

GEOGRAPHICAL AND GEOLOGICAL SURVEYS WEST OF THE
MISSISSIPPI.

MAY 26, 1874.—Referred to the Committee on Appropriations and ordered to be printed.

Mr. TOWNSEND, from the Committee on the Public Lands, submitted the following

REPORT:

The Committee on the Public Lands, to whom was referred the message of the President of the United States concerning the geographical and geological surveys west of the Mississippi, beg leave to report:

On the 15th of April, 1874, Mr. Lazarus D. Shoemaker submitted to the House of Representatives the following resolution, which was agreed to, viz:

That the President of the United States be requested to inform the House what geographical and geological surveys under different departments and branches of the Government are operating in the same and contiguous areas of territory west of the Mississippi River, and whether it be not practicable to consolidate them under one department, or to define the geographical limits to be embraced by each.

On May 2, 1874, the President, in answer to the resolution, transmitted a message to the House, containing his own views thereon, together with the views of officers of the War and Interior Departments, and of Dr. F. V. Hayden, United States geologist, and J. W. Powell, in charge of the Colorado River exploring expedition.

The message and papers were referred to the Committee on the Public Lands, and were in the following words:

Message from the President of the United States, in answer to a resolution of the House of April 15, 1874, transmitting a report from the Secretary of War, relative to geographical and geological surveys west of the Mississippi.—May 2, 1874, referred to the Committee on the Public Lands and ordered to be printed.

To the House of Representatives:

In pursuance of the resolution of the House of Representatives of the 15th instant, requesting to be informed "what geographical and geological surveys under different departments and branches of the Government are operating in the same and contiguous areas of territory west of the Mississippi River, and whether it be not practicable to consolidate them under one department, or to define the geographical limits to be embraced by each," I have the honor to transmit herewith the views of the officers of the War and Interior Departments on the subjects named in the said resolution, and invite attention thereto.

Where surveys are made with the view of sectionizing the public lands, preparatory to opening them for settlement or entry, there is no question but such surveys, and all work connected therewith, should be under the direct control of the Interior Department or the Commissioner of the General Land-Office, subject to the supervision of the Secretary of the Interior. But where the object is to complete the map of the country; to determine the geographical, astronomical, geodetic, topographic, hydrographic, meteorological, geological, and mineralogical features of the country—in other words, to collect full information of the unexplored, or but partially known, portions of the country—it seems to me a matter of no importance as to which Department of the Government should have control of the work. The conditions which should control this subject are, in my judgment, first, which Department is prepared to do the work best; second, which can do it the most expeditiously and economically.

As the country to be explored is occupied in great part by uncivilized Indians, all parties engaged in the work at hand must be supplied with escorts from the Army, thus placing a large portion of the expense upon the War Department; and, as the Engineer Corps of the Army is composed of scientific gentlemen, educated and practiced for just the kind of work to be done, and as they are under pay, whether employed in this work or not, it would seem that the best condition named would be more fully complied with by employing them to do the work. There is but little doubt but that they will accomplish it as promptly and as well and much more economically.

U. S. GRANT.

EXECUTIVE MANSION,
Washington, April 30, 1874.

WAR DEPARTMENT,
Washington City, April 27, 1874.

SIR: In response to your request of the 16th. instant for report upon House resolution of April 15, I have the honor to transmit herewith the report of the Chief of Engineers and accompanying papers, respecting the geographical and geological surveys made by his Department. He reports that the surveys of Lieutenant Wheeler, of the Engineer Department, and those under Professor Hayden, of the Department of the Interior, and that of Professor Powell under the Smithsonian Institution, are operating in contiguous areas of territory west of the Mississippi River; and that in the years 1872 and 1873 the survey of Lieutenant Wheeler embraced a small portion of the survey of Professor Powell; and that, contrary to an agreement made between Lieutenant Marshall and Professor Hayden during last season while both were operating in Colorado, (which agreement was that they should operate on opposite sides of the Upper Arkansas River,) the parties of the latter surveyed portions of the region allotted to Lieutenant Wheeler's parties, causing a duplication of survey of such portions.

I respectfully invite attention to the report and recommendations of the Chief of Engineers, and, in response to your invitation, I must express my conviction that economy and efficiency would be the result of consolidating all such surveys under the War Department, and placing the work under the supervision of the Corps of Engineers of the Army; this, of course, not to include the surveys under the General Land-Office.

This Department has been repeatedly called upon to supply the surveys under various Departments with arms, ammunition, transportation, subsistence, and escort, and it would be very economical to stop this practice.

Very respectfully, your obedient servant,

WM. W. BELKNAP,
Secretary of War.

The PRESIDENT OF THE UNITED STATES.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., April 23, 1874.

SIR: In compliance with your direction to report with full expression of views upon the subject of the resolution of the House of Representatives of the 15th instant, I have the honor to report as follows, viz:

The geographical and geological surveys of the territory west of the Mississippi River now in progress are conducted under the direction of the War Department, Department of the Interior, and Smithsonian Institution. In addition may be named the determination of the northern boundary between this country and the territory of Great Britain, carried on under the Department of State, the scientific part of the duties being performed by engineer officers detailed for the purpose.

The surveys under the War Department are:

1. The geological survey of the fortieth parallel, in charge of Mr. Clarence King.
2. Explorations and surveys west of the Mississippi River, in charge of Lieutenant G. M. Wheeler, Corps of Engineers.

To these must be added the surveys and reconnaissances for the use of troops made by engineer or acting engineer officers on duty at the headquarters of the following military divisions and departments:

3. Military Division of the Missouri.
4. Military Division of the Pacific.
5. Military Department of the Platte.
6. Military Department of the Missouri.
7. Military Department of Dakota.
8. Military Department of Texas.
9. Military Department of Arizona.
10. Military District of New Mexico.

The geographical survey of the fortieth parallel is conducted in a thoroughly scientific

manner, and consists in an elaborate geological survey in connection with a careful topographical survey based upon the determination of the positions of prominent geographical points and their connection with other points by triangulation and measurements, and in examinations in mineralogy, zoology, and botany.

The field-work of this survey is completed, and covers an area of 81,600 square miles.

Two volumes of report with maps have been published, and the remaining volumes and atlases are being prepared for publication.

The work is one of a high order, and will increase the reputation of the country for scientific ability.

The survey in charge of Lieutenant Wheeler is conducted upon the same general plan and embraces the same subjects of inquiry as the survey on the fortieth parallel.

The basis of this work is the collection and preparation of the data for a series of topographical atlas-maps, upon a scale of one inch to eight miles, of the territory of the United States west of the one hundredth meridian; each sheet representing an area of from 17,000 to 18,000 square miles, and so projected that the several sheets may be joined to comprise entire political or other divisions.

For the preparation of each of these sheets that delineate more especially the mountain-forms, astronomic, geodetic, topographic, and meteorological observations are necessarily made.

The examinations in geology, mineralogy, and natural history have been intrusted to gentlemen trained in these specialties.

The operations in the several branches of the survey are conducted in pursuance of a systematic plan, under which an annual project, in detail, is submitted by the officer in charge to the Chief of Engineers.

So far as possible, without detriment to the principal objects of the survey, examinations are made concerning the resources of the country in wood, water, and agricultural productions; the influence of climate; the character of vegetation; the location and extent of precious and economic minerals; the routes of communication for rail and common roads; the character, habits, and disposition toward settlers of the several Indian tribes; the water-supply available for irrigation; the season of rain and snow fall; the condition of mining and other industries, &c.

During the years 1867-'71-'72-'73, an area of 228,150 square miles has been surveyed in California, Nevada, Arizona, Utah, Colorado, and New Mexico.

Maps representing 72,000 square miles of this area, with other explanatory and physical sheets, making a partial atlas, are ready for distribution, and the remainder are well advanced.

The data for thirteen sheets of the proposed geological atlas have been gathered.

One hundred and fifty mining-districts have been examined.

Photographs are obtained, which, besides being illustrative of the country traversed, are useful aids in the topographical and geological branches.

The progress and condition of the work is reported annually to Congress by the Secretary of War. (See Annual Reports of the Chief of Engineers, 1869-'71-'72-'73.)

In addition, preliminary reports and maps for the years 1869 and 1871 have been published.

An astronomical report is now ready for distribution.

It is proposed to publish the data gathered in six quarto volumes, one topographical and one geological atlas, 19 inches by 24 inches:

Vol. 1. General report of the expeditions of 1871-'72-'73, and mining information, 250 pages, with plates.

Vol. 2. Astronomical report, 250 pages, with plates.

Vol. 3. Meteorological report, 30 pages, with plates.

Vol. 4. Geological report, to include mineralogy, 400 pages, with plates.

Vol. 5. Paleontology, 100 pages, with plates.

Vol. 6. Natural history, 400 pages, with plates, embracing reports from several eminent scientists upon the collections in the several branches.

These volumes will be published when authorized by Congress. (See Appendix E E, Annual Report of the Chief of Engineers, 1873.)

The cost of this survey so far has been less than \$1 per square mile, or one-eighth of a cent per acre.

The greater part of the time and money has been expended in field-operations; the preparation of the results for publication is now being pressed forward.

The surveys and reconnaissances by engineer officers, made for the use of the troops in the several military divisions and departments, have been of noted value.

During the past season, in addition to the ordinary duties, the following surveys and reconnaissances have been made, viz:

By Captain Ludlow, in the Department of Dakota, a survey in connection with the Yellowstone River expedition

By Captain Jones, in the Department of the Platte, a reconnaissance of the approaches to the Yellowstone Park from the south and east, resulting in finding a practicable route for a wagon or rail road from Point of Rocks, on the Pacific Railroad, to the Yellowstone Park and Fort Rice.

By Lieutenant Ruffner, in the Department of the Missouri, a reconnaissance about the headwaters of the Rio Grande and Southwestern Colorado, and observations made for the determination of the latitude and longitude of Denver, Colo., and longitude of Fort Hays and Fort Wallace in Kansas, and Pueblo in Colorado; and, in addition, a reconnaissance for the route for a military road from Santa Fé to Taos, N. Mex., to be followed by the construction of the road under appropriation of Congress.

The survey under the Smithsonian Institution is entitled, "Survey of the Colorado of the West and its tributaries, by Professor J. W. Powell."

Although the lines of reconnaissance of Professor Powell were contiguous to the areas being surveyed by Lieutenant Wheeler's parties, there was no actual duplication of work until the years 1872 and 1873, in which the latter survey embraced a portion of the borders of the Colorado, and, to a small extent, the survey of Professor Powell.

The surveys carried on under the Department of the Interior are—

First. The Land-Office surveys.

Secondly. The survey styled in the appropriation bill "the geological and geographical survey of the Territories of the United States, by Professor F. V. Hayden."

The field of this survey in 1871 and 1872 comprised, I understand, portions of the Territories of Wyoming and Montana, including the Yellowstone Basin. It is reported to me that during the last season its parties were transferred to Middle Colorado, and to the scene of the labors of one of Lieutenant Wheeler's parties, as well as that of the reconnaissance party of Lieutenant Ruffner, the projects for both of which parties were prepared and approved when it was understood Professor Hayden was engaged upon the region of the Yellowstone Basin and other portions of Montana; consequently, when Lieutenant Marshall, in charge of one of Lieutenant Wheeler's parties, took the field in Middle Colorado, in accordance with the project for the season's work, prepared under the general plan of survey, he found Professor Hayden's parties about to commence work in the same region.

To avoid duplication of survey, it was agreed between the two parties that they should operate on opposite sides of the Upper Arkansas, which agreement, Lieutenant Marshall reports, was not adhered to by Professor Hayden, and the result was a duplication of survey in a certain part of that region.

I have already expressed my views respecting the consolidation of these surveys under one department of the Government, in a letter to the Hon. James A. Garfield, chairman of the Committee on Appropriations of the House of Representatives, dated February 5, 1873, a communication made at his request, and beg leave to repeat here some of those views:

"The surveys and explorations conducted by the War Department have had for their object the determination of the physical structure and condition of that region for the use of the Government of the United States in its military operations, in the settlement and development of its Territories, and for safe and speedy transit through them. The first and chief object of the expeditions is the collection of data for the preparation of complete maps of the region by astronomical, geodetic, topographic, and hydrographic methods of survey, with different degrees of refinement, according to the facility of movement through it. Joined to these observations are those on the meteorology, mineralogy, and geology of the country, as well as its botany and zoology. The number, positions, and character of the Indian tribes also form subjects of inquiry. The report of the chief of the exploration shows in what manner the results of these various labors can be applied in the establishment of military posts and routes of supply for them, in the military operations constantly going on there, in the establishing or perfecting general routes of communication by wagon-roads, rivers, and railroads, and in the settlement of the country by agriculturists and by miners.

"In the very early part of this century, soon after the acquisition of the Territory west of the Mississippi River, Mr. Jefferson, then President, set on foot its exploration, assigning the charge of the first expedition to Captains Lewis and Clarke, of the Army.

"This was followed, in two years, by an expedition under a young officer of the Army, Lieutenant, afterward General, Pike, killed in the war of 1812-14.

"A few years later these labors were assumed by Major Long, Topographical Engineers, and following him they were continued by officers of the Army, whose names would furnish a long list of men distinguished in their profession.

"The parties are essentially military in their organization, and are nearly always accompanied by troops. I know of but few instances in which they were not. Their organization also comprises men from civil life, accomplished in the different subjects, which require especial training. The chief labors of these parties are devoted to the geographical, astronomical, geodetic, topographic, hydrographic, and meteorological determinations, without which the geological and mineralogical would be comparatively useless—especially in their practical application to military, mining, and agricultural purposes. In these chief labors of the party the officers of the Army are especially instructed and skilled.

"The regularly-organized explorations that have been made in that vast interior region have been almost always conducted under the War Department, and their results have received the highest commendation in this country and in Europe, where the plans of operation and methods of survey are considered as models of their kind.

"Most of the geologists whose names are connected with the development of the geology of that interior region have served in these War-Department explorations.

"If it is intended that these interior surveys shall be conducted solely under one Department, then it seems to me that the War Department has superior claims to any other Department of the Government, since it has been usually intrusted with them, and possesses officers skilled in the operations which form the chief labors of the party—skilled, too, in the application of the results of all the labors of the party to the great practical ends had in view in making the explorations, and trained to the command of men and of the troops that always form a part of such expeditions.

"The War Department and its parties have always maintained cordial relations with the many scientific societies and men of science of the country, who are interested and skilled in the inquiries that form part of the labors of the expeditions, and they have been consulted in the organization of the expeditions, and in the methods of observation to be followed in their own special branches—geology, botany, and natural history."

By placing all these surveys under one Department, there would be unity of plan, greater economy, and greater efficiency, and, as a consequence, more useful results for the same expenditure of money. I can see no advantages to the public service in placing them under several Departments.

I transmit herewith a preliminary atlas of the sheets, as far as published, of the survey of the territory of the United States west of the one hundredth meridian, upon the progress-map of which will be found delineated the routes of the various expeditions conducted under the War Department, a list of which is also transmitted.

The resolution of the House of Representatives is returned herewith.

Very respectfully, your obedient servant,

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

Hon. W. W. BELKNAP,
Secretary of War.

List of explorations and surveys west of the Mississippi River, conducted under the War Department.

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| Captains Meriwether Lewis and Wm. Clarke,
1804-'5-'6. | Lieut. N. Michler, 1849-'50. |
| Maj. Z. M. Pike, 1804-'6-'7. | Lieut. M. L. Smith, 1850. |
| Maj. S. H. Long, first expedition, 1819-'20. | Lieuts. M. L. Smith and N. Michler, 1850. |
| Maj. S. H. Long, second expedition, 1823. | Lieuts. W. F. Smith and F. T. Bryan, 1850. |
| J. C. Brown, 1825-'26-'27. | R. H. Kern, 1850. |
| R. Richardson, 1826. | Capt. Lorenzo Sitgreaves and Lieut. I. C.
Woodruff, 1850-'51. |
| Lieut. J. Allen, 1832. | Capt. Lorenzo Sitgreaves, 1851. |
| Henry R. Schoolcraft, 1820 to 1832. | Bvt. Capt. John Pope, 1851. |
| Capt. B. L. E. Bonneville, 1832 to 1836. | Lieut. G. H. Derby, 1851. |
| Cols. J. B. Many and Henry Dodge, 1833 to
1835. | Lieut. I. C. Woodruff, 1852. |
| C. Dimmock, 1838. | Capt. R. B. Marcy, 1852. |
| Prof. I. N. Nicollet, 1836 to 1840. | Gov. I. I. Stevens and Capt. G. B. McClellan,
1853-'54-'55. |
| Lieut. J. C. Frémont, 1842. | Lieut. R. Arnold, 1854. |
| Capt. N. Boone, 1843. | F. W. Lander, 1854. |
| Capt. J. Allen, 1843. | Capt. J. W. Gunnison and E. G. Beckwith,
1853. |
| Capt. J. C. Frémont, 1843-'44. | Capt. E. G. Beckwith, 1854. |
| Capt. J. C. Frémont, 1845-'46. | Capt. A. W. Whipple, 1853-'54. |
| Lieuts. James W. Abert and W. G. Peck,
1845. | Lieut. R. S. Williamson, 1853-'54. |
| Lieut. W. B. Franklin, 1845. | Lieut. J. G. Parke, 1854. |
| Bvt. Maj. William H. Emory, 1846-'47. | Bvt. Capt. John Pope, 1854. |
| Lieuts. James W. Abert and W. G. Peck,
1846-'47. | Lieut. J. G. Parke, 1853-'55. |
| Lieut. Col. P. St. George Cooke, 1846-'47. | Lieuts. R. S. Williamson and H. L. Abbot,
1855. |
| Bvt. Capt. W. H. Warner, 1847-'48-'49. | Capt. J. L. Reno, 1853. |
| Lieut. G. H. Derby, 1849. | Capt. R. B. Marcy, 1854. |
| Lieut. J. H. Simpson, (road,) 1849. | Col. J. C. Frémont, 1853-'54. |
| Lieut. J. H. Simpson, (reconnaissance,) 1849. | Col. E. J. Steptoe, 1854-'55. |
| Capt. R. B. Marcy, 1849. | Lieut. John W. Withers, 1854. |
| Capt. H. Stansbury, 1849-'50. | Lieut. G. H. Derby, 1853-'55. |
| Bvt. Maj. S. Woods and Bvt. Capt. John
Pope, 1849. | Lieut. G. H. Mendell, 1855. |
| Bvt. Lieut. Col. J. E. Johnston, 1849-'50-'51. | Capt. J. H. Simpson, 1855. |
| Lieut. W. F. Smith, 1849. | Lieut. G. K. Warren, 1855. |
| Lieut. F. T. Bryan, 1849. | Lieut. F. T. Bryan, 1855. |
| Lieut. W. H. C. Whiting, 1849. | Lieut. T. J. C. Amory, 1855. |
| | Bvt. Maj. H. W. Merrill, 1855 |

Lieut. I. N. Moore, 1855.

Lieut. E. L. Hartz, 1856.

Lieut. F. T. Bryan, 1856.

Capt. John H. Dickerson, 1856.

Lieut. W. D. Smith, 1856.

Capt. A. Sully, 1856.

Lieut. G. K. Warren, 1855-'56-'57.

Col. E. V. Sumner, 1857.

Col. J. E. Johnston, 1857.

E. F. Beale, 1857.

Lieut. J. C. Ives, 1858.

Capt. W. F. Reynolds, 1859-'60.

Capt. J. N. Macomb, 1859-'60.

Capt. J. H. Simpson, 1859.

Lieut. J. Dixon, 1860.

Lieut. John Mullan, 1859-'60.

Lieut. R. W. Petrikoff, 1869.

