

SURVEY OF THE COLORADO RIVER OF THE WEST.

LETTER

FROM THE

SECRETARY OF THE SMITHSONIAN INSTITUTION,
TRANSMITTING

*Report preliminary for continuing the survey of the Colorado of the West
and its tributaries, by Professor Powell.*

APRIL 5, 1872.—Referred to the Committee on Appropriations and ordered to be printed.

SMITHSONIAN INSTITUTION,
Washington, March 29, 1872.

DEAR SIR: I have the honor to present herewith a preliminary report of a survey, made in accordance with an act of Congress of March 3, 1871, "for continuing the survey of the Colorado of the West, and its tributaries, by Professor Powell, under the direction of the Smithsonian Institution."

The region mentioned is one of the most interesting, in a geological point of view, in this or any country. The Colorado of the West, and its tributaries, traverse chasms in some places over a mile below the general surface of the country, presenting in many places, at one view, sections of the greater number of all the known geological formations of America. The importance of the exploration, however, is not confined to the advance of science, but is also associated with practical results of value, such as the discovery of coal, salt, the metals, and other resources of the country.

From the specimens deposited in the Institution by Professor Powell, which include, besides those of mineralogy and geology, illustrations of the manners and customs of the people, as well as from maps and drawings which have been exhibited to us, it appears that the work has been well and economically done, and that it forms an important addition to our knowledge of the physical geography of our continent, yet so imperfectly known.

In view of the results already obtained, at a comparatively trifling expense, I would respectfully commend the application of Professor Powell for a renewed appropriation for completing the survey included in his proposed exploration.

I have the honor to be, very respectfully and truly, your obedient servant,

JOSEPH HENRY,
Secretary of Smithsonian Institution.

Hon. J. G. BLAINE,
Speaker of the House of Representatives.

WASHINGTON, D. C., March 25, 1872.

SIR: I have the honor to submit herewith a brief report of the progress made in the exploration of the Colorado of the West, and its tributaries, by the party under my charge.

This report is made in obedience to your instructions, given for the purpose of executing the will of Congress expressed in the following extract from an "act making appropriations for sundry civil expenses of the Government for the year ending June 30, 1872, and for other purposes," approved March 3, 1871; namely:

* * * * * For continuing the completion of the survey of the Colorado of the West and its tributaries, by Professor Powell, under the direction of the Smithsonian Institution, twelve thousand dollars.

The region of country embraced in this exploration is cut by profound gorges, traversed by towering cliffs, and receiving but a very small amount of rain. Much of it is a desert country.

The Green is properly a continuation of the Colorado, and along its meandering course, from the point where it is crossed by the Pacific Railroad to its junction with the Grand, the head of the Colorado, has a length of about three hundred and fifty miles.

The length of the Colorado from this point to the point below the mouth of the Virgin River, reached by Lieutenant Ives, in his exploration of the Lower Colorado, is about six hundred miles, making in all an extent of river of nine hundred and fifty miles to be explored.

The descent of the river in this distance is nearly six thousand feet. In my former exploration of the river I found that the greater part of this descent is made in six different groups of rapids and falls.

The first series is in Red Cañon, where Green River cuts through the northern slope of the Uintah Mountains.

The second series was found in the cañon of Ladore, Whirlpool, and Split Mountain cañons, where the Green River cuts through the southern slope of the Uintah Mountains.

Through these cañons the river falls fifteen hundred feet.

The third series of rapids and falls is found in the cañon of Desolation, where Green River cuts through a plateau south of Uintah and White River valleys, and having a general elevation above these valleys of from four to five thousand feet. Through this cañon the fall of the water is about seven hundred feet.

The fourth series is found in Cataract Cañon, below the junction of the Grand and Green, where the Colorado cuts through another high plateau.

The descent of the river through this cañon is about nine hundred feet.

The fifth series is in Marble Cañon, between the mouth of the Paria and the Little Colorado, where the main river cuts into a plateau, on the north elevated but two or three hundred feet above the river, gradually rising toward the south, until the general elevation of the plateau is more than five thousand feet above the river at the point where the Little Colorado enters it.

