the divide between the Yellowstone and the East Fork, 10,000 feet above the sea and 2,000 feet above the valleys of these rivers. The descent of the valley of the East Fork was over a rolling country, a good deal cut up by ravines and water-courses. The distance from the crest of the ridge to the valley was about six miles, and the difference of elevation 2,300 feet. The last two miles were very steep and rocky, and severely worried the animals. The horse of one of the escort gave out before ascending the crest of the divide, and had to be abandoned. We entered the valley at the junction of two branches of the East Fork, one coming in from the east, the other from the southeast. The valley at the forks of this stream is four miles wide, and is a rolling prairie, with groves of trees and thickets of willows along the river banks. The larger branch forks about three miles up, and still a few miles above breaks into numerous small streams, finding their sources in the high mountain range to the east. Many peaks of this range are distinctly seen from this part of the valley. They are very conspicuous, rising probably more than 12,000 feet above the sea. I expected to have met Dr. Hayden's party in this valley, but saw his train depart down the river just as I descended the mountain. Numér-

ous bands of antelope were seen skipping over the prairie while we remained in the valley.

August 26.—I had intended sending the train down the valley and across the Yellowstone River to-day, while I would overtake it, after ascending one of the mountain-spurs in this vicinity for observations upon the surrounding country. But as the morning broke dark and rainy, the latter part of my plan was abandoned, and I accompanied the train on its march down the valley. We kept along the foot of the hills, on the southern side of the river, avoiding swamps and stony places nearer the stream. The valley is from two to five miles wide, the soil generally poor, except immediately along the river's banks, where many of its terraces are fertile, and would probably answer well for general farming purposes. The mountains on either side continue down to the Yellowstone Valley, though broken by ravines, through which issue small mountain streams. The largest of these joins the East Fork near its mouth, coming in from the northeast, and is called "Slough Creek." We crossed the Yellowstone upon the bridge noted on my route up the river, and halted near the old camp at Meadow Brook. Here the tents were pitched and we remained over the following day, allowing the animals to obtain food and rest. Two packers crossed the river and returned the next day, bringing with them the carcasses of an elk and deer. We were now provided with fresh meat for the remainder of the journey.

August 28.—We set out upon the return to Fort Ellis by the same trail over which we passed more than a month ago. Ascending the mountain's side, familiar objects met the view at every step. We soon reached the little cañon at the crest of a mountain 1,400 feet above our camp of Meadow Brook. Making a cut-off here, we passed over a hill literally covered with agates, many beautiful specimens of which I gathered as I passed along. Thence across Black-Tail Deer Creek, down the cañon of Gardner's River, and, arriving at the "Soda Mountain," camped at the foot of its eastern slope, in a small ravine containing a spring of cold water. A luxurious bath-tub has been hollowed from the slope of the rock, having both hot and cold water conducted to it, in which I took a delicious bath. My impressions of this mountain of springs, formed a month ago, were not quite realized now; still, it is very beautiful, and should be classed among the first natural curiosities of this region. As we passed down the valley the following day, to the little cañon of the Yellowstone, the trail seemed very easy. The hill-sides are barren, the grass dried up, and the contrast from the luxuriant vegetation of the lake basin was very marked. All the objects were very familiar; the Devil's Slide, its parallel walls extending out a hundred feet beyond the mountain's side, and rising upward 800 feet or more. Further on the trail winds along the river's bank, passes lake "Seven," and descends into the cañon, where we camped on our route up. I passed by this spot and entered the farther valley, hoping that the grass there would be less withered, it being traversed by a mountain stream. We here halted for the night. Another of the horses which had been failing for several days, was abandoned a few miles back, near the "Devil's Slide." Our progress was not rapid on the return, owing to the exhausted condition of the animals, and we could make but twelve or fifteen miles a day. It was fortunate that the route was not extended further, for in that case I should have lost several more horses. The mules endured the march much better, and, had they not suffered from sore backs, caused by too narrow saddles, would have returned in as fine condition as when they started. The horses were too large for such service; ponies would have endured the hardships much better.

Another day's march brought us to Bottler's Ranch, and in two more we reached Fort Ellis, where we arrived about noon on the 1st of September.

Through the courtesy of Major Forsyth, quartermaster at Fort Ellis, I visited with him the Crow Indian Agency on the Yellowstone, thirty-five miles from Fort Ellis. The entire Crow Nation and a portion of the Nez Percés had just come in to receive their annuities from Major Pease, the agent of these Indians. The agency consists of a large stockade containing several store-houses—quarters for the agent and his assistants, the trader, and interpreter. A school for teaching the Crows has been established under the charge of Mr. Ainsworth. The Crow Nation numbers about three hundred lodges and musters eight or nine hundred warriors. The men are generally fine-looking, tall and straight, many of them six feet in height. The "Iron Bull," one of the most important chiefs, is a good-natured and genial fellow, and was not afraid of having his photograph taken. Several of the others submitted to the ordeal also, but most of them had superstitious ideas against it. We forded the Yellowstone, going to and returning from the agency, at one of the several fords which are found about seven miles above it. These fords are all difficult, the current of the river being very swift and the bottom covered with large boulders. At this season the depth was about three feet at the fords. In high stages of the river a ferry is used.