Capt. C. W. Raymond, 1869.

Capt. J. W. Barlow and D. P. Heap, 1871.

Capt. J. W. Barlow, 1872.

Capt. W. A. Jones, 1871-'72-'73.

Capt. G. J. Lydecker, 1873.

Capt. William Ludlow, 1873.

Lieut. E. H. Ruffner, 1872-'73.

Clarence King, 1867-'73.

Lieut. G. M. Wheeler, 1869-'73.

International boundary surveys, under the direction of the Department of State, made by officers of the Army detailed from the War Department.

Texas boundary, 1840-'41: Maj. James D. Graham and Lieut. Col. J. Kearney.

Northeastern boundary, 1840-'46: Maj. James D. Graham.

Mexican boundary, 1849-'56, transferred to and completed under the direction of the Department of the Interior: Lieut. Col. J. D. Graham and Maj. W. H. Emory.

Northwest boundary, 1857-'61: Lieut. John G. Parke.

Northern boundary, in progress: Majors F. U. Farquhar and W. J. Twining.

DEPARTMENT OF THE INTERIOR,

Washington, D. C., April 28, 1874.

SIR: I have the honor to acknowledge the receipt, by your reference, on the 16th instant, of a resolution adopted in the House of Representatives on the 15th instant, in the following language, viz:

"Resolved, That the President of the United States be requested to inform the House what geographical and geological surveys, under different departments and branches of the Government, are operating in the same and contiguous areas of territory west of the Mississippi River, and whether it be not practicable to consolidate them under one department, or to define the geographical limits to be embraced by each."

I have the honor to submit the following report upon the subject matter of the resolution, so far as it relates to this Department:

The only geographical and geological survey of the public domain, under the charge of the Department, at the present time, is that which has been conducted during the past five years by Prof. F. V. Hayden, who was appointed United States geologist by Mr. Secretary Cox on the 1st of April, 1869, in accordance with the provisions of the act entitled "An act making appropriations for sundry civil expenses of the Government for the year ending June thirtieth, eighteen hundred and seventy, and for other purposes," approved March 3, 1869, (U. S. Statutes, vol. 15, page 306.) During the period above named Professor Hayden's expedition has explored various portions of the Territories of Montana, Wyoming, (including the Yellowstone National Park,) and Colorado. The field of his survey, during the past year, was the more mountainous portions of Colorado Territory, and the results thereof are now being prepared for publication. The reports, already published, of the previous surveys conducted by Professor Hayden, constitute a valuable addition to that portion of the public documents which relate to matters of scientific investigation, and are sought after by scientific institutions in this country and in Europe. Believing the results of these surveys to be of intrinsic value to the country at large, a continuation of the same was recommended in the last annual report of this Department.

A survey of the Colorado of the West, under the direction of Professor Powell, was authorized by Congress on July 12, 1870, (U. S. Statutes, vol. 16, page 243,) the expenditure of the appropriation therefor being placed under the direction of the Secretary of the Interior; but on the 3d of March, 1871, (*idem*, page 503,) Congress placed the completion of said survey under the direction of the Smithsonian Institution, to which, I am informed, Professor Powell has made his final report.

It is not officially known to this Department whether any other surveys "are operating in the same or contiguous areas of territory west of the Mississippi River."

With respect to the second inquiry of the resolution I have the honor to submit the following views:

In view of the powers conferred and duties enjoined upon the Secretary of the Interior

touching the development of agricultural, mineral, and kindred interests in our vast territorial domain, I respectfully submit that all matter having any relation thereto should be wholly under the jurisdiction of the Department of the Interior. In my judgment, therefore, all surveys which are made for the purpose of ascertaining the geological character, natural history, climatology, and mineral, agricultural, and other resources of the public domain, come entirely within the province and should be conducted under the direction of the Department of the Interior, as contradistinguished from those surveys which may be found necessary for purely military purposes, and which, from their very nature, should properly be conducted under the supervision of the War Department.

The business of the General Land-Office, an important bureau of this Department, has an intimate connection with surveys of a geological character, and the geological surveys heretofore directed by this Department are made to conform, as far as practicable, to surveys made by officers of that bureau.

I am fully of the opinion, therefore, that all surveys of unoccupied public territory, except those for military purposes, should be consolidated under the direction of one Department, and that the Department of the Interior should be charged with their supervision so far as they relate to the following branches of scientific research, viz: geological formations, climatology, mineralogical, agricultural, and other resources, and topography, so far as the latter may be necessary for the construction of accurate maps, whereon the several features above enumerated could be properly illustrated for the information of the people. In these different branches of investigation past experience has demonstrated the necessity for combining geological and topographical examinations, in order to reach more harmonious and valuable results.

Should the foregoing views meet with your approval and with that of Congress, the last inquiry of the resolution would be practically answered. If all such surveys were placed under the supervision of this Department, the possibility of different surveys going over the same ground would be avoided, whereas were they not thus consolidated such a contingency might arise.

In this connection I deem it proper to inclose, for your information, copies of communications from Professors Hayden and Powell, dated the 25th and 24th instant, respectively, wherein the views of those two gentlemen upon the subject of the House resolution are fully set forth.

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

C. DELANO, *Secretary.*

The PRESIDENT.

OFFICE UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES,
Washington, D. C., April 25, 1874.

SIR: In accordance with the request contained in your letter of April 16, 1874, I have the honor to present the following statement:

In regard to surveys operating in the same or contiguous areas, I can only speak of such as I came in contact with while conducting the survey under my charge. I believe it is true that an exploring party connected with one of the other Departments did extend examinations last season upon the territory which you had assigned to me, as per letter of instructions of January 27, 1873, which is hereto appended.

I have not been officially apprised of the object of that exploration, but, as the expedition was conducted under the auspices of the War Department, I presume the chief object of the survey was for military purposes, and, if so, could have no relation to or in any way necessarily conflict with the geological survey under my charge. This is the only apparent duplication of which I have any knowledge; and as the objects of the two expeditions are presumed to have been distinct and different, it was, if this supposition is correct, only apparent, and not real.

My report of last year's expedition, which is now nearly ready to be submitted to you, will show that I confined my explorations and investigations strictly to the territory assigned me, and to the objects and purposes embraced in the instructions heretofore received—that is, the geology, natural history, mineral and agricultural resources of the country explored, and such geographical and topographical work as is necessary for the construction of proper geological maps.

The resolution submitted inquires as to the propriety of placing the various surveys of the western section under one department or head, or of giving to each a definite geographical boundary.

With respect to the first inquiry, I beg leave to submit the following suggestions for your consideration:

It is presumed that the language of the resolution is intended to include all surveys which are made for the purpose of ascertaining the geological character, mineral and agricultural resources, and natural history of the Territories. The experience of geological surveys of the States, and of the civilian surveys under the United States, have thoroughly demonstrated

their value, and shown that it is unnecessary to have a leader accompanying the parties mainly to direct the movements of those who have the entire work to perform, as the geologist in charge finds no difficulty, when he has the arranging of his own party, in doing his full share of personal scientific labor and at the same time guiding the general movements. And, in addition to this important consideration, I may add that such a leader not only occasions unnecessary expense to the Government, but often proves a source of discord and conflict.

Much greater efficiency has always been gained where the leader of the survey is himself an ardent worker in geology and science generally, as he is better able to judge of the work to be performed, and as he urges forward all his scientific assistants by the force of his example and enthusiasm. As an evidence of this, it is only necessary to refer to the geological reports of Owen, Foster, Whitney, Hall, Worthen, and others in this country, and those of Sir W. E. Logan in Canada, and Sir Roderick Murchison in Europe, &c.

On the other hand, it is found by experience that when a scientific party is placed under charge of one who is not himself a devotee and enthusiastic laborer in some special field of science, the work done is inferior in quality and quantity.

The higher the scientific character of the party, the more certainly do they demand a leader in full sympathy with them. Reports on such objects of natural history as can be collected and brought to the room of the naturalist may be, and often are, very valuable, no matter by whom collected, as the works of Professors Baird, Torrey, and others in these reports show. But such is not the case with the geologist; he must of necessity go upon the ground, and, to be successful, must organize his own corps, distribute the work, form his own plan, and have full control of the entire operations. But not only must the geologist go upon the ground in person; the same necessity exists in regard to the paleontologist and mineralogist.

If the language of the resolution is designed to include only scientific and geographical surveys, which are intended to ascertain the value of the public lands, and to determine their character by ascertaining their geological features, mineral and agricultural resources, productions, and climate, in that case, as the land department is under the Department of the Interior, and is one of the chief objects for which this Department was originally created, it certainly is proper that such surveys should be placed under its control and supervision. Placing them under the control of any other would be as unwise and injudicious as it would be to place the military surveys under the Interior or State Department.

In regard to combining these surveys under one control, or head, there can be but one real question: that they should all be under the Department of the Interior, there can be no reasonable doubt; this being conceded, the question arises, would it be judicious to place them under one bureau of that Department?

The first impression of many, in fact of most, persons, might favor such a plan, but I think more mature reflection will show that this is an erroneous idea. It necessitates the expense of a number of salaried officers, clerks, and employés, who are not needed so long as these surveys are special. If a geologist is placed in charge of this bureau, which must necessarily be done if it is to be of any value, it at once gives him a feeling of security and ease, and he no longer looks upon his continuance in office as depending upon the results of his surveys.

Such a system tends very strongly to crush out and destroy that scientific individuality from which the greatest results have always been derived. It also destroys that healthy emulation which produces extra exertion, gives stimulus to energy, and a proper regard for expenses. There is no necessity for such a system in order to prevent conflict or duplication, if all the surveys of this character are placed under the supervision and control of the Secretary of the Interior, as he can easily determine the plan of operation of each after consultation, and can prevent conflict or duplication of work. There is no complicated and extensive machinery necessary; each has its work to perform, and, having done this, reports annually, and the results determine the propriety of its continuance or discontinuance.

Thus, the continuance of each is made to depend upon the value of the work performed, and Congress is left the sole and the immediate judge as to the value. By combining these surveys under a bureau, these important features are, to a great extent, lost.

It is supposed by many who have no practical experience in geological surveys that the ordinary geographical and topographical surveys for other purposes will supersede the necessity for any geographical or topographical work in connection with these geological explorations. But experience has shown this to be erroneous.

Where the country is quite level and uniform in character, any map on a scale of sufficient size which is accurately done and has sufficient details will generally answer all the purposes of the geologist. But in a very broken and mountainous region, like that of the greater portion of the Western Territories, especially the entire Rocky Mountain region, no maps which have heretofore been made can possibly answer the purposes of the geologist.

In these geological surveys of the Rocky Mountain regions, the vertical topography and accurate and minute surveys of certain localities become of most vital importance. In presenting on maps and sections the geological character of these regions, often long and continuous transverse and longitudinal sections are also necessary, yet none of these are brought out in any case by the surveys which are made especially for military and geo-

graphical purposes. If the topography necessary for geological purposes is separated from the geological survey, and the two are done by separate parties, we find by experience that the cost is increased about 40 per cent., which is an important matter to be considered.

Therefore, both for economic and scientific reasons, geologists should control the geological surveys, and make such complete maps as are required to show the physical conditions and resources of the Territories. The maps, if complete enough for the above purposes, will be permanently suitable for all other uses.

Thus it is evident that there need be no unnecessary expenditure of the public money if each department is restricted to its own proper sphere of labor. Geology and geological maps certainly are the province of the geologist.

The resolution asks if it be not practicable to limit these surveys by geographical boundary-lines. To a certain extent this can and ought to be done; and if all the surveys which appertain to the business of the Department of the Interior are placed under the supervision of the Secretary of the Interior, there will be no necessity for, or danger of, conflict or duplication of work. While different surveys of the same character can and should to a certain extent be confined during the same period to different geographical districts, yet there are certain investigations in regard to geological explorations of the great Rocky Mountain range and bordering plains which cannot be thoroughly carried out if too rigidly limited by arbitrary lines.

For example, the great problem of the age and dynamic geology of this range, can never be properly worked out if the examination is limited rigidly to a given transverse section; the action of the great upheaving forces must be traced along their various lines of progress. Again, Professor Lesquereux, the leading fossil-botanist of our country, who has, in connection with the survey under my charge, been studying the lignite coal-beds of this region, in order to make his work of most value, and to determine the age, extent, and value of these beds, must follow them up and examine them throughout, without being confined too rigidly to a given section. Likewise the special paleontologists must, to make their work efficient, be allowed a like privilege. Yet this does not conflict with the idea of confining the main part of each survey to a given district.

In concluding, allow me to say that I think, as these surveys are made at public expense, their utilitarian or general economic object should never be lost sight of; although I believe the Government would be justified in carrying them on if confined to a purely scientific purpose, yet it is the duty of Government to make them of a more general and public benefit. This, therefore, should be, and also has been with me, a very prominent object; while I have endeavored, as far as possible, to add to our scientific knowledge, I have always felt it to be my duty to keep constantly in view, as the primary object, the gathering of such facts and knowledge as will be of use to the public, and tend to develop the material resources of the Territories. To this end I have made it a special object to investigate the value and extent of the coal-fields of this region, its mineral, timber, and agricultural resources, its climate and productions, and, in order to bring this information before the public in as rapid, concise, and useful manner as possible, I have adopted the method of preparing annual reports, using, in all but the purely scientific portion, plain and popular language.

To make these surveys the more directly beneficial, I have, with your consent and advice, gone to those sections which appeared at the time to be the chief objective points of immigration and improvement, striving to keep in advance of the wave of pioneer population, and especially in the direction in which you were moving the land-surveys. In this way you have, by controlling the movements of the land and geological surveys, been prepared to give useful and important information to the many who were seeking homes in the Far West. Therefore, if these surveys are not kept under the control of the Secretary of the Interior, all these important and beneficial results will be wholly lost.

Very respectfully, your obedient servant,

F. V. HAYDEN,
United States Geologist.

Hon. C. DELANO,
Secretary of the Interior.

WASHINGTON, D. C., April 24, 1874.

SIR: In reply to your letter of the 20th instant, I have the honor to make the following statement:

In the year 1870, the survey of the Colorado River of the West and its tributaries was authorized by act of Congress, and the work placed under the direction of the Secretary of the Interior. The following year provision was made for the continuance of the survey, and the work was placed under the direction of the Smithsonian Institution, and has been under the same supervision up to the present time.

Green River is the true upper continuation of the Colorado, and the course of these rivers between the point where the Union Pacific Railroad crosses Green River to the mouth of the Rio Virgin, a tributary of the Colorado, was to be a meandering base or central line of the work. We began by establishing astronomic stations along the course of these streams, averaging in distance apart about forty-five miles by the winding course of the rivers, but

about twenty-five miles in direct lines. These astronomic stations were used as the extremities of lines from which extensive series of observations were taken for the purpose of constructing a net-work of triangles as the base of the topographic work. Then the topographic features were sketched, the most salient points being determined as above indicated. This method was the same as that which had been adopted in previous explorations and reconnaissance of railroad-routes and boundary-lines of Territories, and adopted by various officers of the Government, except that we attempted to make it more thorough and elaborate than anything which had been done previously.

With this geographic work, a geological survey was connected, and it was found that the maps produced from the results of this method were not sufficiently accurate for the proper presentation of the geological facts collected. This inadequacy of the topographic work resulted in the adoption of another method, viz, the expansion of a system of triangles from measured base-lines.

By the first method a district of country embracing 20,000 square miles was explored and mapped, and by the more accurate method last mentioned an area of 25,000 square miles has been surveyed and mapped, including in this survey the descent of the river in boats for more than a thousand miles—a river more difficult to navigate than any other on this continent, or perhaps in the world, running as it does in a gorge varying from a few hundred to six thousand feet in depth, obstructed in many places along its course by dangerous rocks, and beset with rapids and cataracts.

For more detailed information concerning the work which has been performed, I would most respectfully refer you to a report which I have just prepared, to be submitted to the Secretary of the Smithsonian Institution, a copy of which I transmit herewith.

There is now left within the territory of the United States no great unexplored region, and exploring expeditions are no longer needed for general purposes; their methods do not produce results sufficiently accurate to warrant their continuance for economic purposes, as the industrial interests of the country are not greatly subserved by them; nor are the results for scientific purposes of an importance commensurate with their expense.

A more thorough method, or a survey proper, is now demanded. I need not mention the importance of such a survey to the General Government, and also to the State governments, for purposes of intelligent legislation on the railroad interests of the country, nor the value it would be to those persons or companies engaged in the construction of railroads; nor need I mention the importance of such a survey in determining the mineral resources of the country—deposits of coal, salt, ores, precious metals, &c.

About two-fifths of the entire area of the United States has a climate so arid that agriculture cannot be pursued without irrigation.

When all the waters running in the streams found running in this region are conducted on the lands there will be but a very small portion of the country redeemed, varying in different territories perhaps from 1 to 3 per cent. Already the greater number of smaller streams, such as can be controlled by individuals who wish to obtain a livelihood by agriculture, are used for this purpose; the largest streams, which will irrigate somewhat greater areas, can only be managed by co-operative organizations, great capitalists, or by the General or State governments.

It is of the most immediate and pressing importance that a general survey should be made for the purpose of determining the several areas which can thus be redeemed by irrigation. But I will not further discuss the importance of a thorough survey for economic and scientific purposes, but will simply say that a survey which meets all these demands must be thorough and accurate; and if it fails in any of the particulars indicated, such a failure will necessitate a resurvey of the country, involving the General Government in greatly-increased expense.

I have no hesitancy in expressing the opinion that all surveys made for these general purposes should be under the management of one Department, that the work may be properly co-ordinated and kept up to that standard of excellence necessary to the required result.

While I am decidedly of the opinion that it is not wise to continue a system of explorations or meandering surveys for the general purpose indicated, it is not perhaps within my province to say that they are not necessary for military purposes.

If military explorations are needed for such special reasons, it might be well to carry them on without regard to the general survey; but if these military explorations are intended to subserve the purposes of the general survey also, the territorial limits of the various surveys should be defined by act of Congress or regulated by departmental instructions. It would seem to be unnecessary to conduct both over the same areas with the same end in view, and experience has demonstrated that such will be the case under the present management, for quite a large part of the territory embraced in the survey of which I have had immediate direction has been subsequently re-explored by military parties, and this can only be justified on the ground that such exploration was necessary for military purposes, of which I am not a judge.

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

J. W. POWELL,

In charge of the Colorado River Exploring Expedition.

The Hon. SECRETARY OF THE INTERIOR,
Washington, D. C.

As the views of the officers of the War and Interior Departments on the subject of the resolution were antagonistic, and as there were no instructions from the House concerning the message and accompanying papers, the committee conceived it to be their duty to inquire and examine into the subject-matters referred to in the resolution, and, in the light of the information contained in the message and accompanying papers, and such information as they could otherwise obtain, to report to the House their conclusions thereon.

With this end in view, they requested the attendance of Lieut. G. M. Wheeler, Dr. F. V. Hayden, and Mr. J. W. Powell, chiefs of the geological and geographical surveys of 1873, as being the persons most intimately connected with the surveys and most able to give them the desired information.

As their inquiry proceeded, it was thought advisable to request information of General A. A. Humphreys, Chief of the Engineer Corps of the Army, and of Hon. C. Delano, Secretary of the Interior, and of James T. Gardner, topographer to Dr. Hayden's expedition. A written report of Lieutenant Marshall and other documentary matters from the War Office were submitted, and statements from scientific institutions and individuals were laid before them.

The statements of the gentlemen above named and the documents mentioned were submitted to them freely and without hesitation, and are annexed to this report.

Upon the inquiry as to what geological and geographical surveys were operating west of the Mississippi, there was no difference of opinion.