Through this the descent is about five hundred feet. The sixth series is found in the Grand Cañon, where the river cuts through a plateau having an elevation from four to seven thousand feet above the stream. Here the descent of the water is about two thousand feet. The remaining fall occurs along the more quiet portions of the stream.

Along the greater part of their course these rivers are inaccessible from the summits of the cliffs by which they are overhung.

In my former explorations I found that the only practicable method

of exploring these rivers would be in small boats which could be carried over the rapids and falls, and that the exploration should proceed down the streams.

It was further found that, in the small boats necessary to be used, it would be impossible to carry sufficient supplies for the time required to accomplish the work.

From these considerations it was deemed best to explore a number of routes from the settlements in Utah, along the western slope of the Wasatch Mountains and the valley of the Sevier, to the Green and Colorado Rivers, by which supplies could be taken to the boat-party on its progress down the cañons.

On the 5th of August, 1870, having engaged the services of a competent topographer and assistant topographer, I proceeded to Salt Lake City, where I purchased the animals and outfit for a small pack-train, and employed the men necessary to manage it.

Two routes by which Green River could be reached from the settlements in Utah were already known: one at the mouth of the Uintah, and one at Gunnison's Crossing, below the mouth of Price River.

To the first of these I sent an installment of supplies deemed sufficient to last a boat-party three months.

Having made arrangements for the transportation of these supplies, I proceeded with my party to the valley of the Sevier; passed up to its head near the southern line of Utah. From thence I crossed the divide between the headwaters of the Sevier and the headwaters of the Paria, and descended this stream to its mouth, and found it a practicable route by which to get supplies to the Colorado.

I then returned up this cañon to the eastern base of the Sevier plateau, and, skirting along its base to the south, I found my way to the town of Kanab. Here I met supplies that I had sent from Salt Lake City via Beaver and Saint George.

Waiting a few days to rest the animals and prepare the outfit, I sent for a number of Indians, desiring to gain from them some knowledge of the country to the south.

On the 14th day of September, acting on information received from the Indians, I started in a southwesterly direction, and in three days reached the base of the Yuingkaret Mountains.

On the fourth day I crossed these mountains and established a camp on the southern slope. I then sent out my Indian guides, and in two days gathered the chiefs and principal warriors of the tribe which inhabits this region. I explained the object of my visit, distributed presents among them, and obtained a promise from them that we might travel unmolested through their country. They gave me, also, valuable information concerning the location of trails and watering-places, and furnished me a guide. With this assistance I was enabled, within a week, to discover a practicable route into the Grand Cañon. I then returned to Kanab.

On my arrival at Kanab, I at once proceeded to make arrangements for the additional supplies that would be needed during the coming winter. Thirteen days were occupied in this work. In the mean time I had ordered, through the telegraph, a small quantity of Indian goods to be sent to Saint George, and I had sent a wagon to meet them at that point and transport them to Kanab. These articles consisted of cloth, indigo, knives, files, and some other things which it was believed the Indians, among whom I expected to travel, would desire. This time, too, was much needed by the topographers to put their field-notes and sketches in proper form for preservation and future use.

On the 11th day of October, having all things in readiness, I started once more for the Colorado. Sending my train to the valley of the Skumppa, I gave directions that it should proceed down this valley to the foot of the Kaibab plateau; and from thence around the north end of this plateau to the head of House Rock Valley; from thence, down and across this valley to the foot of the Vermillion Cliffs, and leaving House Rock Valley where it narrows into a cañon, to follow the cliffs to the Colorado River.

Taking one man with me, I crossed to the Kaibab in a southeasterly direction, and passed along its foot to the southern extremity. There I climbed the plateau, and obtained a good view between that point and the brink of the Grand Cañon. I believed that the character of the country was such as to warrant an exploration for another route to the river. I then crossed the plateau to a point where the cliffs overhang the river, opposite the mouth of the Little Colorado, but no way was discovered by which the river could be reached. From thence I passed along the plateau to the north, and descended into House Rock Valley; found the trail made by my train, which I followed, and joined the party at the Colorado River.