Immediately after my visit to the Crow Agency I bade good-bye to Fort Ellis, where I had been most kindly received and hospitably entertained by Brevet Colonel and Major E. M. Baker and the other officers of the post.

I left Fort Ellis on the morning of the 6th, taking the stage for Helena. I followed the general course of the West Gallatin for twenty miles to Gallatin City, at the junction of the three forks, viz, the Gallatin, Madison, and Jefferson rivers, which unite at this point and form the Missouri. Beyond, the stage-road passes over a rolling country in a westerly direction, the Missouri appearing in view at several points along the route.

Eighty-five miles beyond the Gallatin I reached Helena, arriving there in the evening. This city, like all mining towns, grew up by accident, and is crowded into a narrow gulch at the foot of the mountains. A fine open country stretches northward to the Missouri River. I remained over here one day and visited the gold mines at Unionville, a few miles farther up the gulch. These mines are in active operation, and, to judge from the amount of treasure carried over the stage-line to Corinne, they must be yielding good returns. Leaving Helena on the 8th, a tedious stage-ride of four days and nights brought me to Corinne, when I immediately took the cars to Chicago, where I arrived on the 15th of September.

REPORT OF CAPTAIN D. P. HEAP.

HEADQUARTERS DEPARTMENT OF DAKOTA,
Saint Paul, Minnesota, January 23, 1872.

CAPTAIN: Agreeably to your request of January 13 I have written a concise account showing generally how the survey of the country explored by us last summer was conducted.

Owing to the fact that everything taken on this reconnaissance had to be transported by pack-animals, we were limited in our choice of surveying and astronomical instruments to those which could most easily be carried and be least likely to get out of order. Our astronom-

ical instruments were two sextants, an artificial horizon, and two chronometers—one mean-solar and one sidereal.

The instruments for keeping the trail were two prismatic compasses and an odometer-cart, drawn by a horse; it was so narrow it would go wherever a horse could, and consisted of a pair of shafts, a steel axle, and two velocipede wheels; it was light, but strong, and answered the purpose well.

Observations for latitude were taken at every camp if the weather permitted. From Fort Ellis to camp at Meadow Brook, near east fork of the Yellowstone, the same trail was taken both going and returning, thus giving opportunities of correcting errors made the first time going over it.

From camp at Meadow Brook to Yellowstone Lake the trail was on one side of Yellowstone River going and on the other returning, this enabled us to plot the river quite accurately.

At our first camp, on Yellowstone Lake, Mount Sheridan could be seen due (magnetic) south of us. The difference of latitude between this camp and a camp near the foot of Mount Sheridan gave the distance between the two camps. From the top of Mount Sheridan bearings were taken to Yellow Mount, Mount Hancock, Mount Humphreys, camp of August 8 at Hot Springs, and at various prominent points in the lake. From Yellow Mount and mount near Mount Humphreys these same points in the lake were located, and from this latter mountain Mount Hancock could also be seen. The latitude of camp at Steamboat Springs was carefully determined by several observations, and bearings taken to Mount Sheridan and numerous points in the lake. Then there were a large number of well-defined points nearly all around the lake, and the bearings were so taken that their relative positions were mutually interdependent. From thence the general shape of the lake was well defined, important points in it well located, and many of the minor details put in with considerable accuracy.

The trail was kept as carefully as possible, but the ground was so broken, the road so winding, and the country generally so difficult, that many unavoidable errors were made. The latitude observations were particularly useful in correcting these, as the general direction of the march was north or south, the tract of country explored being included between the one hundred and tenth and one hundred and eleventh meridian of longitude and extending from the forty-fourth nearly to the forty-sixth parallel of latitude. The observations for latitude were generally on Polaris off the meridian or by meridian altitudes of the sun; when possible both kinds of observations were taken at the same camp, the latter being preferred, and as a rule they agreed quite closely. Observations for time were almost always on the sun, occasionally on a star, Arcturus being generally selected. My assistant, Mr. W. H. Wood, and myself each took about the same number of observations during the trip. The trail was kept by Mr. W. H. Wood and Mr. H. G. Prout.

The astronomical computations were made and the work plotted in the field. On my return to this office the computations were re-examined and the work replotted by Mr. Wood and myself.

Inclosed is a sketch showing the principal points and the bearings taken from them as stated above.

Very respectfully, your obedient servant,

D. P. HEAP,
Captain of Engineers.

Captain J. W. BARLOW,
Corps of Engineers, Chicago, Illinois.