They were acknowledged to be Lieutenant Wheeler's, under the direction of the War Department; Dr. F. V. Hayden's, under the Interior Department; and Mr. Powell's, under the Smithsonian Institution. There were also some minor surveys under Captain Ludlow, Captain Jones, and Lieutenant Ruffner, of the Engineer Corps, which appear to have been reconnaissances rather than minute geographical surveys, and do not come within the purview of the resolution.

Early in the present century it was deemed desirable to the Government to know the extent and character of the great and unexplored region lying between our western settlements and the Pacific Ocean.

With that view, an expedition was fitted out under Captains Lewis and Clarke, who made their way through the then untrodden wilderness to the Pacific, bringing back such information concerning the interior of the continent as their imperfect outfit and the perils and dangers and disasters attending their travel would admit.

Many exploring expeditions followed them, in the endeavor to trace the course of rivers, the trend of mountains, the position of lakes, and to ascertain the vegetable and mineral wealth of the interior of the continent.

These expeditions, however, until a comparatively recent date, were little more than reconnaissances, fixing imperfectly, but approximately, the positions of certain points, and furnishing the rude materials with which to commence to form a geographical map of the vast interior.

After the discovery of gold in California and a want was felt of a better route thereto than the one around Cape Horn or across the plains, surveys were made with a view of making a railroad to the Pacific coast.

These surveys took a more accurate form than those which had preceded them; but as they were confined principally to a search for the most practicable route for a railroad, they were necessarily made along the lower levels of the country, and had little connection with the

higher ranges or loftier mountain:peaks. They afforded little knowledge toward a topographical or geological map of the country, beyond the narrow limits traversed, with their particular end in view. They established the geographical locations of prominent points as they proceeded, noted the courses of the streams, sketched hastily the geology of the country that lay directly in their path, but did not attempt to make a refined topographical, geological, or geographical survey of the country through which they passed.

These explorations were made principally under the direction of the War Department, which, about 1857, ordered Lieut. G. K. Warren, of the Topographical Engineers, to compile "a map of the United States territory between the Mississippi River and the Pacific Ocean, intended to illustrate the reports upon the Pacific Railroad explorations."

Lieutenant Warren says in his report that "the maps used in the compilation have been mostly made from reconnaissances, and but few possess very great accuracy. The geographical positions are therefore rarely determined, absolutely or even relatively, with certainty, and new surveys are constantly making slight changes necessary."

This remark was illustrated in the fact that several prominent points were located from three to twenty miles from their correct position, a matter not to be wondered at considering the difficulties attending the surveys and the want of the better instruments of modern times.

At a still later date, commencing in 1867, a geological survey of the country along the fortieth parallel and west of the one hundredth meridian has been prosecuted under the Engineer Department by Clarence King, and is one of those mentioned in the letter of the Chief of Engineers.

This survey has been made entirely by civilians, and has been executed with much minuteness and care. It embraces an area extending from "the eastern boundary of California to the eastern slope of the Rocky Mountains, stretching north and south something like one hundred miles."

The only results of that survey yet published are a quarto volume on the botany of the region explored and a quarto volume on its mining-industry, both very handsomely published, but more expensively done than a due regard to economy would allow; \$10.60 being the cost of each of the two volumes already printed, and \$8.60 the estimated cost of those yet unpublished. Some maps have also been published, and others, with three additional volumes, are in the course of preparation.

Later geographical and geological surveys, under the charge of Lieut. G. M. Wheeler, have been instituted, and are in progress; and being furnished with the improved instruments and appliances of modern times, the latest of his explorations is a type of the scientific surveys of the War Department as now carried on.

The great need of the War Department is an accurate topographical map of the country, in order to show the best routes between military posts, the best routes for new roads, proper situations for military stations, and a description of the physical features of the country surveyed. In connection with this information, but subsidiary thereto, is a knowledge of the botany, geology, and mineralogy of the parts surveyed, so as to enable the Department to know the character of materials and productions of the soil that may be found, proper for the erection of military posts, the sustenance of men and animals, and to the making of military roads, and also as conducive to the general settlement of the country by immigration.

Under such instructions, Lieut. Wheeler, in 1869, 1871, 1872, and 1873,

made surveys of parts of California, Nevada, Utah, Colorado, and New Mexico.

His first expedition was more a reconnaissance than a survey; but his later expeditions comprised astronomical, topographical, meteorological, and geological observations, and the making of collections in natural history. His party consisted of four officers of the engineers, two of the line, two medical officers, and three astronomical assistants, seven topographers, three meteorologists who were engineer soldiers, three geologists, and two collectors of natural history, and an escort of sixty soldiers; all but the officers, escort, and meteorologists being civilians. Prominent points were established with accuracy by astronomical and geometrical observations by very capable astronomers, and by connecting them with the well-established stations at Denver and Salt Lake City; but a portion of his surveys was made by the meandering method, with the aid of the odometer for measurements, and is therefore not of equal accuracy. Indeed, the large area of country traversed in those expeditions precluded the possibility of accurate geometrical measurements between the established stations, except in those cases where they could be determined by triangulation, and large interior areas were left unsurveyed, as inaccessible, or not immediately necessary to be known for military purposes. They were sufficiently accurate, however, for the military uses mentioned.

The only results thus far published of those expeditions are four topographical maps, which are not of a character to be colored to show the geology of the country; a "progress-map of lines and areas of explorations and surveys" under the War Department, showing the explorations of Clarence King and Lieutenant Wheeler; and a "drainage-map" of the country west of the Mississippi River. There have also been published of these expeditions two preliminary reports, two astronomical reports, and two tables of camps and distances, amounting to about four hundred pages of letter-press; and the photographer of the expedition has taken stereoscopic views of many of the curious geological formations of the country traversed, and of groups of the aboriginal inhabitants.

Material has been gathered for six quarto volumes and a topographical and geological atlas, the publication of which awaits the action of Congress.

Large contributions to the natural history of the country are also among the results of these expeditions, and some are deposited in the Smithsonian Institution, and others remain in the hands of scientists of the country for classification.

Other explorations have been made by other officers during the same year; but as they have been mere reconnaissances, and do not aspire to the rank of topographical surveys, they are not mentioned here.

As the explorations of Lieutenant Wheeler had for their primary object the topographical survey of the country traversed, so the surveys of Doctor Hayden had for their primary object the illustration of the geological formation of the Western Territories, together with the accurate ascertainment of the true geographic position of prominent points that might hereafter remain as the starting-points of land-surveys, the courses of rivers, the position of lakes and mountain-ranges, the opportunities of irrigation, and the investigation of the geological, mineralogical, botanical, zoological, and paleontological riches and resources of the country.

Doctor Hayden is a geologist of twenty years' experience, and has explored the Western Territories very extensively. His later explorations and surveys, commencing with the geology of Nebraska in 1867, have been

under the Department of the Interior. From 1869 to 1873 he has surveyed parts of Colorado and New Mexico, Wyoming, Utah, and Montana.

His corps of assistants is composed of some twenty scientists drawn from the ranks of civil life, and consists of men who are eminent in the various branches of science committed to their charge.

His last expedition in Colorado being a type of his latest and most approved methods of survey, the geographical part of it, as executed by Mr. James T. Gardner, who was Mr. King's chief geographer, may be mentioned here :

"It was based on a trigonometrical survey, with an astronomical base, which was made by the Coast Survey," and which had fixed the precise positions of Sherman and Denver on the map of the Western Territories.

"A base-line of six miles in length was made by Mr. Gardner, and from that a series of primary triangles was extended over the whole area which had been laid out for the summer's work. From that basis these triangles were extended, and Mr. Gardner made his primary triangulation from the tops of the most prominent peaks in that area. All the angles of the triangles were repeatedly observed to determine whether the three observed angles of the triangles when corrected for spherical excess summed up to 180 degrees. The mean error of the primary triangles in Colorado was claimed to be only ten seconds and three-tenths. Inside of that net-work, each one of the distinct parties made a still more detailed net-work of what are called secondary triangles, lying within these primary triangles, so that one acts as a check on the other. Many of these points are made so accurately that mining-claims can be accurately determined from them.

"There was a peak the party was unable for a considerable time to find, because it was located on the maps thirty miles out of its true place. That was the mountain of the Holy Cross.

"The height of the mountain-peaks, the elevation of the surrounding country, the thickness of strata, &c., are determined by barometrical observations, and by means of these topographical surveys, and the various geological formations, whatever they be, whether cretaceous, carboniferous, volcanic, or granitic, whether they be mines or anything of that kind, are laid on the map with great precision by the geologist, with the aid of the topographer."

"The geologists mark with colors the geological formations on little outline-maps made from day to day," as the basis for a more perfect map to be made thereafter in the office.

This minuteness of work, embracing the whole area marked out for the summer's labor, gives great topographical, geographical, and geological accuracy, and makes the main points thus established a desirable contribution to the corrected map of the United States, which yet remains to be executed.

The results of these expeditions, so far as published, are the annual reports of Doctor Hayden for the years 1869, 1870, 1871, and 1872, concerning Colorado and New Mexico, Wyoming and contiguous Territories, Montana, Idaho, Wyoming, and Utah. They are in octavo form, and contain two thousand and twenty pages of letter-press and one hundred and seventy-five illustrations. Some of them are devoted to the description and illustration of the wonderful geysers and geological curiosities found around the headwaters of the Yellowstone, and revealed volcanic operations so extraordinary as to cause Congress to set apart 3,600 square miles of territory containing them for a national park forever. Besides these, there are six pamphlets and two bulletins. The report of the expedition of 1873 is ready for the press and will soon be published.

These reports have been prepared and printed, to the number of 45,000 in all, within less than a year of the termination of the survey in the field; and, having been distributed promptly after their publication, have afforded early information of the results of the expeditions.

The photographer of the expedition also took large photographic views of the most curious geological formations, and the collectors of objects of natural history made very extensive collections in all departments of natural science, which have been deposited in the Smithsonian Institution, and are undergoing classification.

The other geological and geographical survey particularly alluded to in the papers accompanying the President's message is the survey of the Colorado of the West and its tributaries, by J. W. Powell, under the direction of the Smithsonian Institution.

Mr. Powell had been engaged in the survey of Western Colorado and Utah in 1867-'68, and in 1870 Congress made a small appropriation for the purpose of having an exploration of the Colorado River and its tributaries, whose wonderful cañons and the strange geological formations connected therewith had long been heard of, but were imperfectly known.

Mr. Powell has been engaged on that survey for the last four years. His methods of survey were of the most accurate character. The latter part of his survey was devoted to an examination of the Marble Cañon and the Grand Cañon of the Colorado.

To obtain the greatest possible accuracy he ascertained the latitude of the northern part of his base-line by astronomical observations, and his longitude by telegraphic signals from Salt Lake City. His base-line was over nine miles in length, and was measured with wooden rods, leveled on trestles, and aligned by sighting on small steel pins in either extremity.

The rods were thoroughly seasoned, oiled, and varnished, and the extremities shod with metallic cones to insure accurate contact.

Then a system of triangles was extended from the extremities of the base-line over the country, "so as to embrace all the country from the Mar-ka-gunt and Panus-a-gnut plateaus on the north to salient points a few miles south of the Grand Cañon, and from the Beaver Dam and Pine Valley Mountains on the west to the Navajo Mountain beyond the Colorado on the east, and as far north as the southern tributaries of the Dirty Devil River. The angles of these triangles were measured with a seven-inch theodolite. Six of the more distant and important geodetic points were used as astronomical stations, where observations were made with the zenith telescope for latitude for the purpose of checking serious errors in triangulation."

Thus the positions of all the salient topographic features were determined, courses of streams and lines of cliffs meandered, and the great features of Marble Cañon and the Grand Cañon of the Colorado and many prominent points on either side of the great chasm were fixed by triangulation.

The force employed by Mr. Powell in the year 1873 was eight scientists, besides himself, and seven temporary employés.

The results of his surveys have not yet been published beyond a preliminary report and an outline-map of the rivers surveyed, and a geological map in addition.

They consist of the manuscript for three quarto volumes and several maps, and await an appropriation for the engraving of the maps and printing of the volumes. There are, also, collections of minerals and fossils turned over to the Smithsonian Institution, and some of them

in the hands of scientists elsewhere for the purpose of classification. From this brief sketch drawn from the testimony submitted to the committee, and which will be found in the appendix, it will appear that each of the surveying parties has been doing very excellent work for the benefit of the people and appropriate for the particular end it had in view.

The surveys of the War Department were sufficient for their primary object—the making of a military map for the use of that Department, although not sufficiently minute for the formation of a geological map of the country surveyed.

The other surveys appear to have been made with more minuteness and detail, and while they serve to illustrate the geology of the country traversed, they also serve as valuable and reliable contributions to the great geographical and topographical map of the West which is at a future day to be made. It seems to the committee that with a little additional expense they can be made of sufficient topographical and geographical minuteness to be of as much use to the War Department for military purposes as the maps made under the auspices of that Department, being made by the best scientists of the nation, some of whom have been heretofore employed by the War Department in similar work.

There is an abundance of work for the best talent of both the War and Interior Departments in these scientific examinations of the Western Territories for many years to come, and the committee believe that at present it would not be of public benefit to place the whole of the surveys under one Department.

The time is approaching, however, when it may be proper so to consolidate them, with a view to the making of a grand geographical, geological, and topographical map of the Territories worthy of the nation because of its accuracy and minuteness of detail; and the committee believe that they would be conducted most to the public interest by being placed under the control and guidance of the Interior Department.

The limited number of officers of the Engineer Corps, being only about one hundred in all, their general training for military pursuits rather than pursuits in natural science, and the demands upon their services in the superintendence of the erection or repair of fortifications and military posts, the examination of rivers and harbors, the making of military roads, the care of the light-house system, and many other duties that devolve upon them, render it impossible for the War Department to detail a sufficient number of skilled officers to perform these surveys; hence it is that they have to draw on the scientific men in civil life for the larger portion of the work attendant upon such explorations, as appears in the *personnel* of the expeditions.

All the officers of Clarence King's surveys made under the War Department were civilians, as well as the larger portion of those under Lieutenant Wheeler.

The War Department seems, therefore, not to have the requisite force at command for such work; and as these surveys must rapidly increase in magnitude to keep in advance of the settlement of the Territories, the inadequacy of the Engineer Corps, burdened with its other multiplied duties, to carry them on, without aid from civilians, will become more apparent.

The management and care of the public lands belong to the Interior Department. It is pushing its sectionalizing surveys rapidly into the Territories. It is of benefit to it to know what portions of the Terri-

tories are best adapted by their mineral wealth, their arable condition, their supply of wood and water, and coal and iron, for the maintenance of our rapidly increasing population, and hence geological surveys of unexplored Territories give information to the Department of the direction in which the sectionalizing surveys should be carried.

The geological and geographical examinations will be made in advance, and point out the way to favorable regions of country, and fix the main points or stations from which the land-surveys will be conducted; and the two operating together in harmony, under the direction of the Interior Department, will so determine the geography and geology and topography of the country as not only to be available to that Department, but, also, to serve for all the requirements of the War Department, so far as a full knowledge of the country may be involved.

These surveys of the Territories render it desirable to the Secretary of the Interior always to have under his direction and control a corps of scientists to make them, preliminary to the more minute ones for settlement and cultivation.

The committee have no words except of commendation of the labors of either survey. Their work of last year was more accurate than it had ever been done before, and creditable to all; but as there are numbers of eminent men in civil life, of great scientific attainments, ready to take part in these explorations, they think it advisable that the surveys conducted, under the direction of the Interior Department, by Doctor Hayden, should be continued, and that the one conducted under the Smithsonian Institution, by Professor Powell, should be transferred to the Department of the Interior.

By such continuance of those surveys, Congress will give its distinct recognition of the value of the services of eminent scientific men in civil life, and will give an impulse to the prosecution of physical and natural science that will eventually redound to the credit and benefit of the nation.

In this conclusion they are strengthened by the testimony of several of the literary and scientific schools of the country and of men eminent in the highest walks of physical and natural science, and whose labors as specialists have been sought to illustrate the results of the surveys of both Departments of the Government.

In thus keeping separate, for the present, the surveys now making under the War and Interior Departments, a generous rivalry will be maintained among the good men therein, and a stimulus will be given to each to do the best work possible, and a resulting benefit will ensue in more accurate surveys and more extensive and valuable maps and reports.

As to the practicability of assigning different areas for the surveys under the two Departments of War and the Interior, there can be no difficulty.

The committee cannot anticipate that the Secretaries of the two Departments will ever be so wanting in attention to the public interests as to send out surveying parties that will be overlapping each other and duplicating their labors at a loss to the people. Those now in office have both expressed a conviction that no trouble of that kind need arise, and that a very brief consultation will enable them to assign to their respective surveying parties such areas as will enable them to prosecute their labors without the danger of duplication, and for the national benefit.

It is true that a small portion of Colorado was surveyed by two parties last year, and it was charged that it was done in violation of an

agreement between them. As the evidence is directly contradictory and of equal weight on both sides, the committee are of opinion that it was the result of a misunderstanding and not of a preconcerted design.

Ill-judged and hasty expressions have been used on either side, which good taste would have withheld, but there is no good reason why there should be an antagonism between any members of either survey, and with true scientists there can be no rivalry save that arising from a generous desire to excel in their respective specialties.

As the relative economy of the respective surveys has come in question, the committee feel bound to say that they believe the surveys under the Interior Department were conducted with less comparative expense than those under the War Department, considering the amount of money expended and the results thus far exhibited.

The appropriation for the War Department survey for the current fiscal year was \$90,000. This did not embrace the expenses of the Army officers, the medical officers, nor of the sixty soldiers used as an escort. It is proper, however, to say that a portion of that extra expense would have been incurred whether the officers and men were in the survey or otherwise engaged. The published results of the work of those surveys, however, has been rather limited, and an additional appropriation is needed to perfect the work already done and preparing for publication.

The appropriation for Doctor Hayden's survey for the current fiscal year was \$75,000, and an additional appropriation has been asked for of \$20,000 to complete the work. To offset this deficiency there remains \$20,000 of material on hand. The supplies he received from the Army stores were paid for by him. The published results of his surveys for the last four years have been quite extensive, as heretofore shown, and have been promptly made available for public use.

The appropriation for Mr. Powell's survey last year was \$20,000, for which no published results have yet been shown, except a preliminary report and a map or two prepared, and an additional appropriation is needed to perfect the work already done in the field.

The two last-mentioned surveys have been entirely conducted by civilians. For the last two years Doctor Hayden has had no military escort, and needed none. For the year preceding, he had for a short time the escort of seven men.

During his entire surveys, Mr. Powell has had no military escort. Both gentlemen say they need none and desire none, and that such escorts are but a hindrance to their free operations in the field. In the Indian country they are considered by the Indians as a challenge to fight. In other parts they are an obstacle to free movement of the scientists. The expense, therefore, of military escorts is not incurred by the surveys under civilians.

The conclusions, therefore, to which the committee have come are, that the surveys under the War Department, so far as the same are necessary for military purposes, should be continued; that all other surveys for geographical, geological, topographic, and scientific purposes should be continued under the direction of the Department of the Interior, and that suitable appropriations should be made by Congress to accomplish these results.

The statements and letters upon which these conclusions are based will be found in the appendix to this report.

The committee desire that this report be printed and referred to the committee on appropriations, and that this committee be discharged from the further consideration of the subject.

APPENDIX.