While waiting for me, the party had constructed a small ferry-boat and crossed to the other side. The boat was made of lumber, transported on mules from Kanab, a distance of one hundred and ten miles.

The next morning, being the 19th day of October, we started in a southeasterly direction toward the seven Shinomo villages, in Northeastern Arizona, also called the "Moqui villages" and the "Provinces of Tusayan."

Our route lay along the base of a line of cliffs, and we were rejoiced to find a good trail in the direction in which we wished to travel. We had anticipated much trouble in finding water, but from time to time the trail led to springs or water-pockets, and these at such short intervals that no serious want was experienced.

On the ninth day out from the river, we arrived at the ancient town of Oraiby. The simple people of this town received us kindly, and we spent five weeks studying their language, domestic customs, arts, and mythology, in the mean time visiting the six other towns of this "province." The party then started for Fort Defiance, and arrived there on the 5th day of December.

From the time we left the valley of the Sevier to the time we reached Oraiby, the topographers had run a meandering line of our travels with the compass, and sketched the topography adjacent to the route to a greater or lesser distance, as time and opportunity would permit. A barometrical record was kept, and observations made of important altitudes. Frequent astronomical observations were made with the sextant for latitude, but none for longitude. A running geological section was taken along the entire route, and frequent vertical sections where the cliffs presented interesting features. And in this region of naked rocks, towering cliffs, and cañon walls, the geologist may read the rock-leaved record as he runs.

From Fort Defiance I sent my train back to Kanab, with the following instructions:

First. To take with them the collections of fossils, rocks, and articles of Indian art left at Oraiby.

Second. On arriving at Kanab, to refit the train; then, if possible, to explore a route from the Kaibab plateau to the Colorado, and from thence to return to Kanab.

Third. Taking on new supplies, to proceed to the south side of the.

Sheavwits Mountains, and from thence to explore, if possible, a route south into the Grand Cañon, and return from thence to Kanab.

Fourth. Again taking on supplies, the party was to proceed along the eastern base of the Sevier plateau, pass the headwaters of the Skumppa, Paria, and the Escalanti; and, on reaching any stream to the north of these flowing in an easterly direction, to follow it down to its mouth. It was believed that thus they would discover the mouth of the Dirty Devil, and the result proved the conjecture true.

Fifth. Further instructions were given that a small party of Indians should be taken on each trip, and the Indians of the several regions explored should be collected, and the objects of the expedition explained, presents distributed among them, and, if possible, promises secured that our parties should pass through their country in safety.

This party was under the charge of Mr. Jacob Hamblin, an old mountaineer, who has acquired great influence over the Indians of this region, and speaks their language well. A topographer was sent with him to make maps of the routes traveled.

Having sent my train back, I came on to Fort Wingate, and from thence to Santa Fé; from thence to Denver, and taking the railroad, from thence to Washington, arriving here on the 10th day of January.

On my way down from Salt Lake to Southern Utah I had examined into the feasibility of passing from the valley of the Sevier to Gunnison's Crossing on Green River, and found it was not practicable to transport boats to the last-mentioned point with the funds at my command; and so decided that it would be best to embark boats on Green River at the point where the Union Pacific Railroad crosses it, and descend that river, in order to reach the Colorado with boats.

Before starting west, in August, I engaged the services of Professor A. H. Thompson, as astronomer and chief topographer; and in my absence he procured the instruments and material necessary for work in his department. I also turned over to him the astronomical records and the notes, sketches, and maps of my former expeditions, and he was engaged in working them into shape for future use. He also collected the maps and reports of former Government expeditions to countries adjacent to the region of our exploration, and compiled from them a basis for operations. In this labor he was engaged until April, with the assistance of one draughtsman, who returned with me in January.

On my arrival at Washington, I addressed a letter to the Hon. C. Delano, Secretary of the Interior, asking him to submit to Congress an estimate for an appropriation of twelve thousand dollars for the exploration of the Valley of the Green River. The proposition met with his approval, and at his request the appropriation was made.