- No. 1. Statement of Lieutenant G. M. Wheeler.
2. Statement of Lieutenant G. M. Wheeler.
3. Statement of Dr. F. V. Hayden.
4. Statement of Dr. F. V. Hayden.
5. Statement of General A. A. Humphreys, Chief of Engineer Corps.
6. Statement of Lieut. G. M. Wheeler.
7. Statement of Prof. J. W. Powell.
8. Statement of Prof. J. W. Powell.
9. Statement of Jas. T. Gardner.
10. Statement of Jas. T. Gardner.
11. Statement of Hon. C. Delano, Secretary of the Interior.
12. Statements of Professor Powell and Lieutenant Wheeler.
13. Statement of Jas. T. Gardner in reply to Lieutenant Wheeler.
14. Statement of Doctor Hayden, in reply to Lieutenant Wheeler.
- 14½. Statement of Lieutenant Marshall and Lieutenant Wheeler concerning agreement between Marshall and Hayden.
15. Statement of Jas. T. Gardner concerning agreement between Doctor Hayden and Lieutenant Marshall.
16. Memorial of scientific bodies in favor of the surveys under civilians.
17. *Personnel* expenses, and collections of Lieutenant Wheeler's survey.
18. Letter of General A. A. Humphreys, giving publications of War Department.
19. Letter of General A. A. Humphreys, stating cost of Clarence King's volumes.
20. Letter of Commissary of Subsistence, concerning supplies furnished Doctor Hayden.
21. Letter of Lieutenant Wheeler, concerning the correction of the position of Salt Lake City.
22. Letter of Lieutenant Marshall, concerning the correction of the position of Salt Lake City.
23. Two letters of General Humphreys, concerning Lieutenant King's survey under the War Department.
24. *Personnel* of the United States geological and geographical survey of the Territories, with statement of expenditures, Army transportation, &c.
25. Statement of appropriations to Doctor Hayden's surveys.
26. Abstract of the publications of the United States geological surveys of the Territories.
27. Abstract of the publications of the War Department, showing work done by civilians.

GEOGRAPHICAL AND GEOLOGICAL SURVEYS.

COMMITTEE ON THE PUBLIC LANDS,
Washington D. C., May 11 1874.

No. 1.—*Statement of Lieutenant Wheeler.*

The CHAIRMAN. On the 15th of April last the House adopted a resolution requesting the President of the United States to inform the House what geographical and geological surveys, under different departments and branches of the Government, are operating in the same and contiguous areas of territory west of the Mississippi River, and whether it be not practicable to consolidate them under one department, or to define the geographical limits to be embraced by each.

That resolution was referred to the President, and he has sent his message to the House, accompanied by a letter from Mr. Belknap, Secretary of War, and from General Humphreys, Chief of the Corps of Engineers, concerning the geographical and geological surveys of the War Department.

It is also accompanied by a letter from the Secretary of the Interior, Mr. Delano, and by a letter from Professor Hayden, United States geologist, and from J. W. Powell, in charge of Colorado exploring expedition. When the message came to the House, it was referred to the Committee on the Public Lands without any specific instructions as to its duty in the matter.

The questions which seem to be presented in the resolution are these: First, as to the number of geographical and geological surveys; second, as to the practicability of consolidating them; and, thirdly, as to defining the geographical limits to be embraced by each. Incidentally springs up another question alluded to by the President, as to the economy of the respective methods of making those geographical and geological surveys.

The first question in the resolution is already answered, because both parties agree to the fact that there have been these three expeditions. The only remaining questions for the committee to consider are as to the practicability of consolidating them, or whether we can define the geographical limits to be embraced by each. In order to arrive at those conclusions we have asked the gentlemen who are at the head of these three expeditions to appear before the committee to give us their views on the subject. As the War Department appears to take precedence in the matter, we will first call upon Lieut. Wheeler, and probably the best way is for him to take his own course, in regard to the statement he desires to make, and then the committee can subsequently ask him any questions that may be suggested by his statement or the report.

Lieut. WHEELER. The chairman suggests the idea of my taking my own course in what I have to say. I would call the attention of the committee to the fact that under the War Department there are several other expeditions than my own; and I do not consider that it would be proper for me, unless by authority of the Chief of Engineers and the Secretary of War, to speak as to any other survey than my own.

The CHAIRMAN. Perhaps you had better confine yourself to your own. Please state the number of expeditions, and then speak of your own.

Lieut. WHEELER. I would have no right, sir, to speak for the War Department, although I may know their views. The expeditions that have been carried out under the War Department, with headquarters at Washington, since I have been engaged upon this duty, or since 1868, have been those of Mr. King, in charge of the survey of the fortieth parallel, and four under my charge, the expedition of 1869, and the expeditions of the field seasons of 1871, 1872, and 1873. There are some facts connected with these expeditions that it may be well to state; but, if I enter into the subject further than this report goes, I think it will be better that I should answer categorical questions put by the committee, because otherwise I might not touch upon the points that the committee desires to elucidate, though I shall be very glad to answer as to any of them or all of them.

The CHAIRMAN. The limits of this resolution are very narrow. It will be well for you to go on and state generally the manner in which these expeditions have been carried on by you. Probably you had better begin and state what you have done, from the time you started in 1869.

Lieut. WHEELER. That expedition of 1869 was carried on while I was serving at the headquarters of the Department of California, on the staff of General Ord, and was more a reconnaissance than a survey by triangulation processes. The subject of the more economic transit of troops from the more northern Territories to Arizona had been mooted, and information bearing upon this was one of the objects of that expedition. The troops had formerly been exchanged; first, by transfer to the coast, and then by a circuitous and very expensive route, by sea and land, touching at ports on the coast and at San Francisco. The notes of that expedition were reported at that time, and out of them grew the maps that were then made. In the spring of 1871 I was ordered to Washington and placed in command of an expedition which took the field in 1871. We had been engaged meanwhile in working up our notes, and in making various military surveys upon which I was detailed, and on which several trips were made into the interior. That was more particularly a military expedition. The next one was the expedition of 1871, which, according to my instructions, was to make geological investigations, and such collections in natural history, and such observations on points connected with the character and habits of the Indian tribes, as might be necessary to meet the general needs of the War Department, and perhaps of other Departments of the Government, though I don't know how much use of them they may have made; but the work itself was founded upon wants experienced in the use of then existing maps. The great necessity that exists, so far as the War Department is concerned, is to have a correct topographical map of that country.

Coming in from that expedition, at the request of the War Department, I prepared elaborate plans and statements, and a project for a topographical atlas of such portions of the country as lie west of the 100th meridian.

The CHAIRMAN. What was the character of the work done in that expedition? What did it embrace scientifically?

Lieut. WHEELER. Scientifically it embraced astronomical, topographical, meteorological, and geological observations, and also the making of collections in natural history. The expedition was also accompanied by a photographer. That project was approved by the War Department with the expectation that this expedition, and such others as were carried on under their auspices, would gather the materials for the final preparation of complete and comprehensive topographical maps. There are other maps now being compiled at the headquarters of the geographical military divisions and departments, and also at the headquarters of the Army, where are gathered all the information obtained by officers sent out on scouting parties, &c. Again, in 1872, we took the field from Salt Lake City. That expe-

dition embraced portions of Southern and Southwestern Utah. In 1873, with more money, and more officers and civilians skilled in their duties, we took the field at three different points—at Denver, Col., Santa Fé, N. Mex., and Salt Lake City, Utah. Independent of the field-working parties we had astronomical parties organized for the purpose of taking elaborate observations at different points along the line of the Pacific Railroad, and other points within the field of survey; and in addition to them meteorological observations. Altogether there were seven working field-parties this year, and there were in the field at one time five astronomical parties. There was built, also, an observatory, which is to be a permanent working observatory for such field astronomical parties as may occupy this territory from time to time by the War Department. That was in 1873.

This year we covered a little area in the central part of Utah for the purpose of filling out atlas-sheets 50 and 59, so as to have them complete. And the work of that expedition has already been published upon those sheets. We covered, also, sheets 76 and 83, and also portions in sheets 77 and 84; likewise an area somewhat rectangular in form in the central portion of Colorado, for which we have gathered map-materials. This expedition, like the others, has involved the official and civilian *personnel* necessary to make the observations in the different branches which I have referred to. The results of the expedition are well advanced toward publication. Our material is in manuscript form, and we are only awaiting the action of Congress to enable us to make illustrations for our reports. Our expeditions are organized, having in connection with them officers of the Corps of Engineers, officers of the Army who have been detailed so far only with the parties in the field, and medical officers of the Army who look after the welfare and health of the troops, and who are also engaged in making natural history collections, usually selected for their attainments in some one of the branches of natural history. We have, also, civilians who are skilled in the topographical, geological, and meteorological branches. To the officers of the Engineer Corps are delegated the astronomical functions, and the astronomical duties outside of that done at the main astronomical stations.

The CHAIRMAN. I wish to know a little more concerning the *personnel* of the expedition and its operations generally. When did you graduate?

Lieut. WHEELER. In 1866.

The CHAIRMAN. How long have you been engaged in this geographical and geological work? The expedition of 1869, I think you said, was the first in which you were engaged?

Lieut. WHEELER. I do not wish you to involve me in the geological work. I am not a geologist, and I have no special attainments in that line. The geographical work, in one form and another, I have been engaged in since September, 1868.

The CHAIRMAN. How many persons had you in your service this last year on your survey?

Lieut. WHEELER. Do you wish me to state the exact number?

The CHAIRMAN. As near as you can.

Lieut. WHEELER. Besides the officer in charge there were 3 officers of the Corps of Engineers, 2 of the line, 2 medical officers, and 3 astronomical assistants constantly employed—two for a part of the field season; 7 topographers, 3 meteorologists; but they were engineer soldiers; also, 3 geologists, and 2 collectors of natural history. There was an escort of about 60 men for all the parties. I may possibly have made a mistake of one or two persons, but I can refer to my books if the committee desire, and give you a complete list of the persons, their names, &c.

The CHAIRMAN. You may bring them down at the next meeting. How many civilians were there in this expedition who had scientific duties assigned them?

Lieut. WHEELER. I have stated the number.

The CHAIRMAN. How many were there altogether?

Lieut. WHEELER. I would state to the committee that our expedition last year was larger than any one we had before. They have been increasing in size every year.

The CHAIRMAN. What portion of the scientific work was done by the Army officers?

Lieut. WHEELER. The astronomical part in the field, besides the executive duties. They were called upon for more laborious duty than any other of the members of the expedition.

The CHAIRMAN. Their labors were chiefly astronomical and executive; that is, supervising and carrying out plans, and supervising everything?

Lieut. WHEELER. Yes, sir.

The CHAIRMAN. The scientific corps was composed entirely of civilians, except the meteorologists?

Lieut. WHEELER. I object to the term "scientific corps" in that connection.

The CHAIRMAN. I am speaking of these men who did the astronomical work, and the topographers.

Lieut. WHEELER. The most scientific work, so far as the field-work is concerned, is done by the engineer officers.

The CHAIRMAN. Did these medical men belong to the Army?

Lieut. WHEELER. Yes.

The CHAIRMAN. And the topographers?

Lieut. WHEELER. They were civilians.

The CHAIRMAN. And the meteorologists ?

Lieut. WHEELER. They were engineer soldiers.

The CHAIRMAN. The geologists ?

Lieut. WHEELER. They were civilians.

The CHAIRMAN. The collectors of natural history ?

Lieut. WHEELER. They were civilians.

The CHAIRMAN. What other scientific men were there that were civilians ?

Lieut. WHEELER. None other. I think you have gone through the list.

The CHAIRMAN. What has become of the collections that were made ? Are they in the Smithsonian, or where are they ?

Lieut. WHEELER. Partly at the Smithsonian, and a great number of them in the hands of scientific gentlemen who are working them up, and others are at our office in this city.

The CHAIRMAN. Where are the results of these expeditions of yours for the last two or three years published—what works have been published showing them ?

Lieut. WHEELER. The preliminary report of 1871, the annual reports of the Chief of Engineers, and the astronomical report. There are six volumes which are spoken of in the last annual report of the Chief of Engineers which are not yet published. Advance atlas sheets of four rectangles are now issued, and the geological material will be placed upon the maps as soon as they are ready for it.

The CHAIRMAN. Have you published any geological maps ?

Lieut. WHEELER. No, sir ; we have not published any yet, but we have some all ready to be colored, and some partly colored.

The CHAIRMAN. Showing the geology of the country that you have explored ?

Lieut. WHEELER. Yes, sir ; so far as the geologists have been able to gather details. I believe that in the four main sheets now issued the geology of the country can be placed, and there are, altogether, fourteen sheets that have been proposed and are now in the hands of our geologists.

The CHAIRMAN. How many maps have you published since you took charge of that expedition in 1869 ?

Lieut. WHEELER. There was published one preliminary map in 1871, and another in 1872, simply for office use, and we have published, in advance 4 sheets ; in the hands of the lithographer there are 8 others, and the material at the service of the survey to carry us to 27 sheets in the topographical atlas.

The CHAIRMAN. I see here a statement that Clarence King, under your department, made a geological survey to the 100th meridian.

Lieut. WHEELER. No, sir ; our work is westward, here, [indicating on the map.]

The CHAIRMAN. Mr. King was acting under the War Department ?

Lieut. WHEELER. Yes, sir.

The CHAIRMAN. Is he an officer ?

Lieut. WHEELER. No, sir ; a civilian ; his corps were entirely civilians, and, I believe, what organization there is of them now is entirely made up of civilians, so far as I know ; though I am not positive about that.

The CHAIRMAN. With regard to this matter of expense which is referred to here, did or did not the Army furnish transportation and escorts to your survey, and to Professor Hayden's and Professor Powell's ?

Lieut. WHEELER. I don't know that I understand you exactly.

The CHAIRMAN. President Grant says in his message, "There is but little doubt but that they will accomplish it as promptly and as well, and much more economically ;" and Secretary Belknap says, "This Department has been repeatedly called upon to supply the surveys under various Departments with arms, ammunition, transportation, subsistence, and escort ;" how far do you know, concerning any other expedition than your own, what has been furnished by the War Department ?

Lieut. WHEELER. I have no doubt that the War Department has furnished them, but I don't know about it.

The CHAIRMAN. What amount of escort was there last year furnished to your expedition ?

Lieut. WHEELER. Sixty men, I believe.

The CHAIRMAN. What was the expense of your expedition last year ?

Lieut. WHEELER. The money allotted to the survey by the Chief Engineer was \$90,000. That money is not all expended yet, but it will be expended in connection with the survey work proper. There is left of it now about \$22,000.

The CHAIRMAN. Is that over and above the actual expenses of the expedition, or will that amount be absorbed in the work that is being done ?

Lieut. WHEELER. That will be absorbed in the publication of the maps. No new projects will be entered into with that money.

The CHAIRMAN. What do those expenses embrace—the outfit, materials, mules, carriages, &c., or does the War Department furnish those ?

Lieut. WHEELER. It embraces the outfit belonging to the survey proper. When escorts are furnished, they being entirely a military body, the Secretary of War, through his different supply-departments, supplies them with outfit, &c., the same as if they were acting

entirely separate from the survey, and those supplies are paid for from the appropriations made for those bureaus.

The CHAIRMAN. Here is a report of the Engineer Department, which contains an estimate for next year, which I see is about the same as the amount last year, \$90,000,

Lieut. WHEELER. Yes; it will not vary very far from that. We are not held to those figures exactly; but it will be about that.

The CHAIRMAN. I see you have asked for that much for the coming year. I see here for civilians, assistants in the field, \$17,250; for transportation, purchase of animals and forage, \$19,500; materials and incidentals, \$4,750; in addition to those things, what does the War Department furnish?

Lieut. WHEELER. They furnish the escorts with their transportation, and with all their supplies, because they are a military body. In addition to that they furnish the transportation of our civilian assistants to and from the field. While in the field, the transportation of those civilian assistants is paid from the appropriation of the survey. I would call the attention of the committee to the fact that our expeditions have mostly been far away from bases of supply; they have been in some of the most desert and most detestable portions probably of the American or any other continent, and it is with great difficulty that they have been gotten through those territories where the physical obstacles are so great. In a great part of this area escorts have been necessary, sometimes larger and sometimes smaller, but I have always endeavored to keep them at the very lowest point, and I have always found until last year that, generally speaking, the commanders would prefer to send more troops to protect the lives and public property connected with the expedition. Last year, for the seven field-parties the escort numbered only sixty-two men. I may say in addition that we had six engineer soldiers from the Engineer Battalion. The necessity for these escorts increases of course the expenses, which must be applied to every square mile that we work over. Could we go into areas where we should not need these escorts, our movements would be made with much more celerity and promptitude, and we could discontinue them to a great extent.

The CHAIRMAN. Have you any idea of the actual expense of that expedition, including escort and everything?

Lieut. WHEELER. No, sir; I have made no figures on that.

Mr. CLYMER. Does the \$90,000 include the salaries of all the civilians attached to your party?

Lieut. WHEELER. Yes, sir.

The CHAIRMAN. What was the exact character of the astronomical work that you went through last year?

Lieut. WHEELER. (Referring to a book,) I have selected here from the twenty-four main stations that have been occupied in the four years, independent of a great many others where the work has not been necessarily so elaborate or the observations so closely made, two, which are published in this volume, and I state that they are typical stations; not that the observations there are more accurate, but they are typical merely to show the method of conducting the observations, and of keeping the field-record and of reporting the results.

The CHAIRMAN. By whom were the astronomical observations made last year?

Lieut. WHEELER. At the main stations they were made by the civilian astronomical assistants and by the officers at the field-stations.

The CHAIRMAN. They do not belong to the Army?

Lieut. WHEELER. No, sir; they do not.

The CHAIRMAN. This book is their report?

Lieut. WHEELER. Yes, sir; revised by Lieutenant Marshall and myself.

The CHAIRMAN. The ascertaining and locating of points you did by triangulation, of course?

Lieut. WHEELER. Yes, sir; during the past year.

The CHAIRMAN. How many points, generally speaking, did you establish—geographically prominent points?

Lieut. WHEELER. That would be a very hard question to answer.

The CHAIRMAN. I suppose you took the mountain-peaks?

Lieut. WHEELER. Yes, sir; myriads of them, probably 50,000 in the area, colored upon the map.

The CHAIRMAN. But you didn't take them all, did you?

Lieut. WHEELER. I presume we took more than that.

The CHAIRMAN. How are the heights ascertained, by measurements or barometrically?

Lieut. WHEELER. Barometrically.

The CHAIRMAN. Longitude is taken by telegraph pretty much?

Lieut. WHEELER. Yes, sir; entirely so; at the main stations.

The CHAIRMAN. Did you compare that with the chronometer-longitude to see how they agreed?

Lieut. WHEELER. Yes, sir; this is chronometer longitude. The telegraph is merely a means of comparing the chronometer-time at a given locality with the chronometer-time at a known meridian.

The CHAIRMAN. You regulate your chronometer here at the start?

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Lieut. WHEELER. Yes, sir; it is regulated here, and also kept regulated at the observatory where these observations are taken.

The CHAIRMAN. There are two further points in this resolution. One is to inquire whether it be not practicable to consolidate them under one department. What is your view in regard to that?

Lieut. WHEELER. I don't know that my opinion would be worth anything upon that subject. It might be considered prejudiced.

The CHAIRMAN. We want to give you all a hearing, and to have your views precisely as you think proper to give them.

Lieut. WHEELER. Well, sir, my views have not been called for by the War Department upon that point, but I have no hesitation in saying to this committee, in an unofficial manner, that I do not know any reason why they should not be consolidated.

The CHAIRMAN. Which Department would you put them under?

Lieut. WHEELER. Under the War Department, for many good and cogent reasons.

The CHAIRMAN. Be good enough to give us the reasons.

Lieut. WHEELER. In the first place the necessities of the War Department demand geographical surveys to be made. They are necessary for its operations, both in time of war and in time of peace. That work has been done always by our War Department, since the formation of this Government, and I am satisfied that it will continue to be done, and that the wants will become larger year by year, and that the War Department will urge upon the attention of Congress those wants, if Congress during any year fails to make appropriations to meet them. It is a fundamental necessity for that Department to have these geographical surveys made. Those surveys involve the making of maps. In order to make those maps we must have these astronomical, geodetic, topographical, hypsometrical, and meteorological observations made. In order to have them made we must have expeditions. These expeditions are sent to a country very difficult to traverse, unoccupied by settlers, and every time a party is arranged to do this work, there must be quite a little expedition organized, and it must have all the outfit that is necessary to put it into the field, and irregular losses are experienced upon disbanding. Then the man at the head of that expedition has got to have his clerk. There must be draughtsmen and the different classes of assistants. Now, economically distributed, let us suppose we have this vested in three persons who, having the necessary scientific attainments, can make observations in these three branches. Then let us add two others, and I will say we have a fourth, because a medical officer is always needed, and he can be selected for his knowledge of natural history, and his collection will be made and deposited in the Smithsonian. Now, if it costs, say, \$10,000 for an expedition of three persons, it won't cost more than \$12,000 to conduct one of four or five, or some what after that ratio. I have made figures upon it which I could present more in detail, if necessary. Economy, then, seems to direct that if we want these other investigations to be made, we should add these other persons to the expeditions of the War Department. That has been done in all the expeditions since Jefferson sent out his secretary, Captain Lewis, in charge of an expedition to the great West to explore the interior and find out how far it was to the Pacific Ocean. Then the Army were called to occupy the frontier, to establish its posts, and routes of supply were needed, and expeditions were organized to survey and construct them. Then, subsequent to the finding of gold in California there came the great need of connecting the Mississippi Valley with the Pacific Ocean. Expeditions were sent out to run the preliminary lines, and they naturally selected the lines of lowest profile; they saw very little of the mountains; they directed their nearly latitudinal routes to the lowest passes. In 1856, '7, and '8 those surveys were compiled, and a map was made as good as could be made from the material that had been gathered. Then there followed the work of the Corps of Topographical Engineers, to whom further duties of a similar character were assigned, and they carried it on at small expense. They were called away from these duties at the outbreak of the late war, and during the war they were consolidated with the present Corps of Engineers. This class of interior surveys rested dormant for a time, until at the close of the war, when people began to look into the interior of the continent again, and then the geographical military departments received organic form, and their boundary-lines were drawn, and an engineer officer was placed at several of the headquarters. In the year 1867 the expedition to survey the fortieth parallel was organized by Clarence King under the Engineer Department, and this important work was commenced, and the great problem arose of connecting the old linear surveys together so as to afford areal surveys as contradistinguished from the old linear surveys, which had, in all cases, been made for specific purposes. Those purposes having been attained, the results proved economic, and the geographical knowledge from those surveys was of great advantage. Steadily the land surveys, giving the courses of the principal streams and valleys, section and township lines were progressing upon the frontier. These were made at a level of say from two to four thousand feet above the sea, while most of our work has been above that, among the mountains and high plateaus. The problem now is to work out the physical structure, and make a topographical map of that country. My great reason for thinking that the War Department ought to have control of these surveys, is the necessity to the War Department of having the surveys made so as to carry on successfully the work of the Department. One of the first things

I did on my expedition was to furnish information for changing three different contracts at so much per 100 pounds per 100 miles for the Department at posts in Arizona, by shortening the distance, and those were expensive contracts, and we have been going on doing the same kind of work since in a greater or a lesser degree.

The CHAIRMAN. The remaining point that we are to consider is whether the geographical limits, embraced by each of these expeditions, could not be set apart—whether you could not work in harmony together, the military surveys operating in one portion of the country, and the other surveys such as those under the Interior Department, in another part of the country.

Lieut. WHEELER. The only way to do that is to have them all conducted under the same plan, I think. You can say that certain persons shall go here, and certain persons shall go there, but certain persons will always be doing different, and there never will be any harmony between them, and the Government will be publishing results that come from this source and from that source, and there will be no uniformity. The great merit of the work under the War Department I maintain is its simplicity, from the fact that the lines having been drawn, hereafter when we do our work you may reckon us up per square mile, and see what we have been doing. If you cannot have a plan founded upon that idea, I tell you, gentlemen, Congress will not, in my belief, appropriate the money to go out there, and survey those mountains year after year, for it will take a long time to do the work, and make an accurate map. And after you have got it done, you will have to go and make the surveys all over again in twenty years. That has been the case in every country. New settlements will be started; mines will be opened up, and the work will have to be repeated and re-repeated, no matter how it may be done. I maintain that we must found it upon geographical considerations, and the other parts will co-ordinate and harmonize naturally, but if the other party wishes to inflate, as it were, and place geological considerations in advance of geographical considerations beyond the necessities of the case, then I am not in harmony with the other party.

The CHAIRMAN. What this resolution calls upon us to ascertain is whether or not equally capable expeditions could not operate in different portions of the country to the advantage of the public; your opinion is against it.

Lieut. WHEELER. I do not wish to offer any opinion upon that matter.

Mr. ORR. Have you ever come in contact in the same area with any other expedition, so that the work was liable to be duplicated?

Lieut. WHEELER. That occurred last year. I was not in charge of the party, but it is reported here in the report of the Secretary of War in reference to the expedition of Professor Hayden and Lieutenant Marshall.

The CHAIRMAN. Have you any knowledge of the arrangements?

Lieut. WHEELER. I have an official report upon the subject. [Lieutenant Wheeler here read an extract of Lieutenant Marshall's report as touching upon the point of the overlapping of the areas of the two expeditions.]

COMMITTEE ON THE PUBLIC LANDS,
Washington, D. C., May 13, 1874.

No. 2.—*Continuation of statement of Lieutenant Wheeler.*

Lieut. WHEELER said: A question had been raised, when I left off my statement the other day, in regard to a violation of an agreement between Professor Hayden and Lieutenant Marshall. I read part of a letter from Lieutenant Marshall on the subject, and I suppose that the letter itself can be laid in evidence before the committee. I will therefore place the official document in the hands of the committee. It shows the intentional disregard of Professor Hayden of the surveys conducted in that portion of the country under the War Department. By turning to page 3 of the report the committee will notice that the Engineer Department states that there are at present acting under the War Department a certain number of surveys, ten in number; the first being the survey of the 40th parallel, in charge of Mr. Clarence King. The gentleman in charge of that is a civilian, and, following out the apparent thought of the questions propounded to me the other day, I concluded that the idea had been suggested by the chairman, that civilians had a good deal to do with the work in which I was engaged. Very well; they do have a good deal to do with it. Here is a survey in charge of a civilian, Clarence King, and I believe that all his assistants are civilians. I think it would be proper, and would meet the wishes of the Engineer Department and the approval of the Secretary of War, that other persons should be called before this committee, inasmuch as the questions put to me the other day, carried me from the field of statements of fact into the line of argument. Therefore I would suggest to the committee the propriety of calling before it, to answer such questions, the Secretary of War and the Secretary of the Interior. I feel satisfied that the War Department is willing to have that done. I also suggest to the committee to call before it General Humphreys, the Chief of the Engineer Corps, and who has been in the public service for forty years, engaged in im-

portant public works in time of peace, and who also served throughout the late war. I think that Mr. Clarence King, a civilian, who is operating under the Engineer Department, and who is a geologist of prominence and reputation throughout the world, should be also heard before this committee, and that the officers who have served on the boundary commission should be also heard before the committee. There is also at present in this city a Mr. Archibald Campbell, who has been employed on the commission to settle the northern boundary-line between our country and the British Possessions. He is acting under the Department of State. He is a civilian, and I think ought to be heard. I suggest to the committee the propriety of having these persons brought before the committee.

The CHAIRMAN. Let me inquire whether General Parke had any connection with the geological surveys, or whether he has not been connected with that boundary survey entirely, having no reference to geology or mineralogy?

Lieut. WHEELER. I understand that in every one of the expeditions conducted by General Parke the geology and the natural history of the region had been made a subject of examination.

The CHAIRMAN. My recollection is that General Parke has been running the boundary line only.

Lieut. WHEELER. I submit further to the committee, that I am here in an unfair light. I ought not to be called here to answer for the War Department. In due propriety I can only answer certain questions to the committee. The committee evidently wanted to carry me off from these questions into the line of argument. I have attended only to business which I am ordered to perform. I command the expedition, I take it into the country, I do the work assigned to me, but I cannot stand up here and fight the battles of the War Department, nor can I answer for any of its policies. I do not know the moment when I may be removed from my place. It may be next month, or it may be next year. Therefore, knowing the spirit of fairness of the committee and its desire for information, and supposing, from what the chair said to me the other day, that I was the only person to be called for the War Department, I ask that these others whom I have mentioned may be called also.

The CHAIRMAN. Let me explain. This matter came before us concerning these expeditions; and the committee taking it for granted that the gentlemen who had charge of the expeditions would know more about them than anybody else, resolved to examine them in the first instance. But the committee has not come to the conclusion, nor has it ever stated to you or to anybody else that anybody else should be excluded.

Lieut. WHEELER. I understood in conversation with the chairman that these three persons were the only ones who were to be here.

The CHAIRMAN. No; I said that these three witnesses would be cited, and that I did not know whether it would be necessary to examine any one else. But we shall examine as many as we may deem necessary to enable us to arrive at a proper conclusion; and we want you to understand that we meet here without prejudice or partiality.

Lieut. WHEELER. I was asked my opinion.

The CHAIRMAN. And you say that your opinion is good for nothing on those points. I have two or three more questions to put to you in regard to the details of the matter. In running over this pamphlet several things have occurred to my mind as necessary to be brought out in order to illustrate the propositions presented by the resolution and by the reports of the War Department, and of the Department of the Interior. I forgot to ask you, among other things, what is the particular object of your survey?

Lieut. WHEELER. The particular object of our survey is the determination of necessary facts for the construction of a topographical atlas for the entire territory west of the one hundredth meridian. The object is carried out in the main as far as our work is done in area assigned to us from year to year. In addition to the main branches of astronomy, topography, and meteorology assigned to us by the orders of the Secretary of War, there are other duties connected with geology and natural history. These are, to a certain extent, subsidiary. In order to carry out the great object of geographical research which requires the highest scientific training, we must have our expedition composed of men who are trained in these different capacities. It would not be economical to send me out there and to let me work alone and to get up a whole expedition, for one man. But it would be wise for me to take a topographer with me, because there are certain parts of the work which he would probably do better than I could. Every engineer officer has been so trained as to be able to supervise the work and to know what the deductions are worth. It is well also to take a meteorologist, and we do. If individuals prove themselves to be capable of carrying out well their work in geology, and if they are enthusiastic and want to go on these expeditions, they are very frequently suggested, and the person in charge of the expedition is authorized to employ them and to pay them for such duties as may be assigned to them. Hence the custom has grown up in connection with these expeditions to have the geological and natural history part receive attention.

The CHAIRMAN. I asked you the other day to bring the reports and maps made in the Department since 1869. Have you done so?

Lieut. WHEELER. I have communicated your desire to the Department, and they are to be sent to the committee.

The CHAIRMAN. I notice in General Humphreys's report that he says that the cost of these

expeditions and surveys was less than one dollar per square mile. As this question of expense is getting to be a prominent one, I wish you to state how that amount is ascertained.

Lieut. WHEELER. Since I was called to the charge of this work, in 1869, I have expended a little less than \$225,000; and the area which has been covered, and for which we have the map-material, a portion of which is published, a portion of the remainder being in the hands of the lithographer, and the other portion being in the hands of persons who are reducing it in the office, covers 228,000 square miles; hence the cost is a little less than a dollar per square mile.

The CHAIRMAN. What proportion of that \$225,000 went for the payment of salaries, &c.?

Lieut. WHEELER. On page 10 of the appendix of the report of the Chief Engineer appears an estimate for expenditures against an appropriation asked for from Congress of \$90,000. That is divided up into a variety of expenditures, and it appears that part of it is for civilian assistants in the field. Civilians are employed to take care of the animals, to drive the teams, and to act as guides and as laborers in various capacities. A part of it is for the transportation and purchase of animals, and of forage for the animals. The amount estimated there for that purpose, \$19,500, is much in excess of the expenditure. We are generally not closely confined, because these surveys, being of that peculiar character, and outside of the line of settlers, it is difficult to estimate very closely. Then there is an estimate for the subsistence of civilian assistants employed in the field, the number being kept at the very minimum. Then there is an estimate for the purchase and repair of instruments. This is necessary, because the survey itself is very severe upon the instruments, which are usually expensive instruments, and they need annual repair. As the surveys have been growing, we have made annual purchases of instruments, so far as we were authorized, in view of the amount at our disposal. Then there is an estimate for the publication of the maps, as it is necessary in the operations of the War Department that the maps shall be the first thing. There is an annual publication of maps, and there is an amount estimated for them. Then there is an estimate for contingencies, including the erection of monuments at astronomical stations, wherein meridians are carefully established, as a matter of primary importance in the subsequent surveys of States, Territories, and railroads. Therefore we have gone into some little expense in erecting monuments at these permanent stations.

The CHAIRMAN. I see it stated here that Clarence King is under the War Department.

Lieut. WHEELER. Yes, sir.

The CHAIRMAN. Where is his survey?

Lieut. WHEELER. His survey is that of the fortieth parallel. His office is in New York City.

The CHAIRMAN. Are his expenses included in this item?

Lieut. WHEELER. Not at all; only mine.

The CHAIRMAN. Do you know anything concerning the expenses of his survey?

Lieut. WHEELER. I have no critical data to furnish on that point.

The CHAIRMAN. He has published two volumes?

Lieut. WHEELER. Yes, sir.

The CHAIRMAN. You know nothing about the expense of those volumes?

Lieut. WHEELER. I have no data on the subject; that belongs to the engineer department.

Mr. ORR. I do not understand that any part of this \$225,000 was used to pay the salaries of Regular Army officers.

Lieut. WHEELER. No, sir. None of it was used for that purpose.

Mr. ORR. Nor to pay for the escort that was furnished by the War Department?

Lieut. WHEELER. No, sir.

Mr. CLYMER. At the last meeting of the committee, in speaking of the number of officers who were employed in addition to the officers of the Regular Army, on your expedition last year, you said that you might possibly have made an error of one or two persons, but that you could refer to a book which would enable you to give the exact number. Have you done so?

Lieut. WHEELER. That list is nearly prepared, but I want to make it more comprehensive. I will lay it before the committee to-day or to-morrow.

Mr. CLYMER. This statement which you made as to the number of persons employed is, I suppose, substantially correct?

Lieut. WHEELER. It is substantially correct. The details can be given.

Mr. CLYMER. You say that, besides the officers in charge, there were three officers of the Corps of Engineers, two officers of the line, two medical officers, and three astronomical assistants constantly employed. Now, General Humphreys, in his letter on the subject, says, "The first and chief object of the expeditions is the collection of data for the preparation of complete maps of the region by astronomical, geodetic, topographic, and hydrographic methods of survey, with different degrees of refinement, according to the facility of movement through it." Let me ask you whether the engineering officers of the Army are not perfectly competent, by their past education, to perform the general objects of the expedition?

Lieut. WHEELER. Unquestionably they are. They are able to perform any or all of them so far as they can. But one man can only do one man's work.

Mr. CLYMER. What I ask you is, whether by their education they are not supposed to be

fitted to make these astronomical, geodetic, topographical, and hydrographic examinations?

Lieut. WHEELER. Yes; they are.

Mr. CLYMER. These meteorological, mineralogical, and geological departments are incidental and subsidiary to the main objects of the expedition?

Lieut. WHEELER. Yes.

Mr. CLYMER. Then you employ civilians to perform these subsidiary objects?

Lieut. WHEELER. Yes.

Mr. CLYMER. Here is the estimate of the amount needed, making altogether \$19,000. Examining this estimate I perceive that the expenses are entirely for civilian assistants in the field, for civilian assistance in the office, the transportation and purchase of animals and forage, (which I presume are also for civilians,) purchasing materials, and incidentals, (which I presume are intended for the subsidiary objects of the expedition.)

Lieut. WHEELER. No, sir. That is a mistake.

Mr. CLYMER. These assistants and civilian employes in the field are entirely distinct from the military portion of the expedition?

Lieut. WHEELER. Yes.

Mr. CLYMER. There is another item for the publication of maps, &c. Is not the larger portion of the \$90,000 which you ask for here for the purpose of accomplishing what is termed here, in the letter from General Humphreys, "the subsidiary objects of the expedition?"

Lieut. WHEELER. No, sir; not a large share. My exhibit draws a line between the expenditure made, provided we had done nothing but obtain the materials for the map, and the expenditure made by covering all the objects proposed to be examined. An examination of that exhibit will clear up any confusion which may exist in regard to my statement the other day, and will answer the points then made as well as the point which you now make.

Mr. CLYMER. I was not led into any confusion by the statements which you made the other day, for I think they were very clear and satisfactory. But what seemed to me apparent from those statements was, that the necessity for the item of \$90,000 arises from the fact that, in addition to the main objects of the expedition, you had those subsidiary objects to be accomplished.

Lieut. WHEELER. That is not the fact, so far as the \$90,000 is concerned.

Mr. CLYMER. This item of \$17,000, for the expenses of civilian assistants in the field, is clearly in addition.

Lieut. WHEELER. No, sir; we have topographical assistants.

Mr. CLYMER. I understood you to say that all these main objects of the expedition could be accomplished by Army officers.

Lieut. WHEELER. I said by engineer officers; and I said, in connection with that, that one man could only do one man's work. The multiple duties put upon that corps are so pressing that I have only been able heretofore to get a small number of engineer officers detailed; but, little by little, the Chief of Engineers seemed willing to increase the number. I began with one; I now have three. The General of the Army and the Secretary of War seem to entertain favorably the idea of placing some officers from the line of the Army, who can be spared in time of peace, and having them perform a part of these expeditionary duties as well.

Mr. CLYMER. From what you have said it would appear that there are not enough engineer officers of the Army who can be detailed to do this work.

Lieut. WHEELER. I suppose that if Congress orders it there can be more detailed.

Mr. CLYMER. Does not that matter of detail fall properly within the province of the head of the Department? Congress never pretends to go into the matter of details, but gives the power to the Secretary of War. If he choose to detail officers, are there enough officers of the Army to do this work without calling upon civilians to assist?

Lieut. WHEELER. I do not know that I can answer that question satisfactorily. In the first place, I have no officer operating under me unless he is placed there by due authority and order. Officers are not placed there because I want them or do not want them. When the money is appropriated the plan is made out, and the scheme is very thoroughly canvassed before any party takes the field. Having these objects all in view, the plan is so carefully laid out as to draw from the expedition as great results as may be, and the distribution of officers and civilians made.

Mr. CLYMER. But then you say that there are placed under you assistants, to do what educated Army officers are capable of doing, and that they are put there without your consent or knowledge?

Lieut. WHEELER. I can hardly say that they are put there without my knowledge or consent.

Mr. CLYMER. Well, without consultation with you. These civilians are assigned to your office by the Secretary of War?

Lieut. WHEELER. No, they are not War Department appointments. They are virtually appointed because of the authority granted to me by the engineer department.

Mr. CLYMER. If you have the right to appoint them, and if there are Army officers who can perform those duties, why don't you appoint them from the Army instead of from civilian?

Lieut. WHEELER. I have no power over the appointment of officers to specified duties, and cannot answer as to the policy of the War Department.

Mr. CLYMER. Are you deprived, in the exercise of your privilege, of exercising it among Army officers?

Lieut. WHEELER. Most certainly. I am authorized to employ, say twenty civilians, and probably for every position that I have to give, there are twenty-five or thirty applicants. These persons are employed, just as on any public work, by the officer who is in charge. He hires them and pays them, and they do the work, and they form a part and parcel of the service of the survey.