In the mean time I had three boats built at Chicago, after a model somewhat different from the boats used in the former exploration.

In the month of March I organized a river party of ten men, and proceeded to Green River Station, on the Pacific Railroad, taking with me instruments, boats, and other supplies deemed necessary.

This party consisted of Professor A. H. Thompson, astronomer and chief topographer, with Captain M. F. Bishop and S. V. Jones as his assistants; John Stuart, assistant geologist; F. S. Dellenbaugh, artist; W. C. Powell, in charge of barometer; E. O. Beaman, photographer; F. C. Richardson, Andrew Hatten, and J. R. Hillers, general assistants.

All the members of the party acted as boatmen while on the river. Professor Thompson was captain of one boat, Mr. Jones of another, and Mr. Beaman had charge of the third. One of the boats had a high seat placed on the middle deck, on which I sat and acted as pilot.

Arriving at Green River Station, our work commenced.

A thorough geological examination of the region in the vicinity was made, with detailed sections, and the collection of fossils, which were found abundant.

An extended series of astronomical observations were made for latitude, and connection by telegraph with Salt Lake City was secured for the determination of the longitude of this point, Professor Thompson going to Salt Lake City to work the line at that point, with Captain Bishop at Green River. The latitude and longitude of Salt Lake City had previously been determined by officers of the Coast Survey, and also by Clarence King, United States geologist for the fortieth parallel. It is believed that the data were collected for the determination of the initial point of the exploration at Green River Station, with a good approximation to accuracy.

Going myself to Salt Lake City, I met Mr. Hamblin there by appointment, who had been in charge of the explorations during the winter. He reported that the collections had been delivered at Kanab; that he had been unable to find a practicable route from the south end of the Kaibab plateau into the Grand Cañon; that he had found a good route from the Sheavwits Mountains to the river, and that the route down the Dirty Devil was barely possible. I then sent him back to Kanab with supplies to be delivered on the river at designated points and times, and in designated quantities.

On the 22d day of May, the party started from Green River Station on the trip down the river. A running section was made of the rocks exposed in the cliffs along its course, vertical sections made from time to time, and fossils collected.

Arriving at the mouth of Henry's Fork, we stopped here for a few days, established an astronomical station, collected the data for a map, and examined with care the geological structure of the country, which we found somewhat intricate, as was also the topography.

We were fortunate in finding fossils of the tertiary, cretaceous, jurassic, and carboniferous formations, and many interesting facts were observed in the geological structure of the northern slope of the Uintah Mountains, which proved of further value to us in the interpretation of the facts subsequently collected.

On the 29th day of May we entered Flaming Gorge, where Green River cuts into the Uintah Mountains, and continued our journey from day to day through Red Cañon. Only one or two hours each day were spent on our boats, the greater part of the time being devoted to scientific work.

On the 8th day of June we arrived at Brown's Park, where we remained a few days establishing an astronomical station, and studying the region, as at the mouth of Henry's Fork. Having finished our work here, we passed down through Brown's Park, and the next day, being the 14th day of June, we entered the cañon of Ladore.

Our way through this cañon was made with much labor, as the river was interrupted by numerous rapids and falls, much obstructed by rocks, compelling us to make many portages; nevertheless we took sufficient time to extend our map to a distance of fifteen miles on either side of the river; to collect data for the determination of the height of the walls, and the more prominent mountain-peaks. Our geological work, too, was carried on in making a running section along the river, and many vertical sections.

On the 19th day of June, we arrived at the mouth of Yampa River. An astronomical station was established here. On the morning after

our arrival, with three men and one boat, I commenced the ascent of Yampa River, with the hope of proceeding as far as the head of Yampa Cañon. It was with much difficulty that we made a slow progress up the stream, having to pole and tow the boat along against a rapid current, and often being obliged to carry it around rocks. In this way we succeeded in reaching the head of the cañon. On our way up the geology of the rocks was examined, and a map made. A day and a half was spent in climbing the adjacent mountain-peaks and making a topographical sketch of the surrounding country.