Mr. CLYMER. Will the statement, which you are about to submit to the committee, show what the cost of the pay and transportation and other expenses of these persons who belong to the Army proper, is, in addition to, and over and above, the estimate made up by you as a separate item?

Lieut. WHEELER. No, sir.

Mr. CLYMER. Can you give me, from your statement here, the number of Army officers employed in the expedition; the number of men of the Army engaged in it, and an idea as to the amount of their expense in pay and transportation?

Lieut. WHEELER. No, sir, I cannot, because that is a matter which goes into the Bureaus of the War Department, to which I have no access. The expenditures for transportation are made by the Quartermaster's Department.

Mr. CLYMER. As there seems to be a large number of men belonging to the Army employed in this expedition, is it fair to presume that their expense would be at least as much as the expense estimated for?

Lieut. WHEELER. No, sir; not so much.

Mr. CLYMER. There are sixty men of an escort, and I mean to include the whole expense of persons connected with the Army.

Lieut. WHEELER. We are quite intimate with movements of the troops in the country that we are in. Almost all the territory so far assigned to the survey is covered by scouting parties during parts of the year in order to keep the Indians quiet; and these escorts, if they were not out with the survey, would be out under other officers, and about the same expense would be incurred. If these troops were not detailed to go out with surveying parties, a portion, or all of them, would be out on some scouting-expeditions. These expenses are incurred all the time. They are carried on through the channels of the Quartermaster's Department, and of the Commissary and Subsistence Departments, to which I have no access.

Mr. CLYMER. Could not the work of the Army officers, who are educated to perform the particular duties of your expedition, if they were assigned to it, be done without additional expense to the Government?

Lieut. WHEELER. Yes.

Mr. CLYMER. If, instead of employing civilians to perform the duties which might be performed by officers of the Army, these officers were assigned to you, would not their employment by you lessen the expense very much, and would it not be fair to deduct that also from the cost? Might they not do that as well as be somewhere else?

Lieut. WHEELER. That is a matter which I have laid informally before the General of the Army at one time or other, and I would prefer not to lay it either formally or informally before the committee, because it does not come within my province. There is certain military courtesy and etiquette which I might be overstepping if I were to enter into that subject.

Mr. CLYMER. With reference to this matter of expense, do you suppose that a fair estimate for additional expense, over and above this \$90,000 for the cost of transportation and pay of the officers and men of the Regular Army, would be \$60,000; thus making the whole amount \$150,000? Would that be too much or too little?

Lieut. WHEELER. It would be too much. This estimate here covers the greater share of all the expenditures that are to be made. We have a few officers connected with the survey, and their expense is so much a month. I get \$144.66 a month, and another officer gets so much, and he gets so much for his mileage; and that is added to the cost of the expedition. I think there is no expenditure chargeable to the survey except what I stated to the committee the other morning, which comes from the fact that the Quartermaster's Department transports our civilian employes, and also transports the collections made by us in natural history, and our instruments to and from the field, but not while we are in the field.

Mr. CLYMER. Are the surgeons employed in the expedition paid out of this estimate?

Lieut. WHEELER. They belong to the Medical Corps of the Army. The officers of last year are known as contract surgeons—acting assistant surgeons of the Army. They are appointed on this expedition because, in addition to their being able to perform medical duties, they generally perform some special duty in natural history.

Mr. CLYMER. Do they belong to the medical staff of the Army?

Lieut. WHEELER. They do, as I understand.

Mr. ORR. Are they commissioned officers?

Lieut. WHEELER. No, sir; they are not commissioned officers.

Mr. CLYMER. These gentlemen are under contract not only to practice their profession but also to do this scientific service?

Lieut. WHEELER. No, sir; they are only under contract to perform their medical duties. The CHAIRMAN. They are not considered as belonging permanently to the Army?

Lieut. WHEELER. No, sir.

Mr. ORR. They hold their position merely by contract and do not belong to the rolls of the Army?

Lieut. WHEELER. That is so; they do not belong to the rolls of the Army.

Mr. BRADLEY. Are these surgeons paid out of this appropriation of \$90,000?

Lieut. WHEELER. They are not paid out of that appropriation.

The CHAIRMAN. How much are they paid?

Lieut. WHEELER. \$125 a month.

The CHAIRMAN. Are they engaged by the year or by the month?

Lieut. WHEELER. By the year; but their contract is at the will of the War Department.

Mr. CLYMER. The results of your expedition, such as geological specimens and botanical specimens, were given, some of them, to the Smithsonian Institution and some to the War Department. Is it your intention to have them properly classified and prepared for exhibition?

Lieut. WHEELER. Yes; when classified and when the survey is through with them. They have always been sent to the Smithsonian Institution. Certain specimens are in process of examination. Through that institution we have reached a number of eminent specialists in the various branches of natural history, and specimens have been sent to them, and the description of them becomes a part of the volumes prepared to be published.

Mr. CLYMER. These geological and botanical specimens that are not sent to the Smithsonian Institution, are they in the possession of the War Department?

Lieut. WHEELER. Yes.

Mr. CLYMER. What is done with them?

Lieut. WHEELER. They are being classified there.

Mr. CLYMER. Does this estimate of yours include the cost of doing that work?

Lieut. WHEELER. That work is done partially by the persons connected with the service; but, usually, if they are sent to these specialists outside, there is no expense whatever connected with them.

Mr. CLYMER. With reference to those in the War Department, is there any expense connected with them?

Lieut. WHEELER. They are being worked up by the persons connected with the survey, partially, and they remain there in course of being catalogued and prepared to be sent to the National Museum. There are so many branches of natural history that no one man professes to be the master of the whole subject. In botany, zoology, entomology, and other branches of natural history there are persons eminent throughout the country, at the various universities, who are prepared and willing to take the materials and work them up. Then they are returned to us, and we send them to the Smithsonian Institution. I believe that there is a law which requires all these specimens to be put in the National Museum.

COMMITTEE ON PUBLIC LANDS,
May 13, 1874.

No. 3.—*Statement of Professor F. V. Hayden.*

Mr. Chairman, and gentlemen of the committee: I desire to have placed on record the fact that the civilian side of the controversy before you has not been its author. We have all the time stood on the defensive. If we have given any cause for it, it has been simply our success in the line of duty. I regard the question as involving a principle, not the individual, and it must influence the development of the West for, at least, fifty years to come.

The military side of the question has presented a long series of expeditions, from the Lewis and Clarke expedition to the present time. I represent, in my own person, twenty-one years of explorations in the Northwest. Twenty-one years ago this spring I started up the Missouri River on a steamboat of the American Fur Company. That was before Kansas and Nebraska were organized into Territories, and before a white man was allowed to settle in that region. I spent three years up there, and made collections which were sent partly to the Smithsonian and partly to the Academy of Natural Sciences, in Philadelphia. When Lieutenant Warren, of the Topographical Engineer Corps, was sent out there with General Harney's expedition, in 1856, I joined it in the capacity of surgeon and naturalist. When the war commenced I joined the army as surgeon of volunteers; served four years. Then the close of the war having again left me without occupation, I went again, in 1866, into that country, on my own responsibility, and have published already some fifty articles, memoirs, and volumes of various kinds, on the natural history, &c., of that region, exclusive of those connected with the present survey.

So much for the past. In 1867 Congress made a small appropriation of \$5,000, for the geological survey of Nebraska, which was placed under the Commissioner of the General Land-Office. I took charge of it. Next year I succeeded, after a painful struggle, in hav-

ing another \$5,000 appropriated. Then, in 1869, another appropriation of \$10,000 was made, to be expended under the Interior Department, for the geological survey of the Territories of the United States. That was the time when this survey, which I represent, took form.

By the orders of the Secretary of the Interior (who was then Mr. Cox) I was assigned to the Territories of Colorado and New Mexico. I was unable to employ a topographer, and I simply made a survey of the Territory from Cheyenne along the base of the mountains, (where the geology is better shown by what are called the hog-backs, or the uplifted strata,) along the eastern slope of the Rocky Mountains, down to Santa Fé, and back, through the San Luis Valley, to Cheyenne. In less than six months from the time that that survey was organized eight thousand copies of my preliminary report were placed before the world. That number of copies was ordered by Congress; and in about three weeks from the time they were published, so great was the demand for them, I was unable to procure a copy. This little survey stimulated that line of development which is so marked at present, especially in Colorado. At that time Denver was a little city of five thousand inhabitants. The Denver and Rio Grande Railroad was started by friends of mine who say, to this day, that they were stimulated to that enterprise by the report which was the result of that expedition. That was in 1869. The interest thus excited induced the Committee on Appropriations to recommend, and influenced Congress, in 1870, to make, an appropriation of \$25,000 to continue these surveys. I was then assigned to Wyoming. The party passed up the Valley of the Sweetwater to the South Pass, and then, by the way of the Uintah Mountains, back again to Cheyenne. The result of that exploration was the publication, in the following winter, of another annual report of five hundred and eleven pages, of which also a large edition was printed by Congress.

Next year, 1871, \$40,000 was appropriated. The interest that was excited by the Geyser region of Montana led us to explore that region, and so we started the survey from Ogden in Utah Territory, by way of Fort Hall, Fort Ellis, and from there to the headwaters of the Yellowstone. The result of that survey was another annual report which was quite fully illustrated, of five hundred and thirty-eight pages of octavo. The interest excited at that time led Congress to set apart 5,375 square miles about the headwaters of the Yellowstone as a national park for all time to come. My topographer committed suicide at Omaha; but still, with the assistance of other friends, his notes were worked up in the office.

The next appropriation was \$75,000, and the interest in the work was so great that not a word of objection was made to it in Congress. That was in 1872. We then concluded to continue this survey. We started again from Ogden, taking a little different route, and surveyed another line up from Fort Hall to Fort Ellis. There the party was divided into two different divisions, one the Snake River division, and the other the Montana division. [Mr. Hayden here explained to the committee, by reference to maps, the work done by his expedition, and continued:]

The result of the explorations of that almost entirely unknown region of country has been well set forth in an English periodical. It revolutionized the topography of the country. Lakes which were supposed to be sources of rivers running into the Atlantic were proved to be sources of rivers that flowed into the Pacific. It has been characterized as the largest contribution to geological knowledge for a single season that has been made within the last ten years. Some parts of that country were infested by Indians, and as we could get no military escort, it became necessary for us to confine our survey to regions nearer the settlements, and which were not infested by Indians. We therefore selected Colorado, because Colorado was knocking at the doors of Congress to be admitted as a State. I would like to correct here a statement made in this report on page 5, (Ex Doc. No. 240,) in which it is intimated that "the projects for both those parties were prepared and approved when it was understood that Professor Hayden was engaged upon the region of the Yellowstone Basin and other portions of Montana." I wrote a letter on the 27th of January, 1873, addressed to the Secretary of the Interior, and which was approved by him in a letter addressed to the Speaker of the House of Representatives, and published and distributed on the desks of members. This antedates by several days the printed project of Lieutenant Wheeler, which bears date of April 3, and is addressed to General Humphreys. I said in that letter:

"For the last two years the survey has operated about the sources of the Missouri and Yellowstone Rivers, but the expenses of transportation, subsistence, and labor are so great that it seems desirable to delay the further prosecution of the work in the Northwest until railroad-communication shall be established. The Indians, also, are in a state of hostility over the greater portion of the country which remains to be explored. It seems desirable, therefore, to transfer the field of labor for the coming season to the eastern portion of the Rocky Mountain range in Colorado and New Mexico. I propose to commence with the southern limit of the belt of the survey of the fortieth parallel, so successfully completed under the direction of Mr. Clarence King. The north limit of the area marked out is latitude 40° 30'; the western limit, the east bank of the Green and Colorado Rivers; the eastern limit, the 103d meridian west of Greenwich, extending to belt southward to the south line of the United States.

There is probably no portion of our continent, at the present time, which promises to

yield more useful results, both of a practical and scientific character. This region seems to be unoccupied, at this time, so far as I am aware, by any other survey under the Government; and the prospect of its rapid development within the next five years by some of the most important railroads in the West, renders it very desirable that its resources be made known to the world at as early a date as possible."

The CHAIRMAN. What was the result of that letter?

Mr. HAYDEN. The result of that letter was that Congress appropriated \$75,000 for the specific purpose of exploration in Colorado. I think we might infer from their action, based on the letter of the Secretary of the Interior, that the survey as carried on by me in Colorado was done by the express sanction of Congress, and I might almost say by the order of Congress. Now, in order to correct the statement of the Engineer Department, I would like to refer this committee to the project which Lieutenant Wheeler presented to General Humphreys, on the 3d of February, 1873, subsequent to the time when this letter was printed and distributed on the desks of members. I had no right, under my instructions, to make any agreement with Lieutenant Marshall as to surveying opposite sides of the Arkansas, and stated that, so far as our survey was concerned, we had nothing to do but to proceed and do our duty, as we did.

The CHAIRMAN. You have reference to the allegation that there was an agreement between Lieutenant Marshall and yourself.

Mr. HAYDEN. Yes, sir, I refer to that. After receiving our instructions, the party proceeded to Denver and set about making preparations; and we were in the field two months before I knew of the existence of Lieutenant Marshall. I may have heard of him, but certainly had never seen him. As we were riding down into the South Park, about the 9th of July, we came across Lieutenant Marshall's party, and we camped together. He was a very courteous gentleman, and we were very friendly. We talked matters over, and some regrets were expressed that we should be on the same ground. I simply stated to him, as far as I recollect, and as far as my assistants recollect, that I had no option but to perform this work, as we had had the Territory of Colorado assigned to us as a field of exploration. He simply said that he was under orders, and therefore could not disobey his orders.

Mr. CLYMER. You say that you received instructions; have you a copy of them?

Mr. HAYDEN. No, sir, not here.

Mr. CLYMER. This is the crucial point in this matter, and it would be well for you to put these instructions on record.

Mr. HAYDEN. I will do so.

Mr. CLYMER. Did you part there?

Mr. HAYDEN. We parted there.

Mr. CLYMER. Had you any further communication with Lieutenant Marshall on that subject?

Mr. HAYDEN. No, sir.

Mr. CLYMER. And none before?

Mr. HAYDEN. No, sir, I never saw him before; I think that Mr. Stevenson, my assistant, introduced me to him at that time. That was after my party had been in the field two months, and after we had been exploring over a large part of Colorado. I would say here that, so far as my own party was concerned, it was generally rumored and believed that the avowed purpose of Lieutenant Wheeler in coming into Colorado was to precipitate a conflict which had been hanging over us for three years. The presence of his surveying parties there was to be a means of precipitating this conflict.

I would like to read here a letter from Prof. W. D. Whitney, of Yale College, who was present during all the conversation with Lieutenant Marshall:

"YALE COLLEGE, NEW HAVEN, CONN.,

"May 9, 1874.

"DEAR SIR: There has been recently sent to me the reply of yourself and of the Secretary of War to the resolution of the House of Representatives respecting surveys west of the Mississippi, and I find in that of the Secretary of War, twice repeated, a misstatement so remarkable that I cannot forbear offering my testimony, as that of an outsider well acquainted with the facts in the case, against it. The misstatement made is to the effect that there was an agreement made last summer between the chiefs of the Hayden survey and Lieutenant Marshall, that the two expeditions should operate on opposite sides of the Arkansas River so as not to duplicate each other's work. Now, I was with the Hayden party when it fell in, altogether casually and without appointment or anticipation, with Lieutenant Marshall and his party, last July. I was present during a part of the wholly friendly and courteous discussions held between them and heard the whole matter fully and freely talked over in Dr. Hayden's camp, at the time and afterward; and never did I hear a word or hint of any such agreement. I was present at the interview between Lieutenant Marshall and Dr. Hayden and Mr. Gardner, when the latter came back to the Arkansas Valley after the expedition through the Elk Mountains beyond, and heard every word that passed between the parties, and there was no allusion to any such agreement then. I was present at the interview between Professor Stevenson (the geologist of the Marshall party) and Dr. Hayden and Mr. Gardner in the Arkansas Valley a day or two later; and there

was no allusion to any such agreement then. On the contrary, the Hayden party simply proceeded to carry out, in all its details, the plan which had been formed before entering the field at all. To make the alleged agreement would have been to ruin the whole summer's campaign. The very idea of it is little less than absurd.

— "We understood, as I remember, that for some time after the agreement is now declared to have been made. Lieutenant Marshall was engaged in continuing his former work on the hither side of the Arkansas. When the Hayden party returned to the valley of that river, the lieutenant was there, not having yet entered the mountains beyond. The belief was most sincerely held, and repeatedly expressed in the Hayden camp, that the other party were following upon their steps in order to cover the same ground and provoke before Congress precisely the question that is now raised as to the collision of rival organizations.

"I have the honor to be, with the highest respect, your obedient servant,

"W. D. WHITNEY."

"Hon. C. DELANO, *Secretary of the Interior.*

Mr. DUNNELL. Was Professor Whitney attached to your expedition?

Mr. HAYDEN. He was a guest of the expedition.

Mr. DUNNELL. Was he under pay?

Mr. HAYDEN. No, sir. He is professor of Oriental languages at Yale College, and was a guest of the expedition, for the benefit of his health.

Mr. DUNNELL. What were the privileges and advantages of such guests; were their expenses and transportation paid?

Mr. HAYDEN. They receive hospitality. Professor Whitney rendered us very important service in geodetic work.

Mr. DUNNELL. Was he made a guest with a view of his doing work?

Mr. HAYDEN. No, sir. It is a common thing to receive distinguished men as guests on such expeditions.

[Mr. Gardner, one of Mr. Hayden's assistants remarked that the details of the plan for the survey were made in January, 1873; that all the parties but one had been in the field from 29th May, and that when Lieutenant Marshall was met it was impossible to have the plans of Professor Hayden's survey changed, as the parties were scattered all over the Territory.]

Mr. HAYDEN. The organization of the survey at present has been necessarily a matter of slow growth. In 1871 and 1872 it was crystallizing into form, and now it is in perfect form. The men whom I have engaged as assistants are the sifting of about twenty years. It is a very difficult thing to get men fitted for that kind of work. Many of these men have been several years in that region. I represent twenty-one years' service. One of my assistants represents seventeen years; others ten years, five years, and so on. Many of them are graduates of the best scientific schools in the country, and some of them are graduates of the best schools in Germany. They are not scientific men simply by virtue of their being graduates of scientific schools, because a scientific man is, like a poet, God-made. You cannot manufacture a scientific man at a military or a scientific school. A scientific man has been described as one who, by his own personal investigations, has penetrated beyond the boundaries of the known, and has added to the sum of human knowledge. If this work were transferred to the War Department, this organization, with all its training for the scientific work, would be liable to be placed under the direction of an officer not two years from the military school. That is why we feel so earnest in this matter. I will read the list of my assistants:

James T. Gardner, geographer. He has been ten or twelve years in the service.

James Stevenson, quartermaster and chief executive officer. As an executive officer, I have never seen his equal, either military or civil.

William H. Jackson, photographer. He is of world-wide fame in his line.

William H. Holmes, artist and assistant geologist. He is known as the first artist in the country in that special work.

Cyrus Thomas, entomologist and agricultural statistician. He has written a great many articles on the agricultural resources of this country, and which have been republished in the Old World. Here is a quarto volume which he has written.

I will not go through all the list of my assistants, or of the collaborators of the survey, who are now preparing reports on our collections, which we had not ourselves specially reported on.

This organization explored a portion of the Territory of Colorado in the spring of 1873. In the spring of 1870 I presented a scheme to the Appropriation Committee, and it was accepted as the correct one; that is, that we should take up the Territory or Territories, by their boundary-lines, and work them up carefully, and have the results published as contributions from the General Government to those Territories as wards of the Government before being admitted as States, so that, when admitted, these reports might be the basis of the future work in the development of their physical geography, just as Pennsylvania and Ohio and other States have done. That was the plan.

We started from Denver in June, 1873, and commenced the survey of the different areas marked out for the season's work. The results are here and can be presented at any time.

As to the details of the work I will not take the time necessary to explain them; but they comprehend all the different branches of science connected with such surveys. We feel that, inasmuch as this is a survey under the patronage of the General Government, it is our duty to embrace in our plans as many of the various departments of natural science as we can. The friends of botany, paleontology, entomology, &c., who contribute to the taxes from which the appropriation is taken, are entitled to consideration; but the main object, as a matter of course, is the geology, with such topography as is necessary to present it in a proper manner.

The CHAIRMAN. You might probably go into a little more detailed statement of the manner of doing the work. The Engineer Department has given us the *modus operandi*; and it would probably be just as interesting to know how you performed the different branches of your work—astronomy, topography, geography, &c.

Mr. HAYDEN. In the first place it became necessary to ascertain what had been done. We investigated the maps which had been already produced. We found it necessary to take the land-surveys under the Interior Department, in order to prepare what we call a field-map. Here is one for the Territory of Colorado, [exhibiting it.] We found that none of the other maps which had been prepared was sufficiently accurate for our purpose at all; but we found that the land-surveys under the Interior Department would answer our purpose. Then we felt the necessity of having a map so carefully prepared that we could lay down the geological formations in colors. It became necessary, therefore, to adopt some plan comprehensive enough in its character to cover the plans which we had made. Mr. Gardner, as chief assistant, can explain that much better than I can. It is based on a trigonometrical survey, with an astronomical base, which was made by the Coast Survey. We were able to co-operate with that civilian organization, which had already fixed Sherman, and during the summer of 1873 established another point at Denver, one at Colorado, and another at Trinidad. Then a base-line, of six miles in length, was made by Mr. Gardner; and, from that, a series of primary triangles was extended over the whole area which we had laid out for our summer work. From that basis we extended these triangles; and Mr. Gardner, who had charge of the primary triangulation, made his primary triangles from the top of the most prominent peaks in that area. Inside of that net-work, each one of the distinct parties made a still more detailed net-work of what are called secondary triangles, lying within these primary triangles—so that one acts as a check on the other. Many of these points are made so accurately that mining-claims can be accurately determined from them. There was one peak which we were unable, for a considerable time, to find, because it was located on the maps thirty miles out of its true place. That was the mountain of the Holy Cross. They, the members of the party, act and re-act on each other in their work continually. They are all civilians, and are all in sympathy with each other. The consequence is that one throws his store of knowledge into the other's lap, and *vice versa*. The elevation of the mountain-peaks, the elevation of the surrounding country, the thickness of strata, &c., are determined by barometrical observations, and by means of these topographical surveys; and the various geological formations, whatever they be, whether carboniferous, or cretaceous, or volcanic, or granite, whether they be mines or anything of that kind, are laid on the map with great precision by the geologist with the aid of the topographer. The geologists mark with colors the geological formations on little outline maps, made from day to day. Many of our men are draughtsmen and make sketches and illustrations in their books; and on these are marked the elevations of the mountain-peaks and also the different geological formations; so that, when they come from the field to the office there is that same mutual action and re-action. The consequence is that the work is very much increased in quantity as well as in quality.

Adjourned till 9½ o'clock to-morrow.

COMMITTEE ON PUBLIC LANDS,
Washington, D. C., May 14, 1874.

No. 4.—Continuation of the statement of Professor F. V. Hayden.

Mr. CHAIRMAN AND GENTLEMEN: I spoke yesterday about the character of the organization, but I wish to say a few words more in regard to it. I stated that it began small, that is, sprung up from small beginnings. It was really what might be called a sort of creation, a new formation which had, as a matter of course, to struggle upward breasting apathy and some opposition. It had not behind it the prestige of antiquity from which to obtain appropriations, and therefore when I present to you the results, I hope it will be taken into consideration that those results have been brought about under circumstances that were originally extremely unfavorable. It has had to work its way upward. Rumors have been circulated abroad, to a certain extent, that it is an irresponsible body. It had to go through a formative process; but it is now a compact organization, complete in all its parts, under the control of the Secretary of the Interior. I desire, therefore, to convey the impression to the

committee that this plan is now complete and perfect in all its parts for the special duty for which it is intended. It is, however, capable of expansion to meet the needs of the Government, and yet have the plan preserved. The size of the party must of course depend on the amount of the appropriation, and it is very desirable that it should be uniform, in order that the young men who devote themselves to this special scientific work may feel that their position is permanent. The capacity of the organization for producing work increases every year. Each assistant is worth to the Government from 50 to 100 per cent. more each succeeding year.

All the members of the scientific party are selected for their special fitness for the work, and they have come to the front, as it were, because they are specially fitted for the work which is assigned to them. On that account some of them have already attained great distinction for their skill.

The survey has decided upon a grade of work which is believed to be sufficiently accurate for a complete topographical and geological survey; and with this grade we have estimated that, with our present force, we can survey 20,000 square miles in a season. It is the intention, as a matter of course, to keep this organization compact and to maintain mutual good feeling and interest in the work so as to increase its capacity and power for the production of good work from year to year. The quality as well as quantity should increase annually.

The entire party is separated into six smaller parties. The area to be explored is divided into three districts. One topographer, one assistant topographer, and one geologist make the scientific portion of each. There may, or may not, be one or two other secondary assistants; there are also two packers and one cook. That makes up the little parties that are assigned to the districts. These parties are confined strictly to the areas previously marked out for them. The chief geologist overlooks the entire work and makes such special studies and examinations as he may think advisable to render the work more complete. There are, then, other parties which are equally important: The primary-triangulation party, which travels over the entire area and connects the whole work by a system of triangles from the summits of the loftiest peaks.

[Mr. Hayden here exhibited to the committee maps showing the system of primary triangulation in Colorado, also photographic views of mountains, &c.]

Besides this primary-triangulation party, which has to be compact in form, we have also the quartermaster's party, which furnishes supplies for all the other parties. When these three parties are located in their special districts they have their particular duties to perform, and we do not desire to have them interrupted for a day. We therefore have depots of supplies, and the quartermaster's party transports from time to time supplies to the other parties, so that they are able to work right through the season without losing a single day. This, you will see, is extremely essential.

Then there is a photographic party also, which collects photographs. We have found them most essential in the preparation of our geological reports and maps, and we have also found them to be very attractive to the public. These photographic views are used in school-books, journals, &c., and the demand for them for the purpose of engraving is very great. We all know that it is through the eye that we acquire most of our knowledge, and these pictures help the eye very much, giving, as they do, clearer conceptions of mountain forms than pages of description could do.

Connected with these three parties there are also some young men who are collectors in natural history. We never allow anybody, however high or however low his position may be, to be connected with our party unless he is capable of working with us; and, as a matter of course, if he is not capable he drops out in a day or two and disappears. In botany, natural history, entomology, &c., very large collections are made, although these matters come in incidentally. We consider geology as the anatomy of the country, while we regard topography as the external covering, as it were. The one is essential to the other. They act and re-act upon each other. The topography or the surface form of a country is as intimately connected with the geological structure as are the muscular and bony portions of a man. The time spent in the field is usually from five to six months. When the autumn weather becomes too cold to work to advantage in the field, (which is about the 1st of November,) the party returns to the office in Washington, and the results of the season's work are at once put into shape for publication before the time comes to take the field again. The annual report is thus prepared, which may be regarded as a record of progress. In this way the entire work is kept up to date, so that if any accident were to happen to the party or to any member of it, the Government would not be the loser. The map of each division has been reduced by photographing to a certain scale, so that the geologist may color the geological formations upon it.

[Mr. Hayden here exhibited to the committee the maps reduced by the photographic process, and also a map showing the amount of agricultural, grass or timber land, &c., colored, and maps showing the contour lines of the country 200 feet apart; also geological maps and a panoramic view of the Territory of Colorado from Long's Peak to Pike's Peak.]

I have now called the attention of the committee to a portion of the results, and if I were to continue it would require many hours to complete my statement. I would like now to begin back again and exhibit before the committee the results of the work of the survey from the beginning in 1869 up to 1873. All these maps, sections, &c., which I have now shown

to the committee are the results of the work of 1873. The annual report for the year 1873 is now ready for publication. The work is cumulative. We have now got things just where we can go on with the work. We have had up to this time to struggle, to a certain extent, against apathy and the development of our plans, but we have got now where we can see the great field before us. We could accomplish more within the next two years than in all the preceding years.

Mr. CLYMER. You were anxious to compare your work of 1873 with that of Lieutenant Wheeler. I wish you to go on and make a connected statement in detail of the geological and other results obtained by you in the expedition of 1873. Are you prepared to do so, or do you wish to leave it to somebody else?

Mr. HAYDEN. I am prepared to do so myself. The results are a part of what I am now showing you.

Mr. CLYMER. What geological collections did you make?

Mr. HAYDEN. Our geological collections consisted of a very large quantity of rocks and fossils and other specimens illustrating the different portions of the country which we examined. These three different districts were examined carefully, and rocks were collected and placed in the Smithsonian Institution. The law is positive that these things shall be deposited in the Smithsonian Institution. On our return all the collections in natural history are put in the hands of the collaborators of the different branches, who report upon them. Three assistant geologists make their reports to the geologist in charge, and there are also reports from the geographers, and a large number of reports from naturalists. I have here one of the publications on botany, &c., and bulletins one and two, which are the results of the survey for 1873.

Mr. CLYMER. I wish to get your work of 1873, distinct from your former work, because we are comparing that with the result of Lieutenant Wheeler's expedition.

Mr. HAYDEN. I was going to commence back and bring it up to 1873. In 1869, after the close of the first season's field-work of the survey in its present form, on a little appropriation of \$10,000, I prepared a small report of 150 pages, 8,000 copies of which were published. These annual reports are, as far as possible, descriptive, to a very great extent. Popular language is used in them in order to make them more acceptable to what I might call the great intelligent masses of the people, who are interested in such work as this. They have proved to be very acceptable, because they meet the wants of the people. In 1870 we published another annual report of 511 pages, illustrated.

The CHAIRMAN. How many copies did you print?

Mr. HAYDEN. I think there were 9,000 copies printed. In 1871 we made the report of the Yellowstone region, of which 12,000 copies were printed; that work is nearly out of print now. It contained 538 pages of original matter. The annual report of 1872 contained 844 pages, and there were 16,500 copies of it published.

The CHAIRMAN. Were they entirely distributed?

Mr. HAYDEN. It is very difficult to get any copy of that work now anywhere. I never asked any for myself, but depended on what I could pick up, but we are unable to get any now.

I want to call the attention of the committee to a little economical plan adopted by us in reference to these illustrations. We let our photographs of this curious scenery go to an illustrated paper, "The Christian Weekly," for which excellent wood-cuts were made, and one of my young men wrote the text. For permitting the editors to use these photographs in their paper we get the electrotypes for use in the annual reports. They must have cost the proprietors of the paper from \$800 to \$1,000, and we got them for \$20, the cost of electrotyping.

The CHAIRMAN. You lend them your photographs, and they lend you their plates.

Mr. HAYDEN. We let them take the photographs, and they give us the electrotypes. We have filled up four or five numbers of Appleton's "Picturesque America" on these conditions: We are to have the electrotypes of those illustrations, which are very truthful, and which will convey their scientific lesson as they have already conveyed their æsthetic lesson.

I now call the attention of the committee to another class of publications. I have divided the publications on the plan of the Smithsonian Institution. The longer that scientific men look at the plan of that Institution the more they are impressed with the wisdom of it. We have adopted the plan of annual reports for the people, containing a record of progress, and they are made as popular as can be, consistently with scientific accuracy. Then we have a series of publications that are not quite so original, but are somewhat compilations. For instance, here is a list of elevations west of the Mississippi. We send off circulars and get elevations, railroad profiles, &c., and we look up all the surveys and collate them in pamphlet form. We hope to produce soon a relief map of the country west of the Mississippi, in contours of 1,000 feet.

Then there are the meteorological observations, which, though of not very great importance, are data on which information in relation to climate is based.

Then we have a catalogue of photographs of scenery, miscellaneous publications, No. 4, and of Indians, representing sixty-five different tribes. They were not all made by the photographers of the survey; but I have an influential friend who bought a great many of them and turned them all over to us. He has promised that he will eventually turn them over to the Government, this great collection of Indian negatives.

Then we have published a hand-book or synopsis of the Flora of Colorado, and several other pamphlets, the result of last year's work. Among my collaborators there was a pressure for immediate publication, on account of the great amount of new matter obtained in 1873, and therefore I felt under the necessity of starting a bulletin. Here [exhibiting them] are bulletins No 1 and No. 2. Then [exhibiting them] are quarto volumes of which but small editions are published, as they contain technical matter.

The CHAIRMAN. Is that quarto series published out of your appropriation ?

Mr. HAYDEN. The engraving and printing of the plates, with the paper, comes out of the appropriation, but the text is printed at the Congressional Printing-Office. Some persons might object to the quarto publications because the language is technical ; but I regard it as extremely essential. Without this technical work we could not have the popular information descending down into the school books—just as a watch, which is of such importance to us, is the result of hundreds of years of brain-work, and of the most abstruse astronomical calculations. Here [exhibiting it] is a monograph on grasshoppers, so destructive to the crops in the West. The next work is one which we have not published fully. There are only one hundred copies of it published. They are the geological sections prior to 1873.

The CHAIRMAN. Do I understand you that all these works are since 1869 ?

Mr. HAYDEN. They are all since 1869—illustrating the work done since that time. We have over ten volumes of quarto under way, for which we have the plates on hand. Here [exhibiting it] is a work on cretaceous fossils.

The CHAIRMAN. When will that be out ?

Mr. HAYDEN. Just as soon as we have got a little more money. We hope that they will all be out within a year or two. The third, fourth, fifth, and sixth annual reports are the results of our work since 1869 ; and the seventh annual report is ready for the press.

I do not know that I need go any farther in this matter, but I would like to present a few other points which I wish to have put upon the record. I stated to the committee that we desired to bring this survey up to a scientific standard, as a survey under the auspices of the General Government, so that it may become, as it should be, a model, to a certain extent, for our State surveys. To show the committee that it has been already used to influence the State governments in this matter, I would like to read one or two paragraphs of a letter from Mr. James Macfarlane, the author of "The Coal Regions of America, their topography, geology, and development," to Hon. James Webb, representative in the Pennsylvania legislature from Bradford County :

"The United States Government is giving a noble example to all the States. If the present system of geographical and geological surveys under Doctor Hayden are continued the world will soon know more of the geology, topography, mineral and agricultural resources of the deserts of Montana, Idaho, Colorado, Nevada, and Arizona than we do of some of the counties of Pennsylvania."

I will read another paragraph from an article in the Penn Monthly for March, 1874, written by Professor Lesley, who has been laboring for some years to get a new geological survey of Pennsylvania, and who is well known to be the first geologist in the land :

"At last the United States Government was made aware that its vast territorial possessions must be explored. Western men clamored at the doors of Congress. Doctor Hayden had aroused a genuine enthusiasm for geological knowledge in the interior by his personal publication of his own unaided explorations. The geological survey of the Territories under the auspices of the Secretary of the Interior was commenced. Doctor Hayden has received larger and larger appropriations each successive year. The work will never stop ; of that you may be well assured. It is of a nature so imperative, and its nature has been so clearly demonstrated to the satisfaction of our western population, that no British survey, no Austrian survey, will surpass the survey of its Territories by the United States Government in the course of the coming twenty or thirty years. As it goes on it will become more local, more precise, more exact in its details, more full in its illustrations, and always more rich in its consequences."

The CHAIRMAN. You have given a list of the officers engaged in your survey ?

Mr. HAYDEN. Yes, sir ; it is in the pamphlet.

The CHAIRMAN. The collections made in your expedition are in the Smithsonian ?

Mr. HAYDEN. Yes, sir ; there are a few minerals on the shelves at our rooms, but they will be turned over. All these collections go to the Smithsonian Institution.

The CHAIRMAN. It is stated that the Army has repeatedly been required to furnish escorts for your parties. Please state for what expeditions they were furnished, and to what extent.

Mr. HAYDEN. I have received great kindness from the military authorities. I do not deny it. When I went into the Yellowstone country in 1871, General Sheridan ordered Captain Barlow and Captain Heap, of the United States Engineers, to go up there. They got to Fort Ellis about the time that I did. They were ordered to co-operate with us in the exploration of the same territory. We worked together harmoniously. Captain Barlow published his report and map, and I published mine. There was an escort of thirty or forty soldiers with us. They staid with us ten or twelve days, and were then called back Seven soldiers were left with us. That was in 1871.

The CHAIRMAN. What amount of transportation did the Army furnish you at that time?

Mr. HAYDEN. I forget how much exactly; but it was to a considerable amount.

The CHAIRMAN. What escort and transportation were furnished to you in 1872?

Mr. HAYDEN. No escort whatever. We obtained some transportation from the War Department, but a large part of it was what was called condemned material—animals and wagons.

The CHAIRMAN. What was the extent of your party in that year, 1872?

Mr. HAYDEN. It was a very large party. It was in the flush of the excitement in regard to the Yellowstone region, and the pressure was very great.

The CHAIRMAN. Was any portion of the transportation and subsistence in that year furnished out of your appropriation?

Mr. HAYDEN. All of it. We always paid for our subsistence and transportation.

The CHAIRMAN. There was no escort furnished to you in 1872?

Mr. HAYDEN. No, sir; we were refused an escort.

The CHAIRMAN. Did you apply for an escort?

Mr. HAYDEN. Yes. We did not need it, as we were going to the Yellowstone country; but we applied on the general rule of applying.

The CHAIRMAN. Who refused you?

Mr. HAYDEN. General Hancock.

The CHAIRMAN. You applied to him for an escort?

Mr. HAYDEN. I applied to the Secretary of War.

The CHAIRMAN. And General Hancock refused you?

Mr. HAYDEN. Yes, sir.

The CHAIRMAN. Had you an escort in 1873?

Mr. HAYDEN. No, sir.

The CHAIRMAN. Had you any transportation from the Army in that year?

Mr. HAYDEN. I think not.

The CHAIRMAN. Had you any subsistence from the Army?

Mr. HAYDEN. No, sir; we have always bought it.

The CHAIRMAN. Had any of your parties in 1873 soldiers?

Mr. HAYDEN. No, sir.

The CHAIRMAN. I think that Lieutenant Marshall stated in his report that you agreed to go with him on one side of the Arkansas, because of the protection incidental to the proximity of soldiers.

Mr. HAYDEN. I do not like to reply to that. It is something which has not entered into my brain.

The CHAIRMAN. You did not go there because of an escort?

Mr. HAYDEN. No, sir. There was an officer of the Army with us, who furnished his own horse and transportation, and everything. He was an entomologist, and had a great enthusiasm for natural history. He sent letter after letter of request to accompany us. I sent one of his letters to General Sherman, with a note of my own, and General Sherman, who has always taken the deepest interest in this work, indorsed the letter, and this officer went with us.

Mr. BRADLEY. Then he was with you at his own solicitation?

Mr. HAYDEN. At his own extreme solicitation?

The CHAIRMAN. What did you do with the horses and wagons and other materials of transportation which you had last year?

Mr. HAYDEN. We stored the materials and pastured the animals on the plains, near Denver.

The CHAIRMAN. About how much property is there there?

Mr. HAYDEN. About seventy or eighty animals.

The CHAIRMAN. And wagons?

Mr. HAYDEN. We had no wagons.

The CHAIRMAN. Tents?