Embarking again, we descended to our camp at the mouth of the river in about three hours, without toil at the oars, having but to steer our boat and glide past the cliffs. Two more days were occupied in tracing the course of a group of interesting geological folds. During this time our topographical sketches had been extended to a distance of many miles on either side of the river; a quantity of fossils collected, and the structural geology of the country examined.

On the 1st day of July we entered Whirlpool Cañon, and arrived at its foot, in Island Park, on the 5th day of July. The work was carried on through this cañon as in those above. At the lower end of the park an astronomical station was established, and we spent three days in extending our work over the country, as at the stations above. Another group of geological folds was found here, and an interesting collection of cretaceous, jurassic, and carboniferous fossils made.

On the morning of the 8th, with three men, I took one of the boats and pushed on through Split Mountain Cañon, and down the valley below, and on the second night arrived at the mouth of the Uintah, leaving behind a portion of the party to come down as rapidly as they could proceed with the work. The next morning I started, with one man, and walked to the Uintah Indian agency, a distance of thirty-eight miles.

Here a supply of rations had been stored for our party the previous fall, and I came to make arrangements for having them delivered at the river.

On my arrival at the agency, I found a messenger waiting for me, who had been sent by Mr. Hamblin to inform me that it would not be possible to take the rations to the mouth of the Dirty Devil. The cause of this decision was this: The stream along the greater part of its course flows through a cañon so narrow that the water in many places occupies the entire channel, and the walls are so precipitous that a descent to the river cannot be made. The trail followed the winter before made a long detour to the south around this portion of the cañon, along a region of naked rock. During the season of rains, the water falling on these rocks not being absorbed by sands or loose earth, collects rapidly into streams, and rushes in torrents down the steep slopes. Such a stream, having in its course a ledge of rocks over which it falls, will scoop out a deep basin at the foot of the fall, and when the stream runs dry, perhaps in a few hours, the basin will be left full. Now, in the country along this trail no water was found, except in the wells thus formed, and they were full. But during the summer Mr. Hamblin had found the wells dry from evaporation. It should be remembered that the summer of 1870 was unusually dry. This would necessitate a change of plans. Thereupon I sent a messenger to Professor Thompson, with instructions for him to remain at the mouth of the Uintah, and work up the valleys of that river and the White until he should hear again from me.

Obtaining the services of an energetic man, and two good horses, I crossed the mountains to Heber City, and hiring fresh horses proceeded

from thence to Salt Lake City, riding one hundred and eighty miles, scaling the Uintah Mountains, and for much of the way having no trail, and making the trip in three days.

Knowing that by previous arrangement Mr. Hamblin would be in Kanab at that time, I sent him a telegram to come immediately to the city by stage. He arrived in five days. On conferring with him, I decided to return to my party and send it down the river, with instructions to proceed with the work as far as the foot of Gray Cañon, six miles above Gunnison's Crossing.

This accomplished, I left the mouth of the Uintah, taking one man with me. In the mean time Mr. Hamblin had left the city, with instructions to proceed to Cove Creek, a small tributary of the Sevier. It was my intention to join him there, but I desired to examine the geological structure of the plateau to the south of the Uintah Valley, where it merges in the mountains to the west. For this reason I decided not to cross the mountains to the wagon-road leading south, but to proceed along the eastern slope of the Uintah Mountains, crossing the plateau before mentioned, and then, if possible, explore some route across the mountains to the valley of the Sevier. I was successful in carrying out this plan, making a running geological section along the way, and collecting some interesting fossils.

I fell in with bands of Indians; stopped at their camps two or three nights, and induced a small party to travel with me, and so had a fine opportunity to continue my study of the Indian races.

After crossing the plateau, passing the head-waters of the Price River, and reaching the head-waters of the San Rafael, I ascended the mountains to the west. I found them composed of cretaceous and tertiary strata, nearly horizontal, and the summit was a vast and almost level plain. Perhaps this should have been called a plateau rather than a mountain range. I crossed this plateau to the west, and could look over the valleys of the Sevier and Sanpete, and see a dozen beautiful towns with broad fields of waving grain near by, the granary of Utah. Here my Indian friends left me to return to their homes in the valley below. Arriving at Cove Creek and waiting a day, I was joined by Mr. Hamblin.

I then consulted with some mountaineers and with a party of Indians camped near by, and from the information received concluded that it would not be safe, with the limited time, to attempt the descent of the Dirty Devil River by any other route than that explored the previous winter. I then sent Mr. Hamblin to Kanab, with instructions to transport supplies to the mouth of the Escalants.

I made up a pack-train, purchased a small amount of rations at Gunnison, a Mormon town near by, and set out to meet my party at the foot of Gray Cañon. On my way I was enabled to make a geological section of the western slope of the Wasatch plateau, and another on the eastern side. Two interesting geological folds were crossed before reaching Price River. At that point my train remained in camp for two days, while I ascended the south fork of the river to the foot of the Wasatch plateau and made a running section. Returning to camp, I continued down the Price River, making a section as I went, for a distance of about twenty miles, until I found the cañon so narrow that it was not possible to take the pack-train further in that direction. I then made a detour to the south, discovered the old Gunnison road, and followed it to Green River, and going up the stream to the foot of Gray Cañon, found my boat-party. This was on the 29th day of August.

I found that Professor Thompson had brought the party through in

safety, but not without great labor, as the river was very low—more than forty feet below high-water mark; and at many points, where the rapids were beset with rocks, they had been compelled to make portages. They had made more than a hundred portages along the course of the two cañons, where I had made but three two years before. Notwithstanding this labor, they had accomplished a good amount of scientific work.

Permit me briefly to review it. While I was at Salt Lake City, the professor sent one party up White River to the east, a distance of fifty miles. Captain Bishop, one of the party, sketched the topography of the valley; Mr. Stuart examined the geology, collected fossils, and made a running section. The party descended the river on a raft, locating its meandering time. Professor Thompson made a map of the valley of the Uintah, and a geological section along this river from its mouth to the mountains. He also established an astronomical station, and made an extended series of observations for latitude and longitude.

On his way through the Cañon of Desolation, he carried on the topographical and geological work in the same manner as had been accomplished in the cañons above.

Price River was explored; a geological section made along its course to a point above that to which I descended, as related above. Thus his work overlaps mine.

An astronomical station had been established at the foot of Gray Cañon, and a series of observations made for latitude and longitude.

On the 1st day of September we set out on our journey through Labyrinth Cañon, and reached the mouth of the San Rafael in two days. Here another astronomical station was established. Taking one man, I ascended the San Rafael, and connected the work with the observations made by me at the source of this stream, along the base of the Wasatch plateau. Others of the party were engaged in extending the map and geological work to the east, and their work was carried nearly to Grand River.

Again we started down Labyrinth Cañon, and stopped at its foot one day. Two days more, and we had passed through Stillwater Cañon, and were at the junction of the Grand and Green. Here we established another astronomical station, and gave four days to topographical and geological work. And now our work on Green River was finished. The data collected, supplemented by maps, sketches, geological sections, and astronomical observations, made in my former explorations, will, I believe, enable me to give in my final report a good representation of the geographical features and geological structures of that portion of the valley of the Green south of the Union Pacific Railroad.

On the 19th day of September we started down the Colorado, entering Cataract Cañon. Our progress was slow, for the channel was obstructed by rapids and falls, where we were compelled to make many portages. A great number of lateral cañons enter into the principal one; each one of these has its system of side cañons. All this makes the topography very intricate. The geological structure seemed also at first very obscure. The rocks were tilted at various angles, and in almost every conceivable direction; yet, on careful examination, it was found that this apparent confusion could be unraveled. First, it was observed that the dip of the rock was in a direction away from the cañon on either side, along its entire tortuous course. On passing up the lateral cañons, the rocks were found to dip from these on either side; and passing up into their side cañons, still the rocks dipped into the cliffs, and away from the gorge. And this rule for the dip was every-

where observed. We made a plot on a topographical sketch showing the direction of these tilts; and with this and many other facts collected, I have confidence in the belief that in my concluding report I shall be able to make clear the character of the phenomena and explain the cause. We reached the mouth of the Dirty Devil on the 30th day of September.

Three days were given to work in this vicinity, and an astronomical station established. One of our boats was carried into a cave and filled with sand, as we wished to leave it here for future use. Failing to get a supply of rations at this point, it would be necessary to proceed to Escalante Creek in a shorter time than would be required to carry on our work according to the plan by which it had been accomplished above.

We proceeded down the river, stopping only to make a map of the same, and a running section, until we reached the point mentioned above, where we found Mr. Hamblin with our supplies.

Our arrival was none too early, as we had scarcely two days' rations left in the boats. Here I left for Salt Lake City.

Professor Thompson again took charge of the party, established an astronomical station, carried the work over the adjacent country, continued down to the mouth of the Paria, carrying on the scientific work according to the original plan. He established another astronomical station here, and extended his work over the surrounding region as far as practicable.

In the mean time the pack-train had gone to Kanab; there taking on supplies, returned to the river, and met the party at the mouth of the Paria. From thence Professor Thompson went to Kanab with the party and train.

My trip to Salt Lake City was for the purpose of procuring additional supplies and instruments.

I arrived at Kanab, in return, on the 29th day of November. In furtherance of plans previously made, Professor Thompson was examining the country for the purpose of locating a base-line. I joined him in this work, in which we were engaged two weeks. The members of the party were variously employed during this time. The ground for the base-line having been determined, we made preparations for its measurement, but were delayed by three weeks of cloudy nights before the necessary observations could be taken to determine the meridian direction.

In the mean time, parties were at work erecting monuments on such conspicuous points as were selected for geodetic stations. As soon as the direction of the line was determined, the measurement began. Leaving this in charge of one of his assistants, he commenced the observations for triangulation. The latitudes of the extremities of the base-line were determined by astronomical observations. There is a telegraph-office at the north end of the line, connecting with Salt Lake City, and by the use of this the longitude can be determined with a good approximation to accuracy. This was left for some future time, on account of the ill health of one of the assistants. During the greater part of this time I was occupied in the study of the Ute language, and other matters of ethnological interest. I also made a trip to the Kanab plateau, for geological purposes, and explored the cañons of the Kanab. A running section was made from the mouth of the Kanab to its source in the Sevier plateau; another from the Kanab to the Kaibab; and still another from the Kaibab west to Virgin River, at a point opposite Saint George.

Allow me to make a summary statement of the work which has been accomplished.

The region has been traversed from north to south for a distance along the river of six hundred and forty miles. At various points the region to the west of this line has been crossed to the base of the mountains and plateaus that form the western rim. The country to the east of the river has been carefully explored to a distance of ten to twenty-five miles, and at White River to a distance of fifty miles, and on the northern rim of the basin of the Little Colorado to the town of Oraiby, one hundred and twenty-five miles. From the mouth of the Little Colorado the course of the river is in a direction to the west for a distance of three hundred miles, when it turns again to the south, near the mouth of Virgin River. The Sevier plateau lies from sixty to one hundred miles north of this portion of the stream, and is cut with a labyrinth of deep cañons. Along four lines we have descended to the Colorado, and a system of triangles extended over this country from a base-line at Kanab, and the party is engaged now in tracing the topography.

On all the region north of Paria River the base for the topographical work has been the meandering line of the river, composed, necessarily, of units of estimated distances, corrected by astronomical determinations of latitude and longitude—a method not entirely accurate, yet the only one practicable with the funds at my command. A tri-daily record of barometrical observations has been made in the trip down the river, and altitudes have been measured by comparative differences in barometrical readings, and high-water mark on the river taken as the base, so that all the altitudes are related to the river. The constantly varying height of the river above the sea can be approximately determined by the series of observations first mentioned, combined with the series made by me during the former exploration.

Several hourly series, of eight days' continuance each, have been made at important points along the route. At various points in the region explored the ruins of ancient communal houses were discovered. These houses were built for the accommodation of from fifty to two hundred persons each; the material of stone and mortar. Houses like these were used by the Aztecs, in the valley of Mexico, and similar houses are now used in the "Province of Tusayan," in Northeastern Arizona. The location of these towns of a single house will be shown on the map. In some of the ruins fragments of pottery, articles of basket-work, stone implements, and other relics were found. Etchings on the rocks, many of them believed to be records in hieroglyphics, were found, and drawings made of the same.

Vocabularies were made of the Shoshone language, the Navajo, the Oraiby, the Uintah, Ute, and the Pah-Ute. Materials were collected for a grammar and dictionary of the last-mentioned language.

There has also been collected much material for the illustration of the domestic life, habits and customs, songs and mythology, of the Utes. Large collections of articles of Indian art have been made.

The extent and character of such valleys as may be redeemed by irrigation have been noted. The forests, mainly situated on the plateaus, have been examined, and their location and extent will be given in my final report. Much mineral coal has been discovered, and care taken in the examination of the same. The locality and extent of these beds will also be given. Other deposits of mineral have been discovered, but not thoroughly examined.

Such, in part, is the result of labors already performed.

The various collections made, during the exploration, of fossils, minerals, and works of Indian art, have been shipped to the Smithsonian Institution from Salt Lake City, and will doubtless arrive in due time.

When the party has finished tracing the topography of that region over which the system of triangulation has been extended, Professor Thompson will repair to the mouth of the Dirty Devil, and four members of the party, taking the boat left there, will proceed down the river, and complete the work as far as the mouth of the Paria. There I expect to join them for the exploration of the Grand Cañon.

Of the appropriation of twelve thousand dollars last made by Congress, there yet remains in my hands a little more than two thousand dollars. This will be sufficient to complete the exploration of the Grand Cañon.

To the Chicago, Burlington and Missouri, the Chicago, Alton and Saint Louis, the Chicago and Northwestern, the Union Pacific and Kansas Pacific Railroads I am indebted for very great favors. The officers of these roads have given me transportation for men and material. But for this assistance it would not have been possible to make the explorations with the amount appropriated by Congress. I am pleased thus to bear testimony to the liberality of these gentlemen, and to their interest in scientific exploration, and feel flattered by the confidence they have given me. I have been engaged for five years in the exploration of this region, and during this time these railroads have contributed nearly as great an amount as the General Government to the accomplishment of the work, in the form of passes and free freight-bills.

The operations of the two years are so intimately connected that it would not be possible to convey a clear idea of what has been done, with the reasons for the same, without combining the several statements in one report. I have therefore deemed it wise so to do, and will transmit a duplicate of the above to the Hon. C. Delano, Secretary of the Interior.

I would respectfully ask your attention to the propriety of continuing the work in this interesting country. First, in extending the system of triangulation over the upper portion of the valley of the Virgin, the Sevier plateau, and the district lying between the Paria and the Dirty Devil. This can be done from the base already established, and at the same time trace the topography and examine the geology of the country. Second, to establish a base-line in the valley of the Sevier, and extend like work over this and the valley of the Sanpete, over the Wasatch plateau, and the streams running east into the Colorado and Green Rivers, and connecting on the north with the surveys made by Clarence King along the 40th parallel. This would enable us to fill up the inter-spaces in our past explorations, extend them over a region of country forming a part of the same great basin of drainage, and complement the geological work done. The knowledge of the country obtained in the past would greatly facilitate this. The party in the field could at once proceed with the work without loss of time, and the train and instruments now in use could be employed without further expense. By slightly increasing the party, the whole could be finished in one year.

I estimate that an appropriation of twenty thousand dollars would be sufficient for this purpose.

Invoking your careful consideration of this matter, and such action as you may deem wise, I am, with great respect, your obedient servant,

J. W. POWELL.

Professor JOSEPH HENRY,
Secretary of the Smithsonian Institution,
Washington, D. C.