Mr. HAYDEN. Tents and saddles, and all the paraphernalia of the expedition.

The CHAIRMAN. What is your estimate of the value of the property that remains from your expedition of last year?

Mr. HAYDEN. I suppose it is worth from \$15,000 to \$20,000.

Mr. BRADLEY. Have you an inventory of it?

Mr. HAYDEN. I can get it.

Mr. BRADLEY. At the close of your expeditions, do you take an account of the property you have on hand?

Mr. HAYDEN. Always.

Mr. BRADLEY. And you estimate what you have now at \$20,000?

Mr. HAYDEN. Somewhere in that neighborhood.

Mr. BRADLEY. Out of what appropriation did you purchase that property?

Mr. HAYDEN. Out of the regular appropriation for 1873.

The CHAIRMAN. What was the expense of last year's expedition, as nearly as you can tell?

Mr. HAYDEN. I should say about \$55,000.

Mr. BRADLEY. Supposing you had not been in command of any of these expeditions prior to the present time, but were now about to proceed on one; have you not some matters, data, plans, paper, maps, reckonings, and things of that kind, which have been obtained heretofore, and which are available for 1874?

Mr. HAYDEN. Our survey is a continuation. We go right along. We know no beginning and no end, and I trust we never shall. It moves along as a unit. All our work of the past is available for the future.

The CHAIRMAN. Will you want any new instruments?

Mr. HAYDEN. Yes; we want them very much. The Coast-Survey has loaned us very many instruments; but we need instruments of our own. These large theodolites cost a good deal.

The CHAIRMAN. I notice in the deficiency bill an item of \$20,000 for additional expenses of your expedition. Please to explain that.

Mr. HAYDEN. There were a good many reasons for that. The cost of transportation of a large party and of all the instruments is very great. In 1872 the cost of transportation and of everything very considerably exceeded my expectations. In order to save a thousand dollars, which I might have saved by dismissing one of the parties at Fort Hall, I sent a young man down to Fort Hall by stage from Bozeman, and it happened that the stage was robbed, and we lost about \$4,000. That fact has not come before Congress yet. The evening previous there was \$100,000 of treasure on the stage, and it is supposed that the robbers were after that. That \$4,000 is a part of the expense.

The CHAIRMAN. The \$75,000 appropriation for 1873 has been expended?

Mr. HAYDEN. Yes.

The CHAIRMAN. And now you ask for \$20,000 in the deficiency bill, making \$95,000.

Mr. HAYDEN. Yes.

The CHAIRMAN. If you deduct the value of the property which you have on hand from that amount, it leaves as the expenses of that year how much?

Mr. HAYDEN. I should think \$50,000.

The CHAIRMAN. You have on hand from fifteen to twenty thousand dollars' worth of stock?

Mr. HAYDEN. Yes.

The CHAIRMAN. Deducting that from the \$95,000 would leave \$75,000 as the expense of last year?

Mr. HAYDEN. Yes.

The CHAIRMAN. Then your expenditure must have been at least \$75,000?

Mr. HAYDEN. Probably it was. I suppose it was. I can give you the exact figures, as I have all the accounts.

The CHAIRMAN. Who audits your accounts?

Mr. HAYDEN. The First Comptroller, Mr. Taylor.

The CHAIRMAN. There are two questions in the resolution. One of them is, Which does this work the most economically? The other is, Cannot each have geographical limits as, signed to it without any conflict between the Interior and War Departments? What have you to say to these questions?

Mr. HAYDEN. So far as economy is concerned, that question can be better settled by the committee. I should say, as a matter of course, that comparing the results, (which ought to be taken into consideration,) the civilian organization can do the work far more economically than the Army organization; but I am, of course, an interested party. As to defining the limits of each, that is a matter that I have never taken into consideration, neither do I very much care one way or the other. Although there have been parties going over the same ground with ours, we have never found any fault with them at all, because, as I said to Lieutenant Marshall, he did not do us any harm, as the reconnaissance which he made was only that which was necessary to be made before this systematic work of ours could be done, and I said to him that he might go on and publish his maps and reports, and that we would do the same. As to distributing areas, I should say that the whole Rocky Mountain region is one grand unit.

Mr. BRADLEY. What is your judgment as to whether the territory can be divided?

Mr. HAYDEN. It can be done just as well as not.

Mr. BRADLEY. What you mean to say is, that the geological structure of the Rocky Mountains is pretty much the same?

Mr. HAYDEN. Yes; that it is a unit, and that one master-mind has got to mould it into one whole, and that sometimes, in order to make our work more perfect, it is necessary to look into other parts of the country than those to which our work is specially confined.

The CHAIRMAN. What is the particular advantage to the Interior Department of the service under civilians in respect to the public-land system of the United States?

Mr. HAYDEN. It is, as I consider, a part of the development of the public domain, which is the primary object of it, and we find that we can make use of the work which is done under the Interior Department. Their land surveys are more in detail, and more accurate than any other maps we have. Up to this time there is not a single square mile of the Rocky Mountain region sufficiently accurate and in detail on the engineer maps that we could use for geological purposes. We have for our main objects the opening up of the public domain and impressing the information on the people. For that purpose we have our agri-

cultural reports, our reports on irrigation, reports on mining, coal-beds, and gold-mines, &c. These are all embraced in our reports; also, the grass-lands and the cultivated lands. They are intended to convey information to persons intending to settle on the public lands.

Mr. CLYMER. You mean to say, then, that the Interior Department furnishes you with the skeleton and outlines of the public land, and that you place upon that skeleton the agricultural, mineralogical, botanical, and other capacities of that region?

Mr. HAYDEN. That is it exactly; that is a clear statement of it.

The CHAIRMAN. State how those points which are intended to be examined are designated beforehand. Are they designated by yourself on your own motion, or at the suggestion of the Secretary of the Interior, or how?

Mr. HAYDEN. By both. There are continually matters coming before the Secretary of the Interior which he desires to have examined. As a matter of course, the Secretary of the Interior would have special points to be examined, and we desire to cover all other points that are contiguous to us.

Adjourned to 9.30 a. m., May 10.

WASHINGTON, D. C., May 16, 1874.

No. 5.—*Statement of General A. A. Humphreys, Chief of Engineers.*

The CHAIRMAN. I suppose that General Humphreys is aware of the resolution under which this committee is acting. There are two or three points on which I shall ask General Humphreys to give his opinion. The first is, whether it be not practicable to consolidate the surveys under one department of the Government. The second is, whether it be not practicable to define the geographical limits to be embraced by each. The other questions growing out of these are as to the relative expense and economy of the surveys. General Humphreys will be good enough to give us his views upon these points.

General HUMPHREYS. I do not see why the surveys should not be consolidated if it be the wish of Congress that they should be. From the organization of the Government, or from the time that the Government has had territories to explore, the explorations have been conducted under the direction of one Department, and almost exclusively under that Department. That has been so until within the last few years. The Department under which they were conducted has been the War Department, which for seventy years has explored, reconnoitered, and surveyed those interior regions. The War Department, to the almost entire exclusion of all other Departments of the Government, has been charged with that duty by Congress. It has a large body of scientific officers, trained in the execution of the chief labors of such parties—the astronomical, the geodetic, topographical, and meteorological parts, which form the basis of the geological portion of the work, which is but a fractional part of the whole, costing but a small part of the whole cost of the survey. Geology has generally formed a part of the surveys of the War Department. It was by those explorations that the War Department made known to the country the character and capabilities for settlement of those interior regions, and the practicable lines of travel through them, and it thus led the way to the settlement and occupation of the country by agriculturists, miners, and others. The great routes of communication and of supply through the interior have also been ascertained by it.

The science of the War Department is not exclusively military. On the contrary, the officers of engineers have associated with them a large number of scientific gentlemen, with whom the most cordial relations exist; and having that large body of the best trained scientific men, civil as well as military, at its command, the War Department, having the most experience in such works, can, in my judgment, make these surveys and explorations better, more expeditiously, and more economically than any other Department of the Government.

Let me ask the attention of the committee to the fact that from the organization of the Government to the present day Congress has not limited the duties of the War Department to purely military works; nor has Congress ever enjoined upon that Department the execution of its purely military works, such as the construction of permanent fortifications, solely by the employment of commissioned officers and enlisted men. Even purely military Governments do not pursue such a policy. Some of the most important duties imposed upon the War Department relate to the commerce and navigation of the country, foreign and domestic; and the propriety of that assignment has never been questioned any more than the propriety of assigning to it the exploration and survey of the Territories with a view to their settlement and occupation.

I will ask the attention of the committee to the classes of duty imposed upon the War Department. From the first organization of the Coast-Survey, although its object was directed solely to the foreign and coastwise commerce of the country, Congress required that officers of the Army should be associated with that survey, and should take part in it; and they have done so from the very first.

Congress has always intrusted to the War Department the improvement of rivers and harbors, and a great variety of surveys, having in view finally the improvement of rivers and harbors and their preservation. So it intrusted it with the surveys and investigations required to prepare plans for the protection of the alluvial region of the Mississippi River against inundation. It has placed the construction of light-houses in the hands of Engineer officers solely. It intrusted the War Department with the explorations for Pacific railroad routes.

It has required the survey and demarcation of some of the national boundary lines to be done by Engineer officers; and even where there was no requirement for Army officers to be employed on such surveys, they have been so employed at the request of the Department having the surveys in charge.

Congress has recently established a service in the War Department—the Signal Service—which relates in a great measure to the safety of commerce and navigation.

The War Department has had in its employment, from time to time, in geographical explorations, men who were distinguished in the various branches of science. In the early time there was Nicollet, a civilian, and there is now one of its great works conducted by a civilian—Mr. Clarence King—the geological, topographical, and geographical survey along the fortieth parallel.

That is the reply to the first part of your question.

The CHAIRMAN. Is Mr. Clarence King's surveys under the War Department?

Gen. HUMPHREYS. Yes, sir.

The CHAIRMAN. How long has Mr. King been on that survey?

Gen. HUMPHREYS. He was first employed in 1867. He came to me in 1867 with the very highest recommendations from Colonel Williamson, of the Engineers, who was the senior officer on the Pacific coast, engaged in surveys and explorations. Mr. King had served with him, and had also taken part in the geological survey of California. He came to me with the very highest recommendations from Colonel Williamson, and it was from those recommendations that he received my recommendation to the Secretary of War that he should have the charge of the exploration of the 40th parallel. That was not long after the conclusion of the war, before we had resumed those interior surveys on a large scale. Of course during the war we had no officers to send upon them, and it was some little time after the war before the many Engineer officers in command of troops and on other purely military duties resumed their labors in the Engineer Department.

The CHAIRMAN. Is Mr. King still on the survey?

Gen. HUMPHREYS. He is.

The CHAIRMAN. What are the termini of that survey?

Gen. HUMPHREYS. It begins on the eastern boundary of California, and extends to the eastern slope of the Rocky Mountains, stretching north and south something like 100 miles.

The CHAIRMAN. What force has Mr. King had under him?

Gen. HUMPHREYS. I have not the details with me.

The CHAIRMAN. Are there any Army officers with him?

Gen. HUMPHREYS. None whatever.

The CHAIRMAN. Has he had any escort?

Gen. HUMPHREYS. Sometimes he has had escorts. We have had escorts from time to time with different parties. His escorts have been generally cavalry.

The CHAIRMAN. Mr. King's force is wholly civilians?

Gen. HUMPHREYS. His force is wholly civilian.

The CHAIRMAN. In your expeditions you say that you have drawn to your aid a large number of civilian scientists.

Gen. HUMPHREYS. Yes; in the varied duties of the War Department.

The CHAIRMAN. Why was it that you had scientific men from the civil life pretty much, instead of drawing them from the Army?

Gen. HUMPHREYS. In many of our surveys we have to employ a large number of civilians, because we have not officers enough in the Corps of Engineers to fill these places and cannot obtain the detail of other Army officers for them. We have employed geologists to accompany these expeditions, because it is well to have with them men who are devoted to special branches of science.

The CHAIRMAN. In Lieutenant Wheeler's expedition, were not the chief astronomers men from civil life?

Gen. HUMPHREYS. I think that Army officers have also performed some of those duties in his parties.

The CHAIRMAN. I notice in these lists that the civilian officers far exceed in number the Army officers. Why was that?

Gen. HUMPHREYS. Simply because of the large amount of duties imposed upon the Engineer Corps. The Engineer Corps consists of about 100 officers; and, in order to execute our duties, we have to employ civilians. On the northern boundary-line the astronomical and all other scientific duties relating to the boundary are performed by Engineer officers, because it is especially required by law.

The CHAIRMAN. With reference to that northern boundary-line, my recollection is that the officers of the Army fix the line by astronomical observations.

Gen. HUMPHREYS. They are now marking it by astronomic, geodetic, and topographic methods.

The CHAIRMAN. Gen. Parke has been directing a part of it?

Gen. HUMPHREYS. Yes; the western portion, from the crest of the Rocky Mountains to the Pacific Ocean. As to surveys generally, let me mention that refined methods of survey were introduced into this country chiefly by the Army in the performance of the duties assigned to the War Department, and its officers are skilled in every kind of survey, from the most difficult and refined to the simplest and rudest, and are also skilled in the administration of a great variety of works. The great variety of their duties gives them an experience which few others possess the opportunity of gaining; and there is no doubt, because their education, experience, and training have best fitted them for such various duties, that Congress has directed the War Department, from time to time, to take charge of so many different classes of works, or to aid in carrying them on.

The CHAIRMAN. I notice in the statement, which you have sent to this committee, a list of surveys and explorations west of the Mississippi River, conducted under the War Department. How far back in those surveys was special attention paid to making the maps geographical, topographical, and geological?

Gen. HUMPHREYS. Almost from the very beginning. The maps of Colonel Long's surveys were so.

The CHAIRMAN. Did Long make maps in 1819 and 1820?

Gen. HUMPHREYS. Yes; and they were the only maps which we had of that country for a long time.

The CHAIRMAN. I suppose that many of those explorations were merely reconnaissances?

Gen. HUMPHREYS. Most of them were well made; all those the results of which have been published were made with good instruments. Of course the character of those surveys would be modified from time to time, according as the facilities existed for the transportation of instruments, and as the objects of the surveys changed. Sometimes the only instruments one could have were those that could be carried about the person, such as a pocket-sextant, pedometer and a small pocket-compass, with which quite a good survey or reconnaissance can be made. I have myself made reconnaissances quite accurately with merely a pocket-compass and a watch.

The CHAIRMAN. Such surveys would not be very reliable for the settlement of the public land, or for fixing points?

Gen. HUMPHREYS. Such as I mentioned having myself made were not for the issue of land-patents, nor for the fixing of titles to lands. By the by, the admirable system of surveys for the sale of public lands was devised by an officer of engineers, Lieutenant-Colonel Mansfield, at the time professor of philosophy at West Point. He was appointed surveyor-general of the Territories. That was a long time ago when the Territory was not much occupied. It was after 1812.

The CHAIRMAN. How far back has special attention been called to this subject, in the manner in which Lieutenant Wheeler has been paying attention to it, geographical, topographical, geological, &c.?

Gen. HUMPHREYS. I think that you will find that from a very early day geology formed part of the observations of those expeditions. It certainly did in Featherstonhough's examination; it certainly did in all the Pacific Railroad surveys, which were made more than twenty years ago.

The CHAIRMAN. I thought that those points were not made specialties until very recently.

Gen. HUMPHREYS. They were made specialties certainly in the Pacific Railroad surveys, which took place in 1853; and they have been so continued ever since.

The CHAIRMAN. From what you have said, I gather that your opinion is that the geological surveys of the country should be under one head, the War Department?

Gen. HUMPHREYS. I have said that the surveys under discussion should be. The geological survey is based upon surveys which determine the position and form of the surface of the earth. That is the more exact scientific survey which precedes the geological survey, and without which the geological survey would be of comparatively little value. They must have the first-named surveys as the basis; and, in my opinion, the War Department is better prepared than any other Department of the Government for conducting the complete surveys. They require the association of geologists for that branch of investigation. I include in the War Department (and I object to having separated from it) those gentlemen from civil life who are engaged with it. The War Department and the officers of the Army are not in antagonism with the science of the country, but have always maintained friendly and intimate relations with it, and Army officers have always been associated with the various scientific societies, and are not in an attitude of hostility toward them or the scientific institutions of the country; and I repudiate any intimation on the part of any one that the Engineer Department holds that position because it may not accede to the pretensions of a few who are not recognized as exponents of or authorities in the branches of science they are engaged upon.

The CHAIRMAN. That being the case, is it possible to define the geographical limits that may be embraced between the War Department survey and the surveys of those individuals to whom you refer?

Gen. HUMPHREYS. I think that if Congress directs surveys to be carried on by them of the same character as those carried on by the War Department, it might be left to the heads of the War and Interior Departments to make such divisions of the territory. I do not know what may be the policy of Congress in regard to the duties of the Interior Department. When the settlement in any region reaches such a point that it becomes advantageous to the Government to sell its land, the surveys of the General Land-Office are extended over it, and here, it seems to me, would come in the geological surveys of the Interior Department as part of the survey having reference to the sale of the land, and thus be connected with the General Land-Office.

The CHAIRMAN. What I desire to know more particularly is this: if the Interior Department feels that for its better conduct it should keep up these geological surveys, is there any difficulty in assigning geographical limits to the surveys of the Interior Department and of the War Department, so that they may go along without clashing and in harmony?

Gen. HUMPHREYS. I think that the heads of those Departments could arrange the limits of the surveys.

The CHAIRMAN. Let me inquire what is the primary object of those surveys of the War Department, such as Lieutenant Wheeler has had in charge?

Gen. HUMPHREYS. The primary object is to make known the character of those interior regions and their fitness for occupation and settlement, and to determine the great lines of communication through them, and for the proper management of the military operations of the Government. When the title to the territory west of the Mississippi River was fully settled, Mr. Jefferson at once set on foot those explorations of the country for the purpose of making it known to the people and directing emigration toward it, and the Government has continued that policy ever since.

The CHAIRMAN. Can you give me any idea of the expenses of Lieutenant Wheeler's expedition last year over and above the appropriation of \$90,000?

Gen. HUMPHREYS. He had some military escort and the supply for that military escort, the expense of which came from the appropriations for the Army.

The CHAIRMAN. Can you give me an estimate of what that expense was?

Gen. HUMPHREYS. I cannot without referring to the Quartermaster's and Commissary's Departments.

The CHAIRMAN. Then you have no idea of the force employed in Clarence King's surveys, or of the cost of it to the War Department?

Gen. HUMPHREYS. I have not those details here. I supposed that for such details you would refer to the officers having charge of the surveys. I telegraphed Mr. Clarence King to ascertain if he could come here at once, but he has been quite unwell for some months past, and is absent by authority. He is now in San Francisco. Will be here toward the close of the month. I should have brought with me all these memorandums as to expenses, if I had supposed that the committee desired the information from me concerning it.

The CHAIRMAN. The matter of expense has been referred to by the President and the Secretary of War.

Gen. HUMPHREYS. I supposed that Lieutenant Wheeler had given all the information concerning his parties. I presume all the information wanted can be furnished to the committee. I would say again that I object to the attempt to separate and antagonize the different classes employed by the War Department. I object to a separation and antagonism of those gentlemen from civil life who are associated with us, as though they were necessarily in an attitude of hostility toward us. I object to any such presentation of the subject. I know that an effort has been made, through the newspapers and in other ways for the last eighteen months, to create the impression that there was a hostile feeling between them, and that due credit has not been given to those from civil life for their labors. Credit is always given in the War Department to every one for everything he does.

The CHAIRMAN. One of the reasons given why Mr. Hayden's expedition should be placed under the charge of the military was that he required military escort. Has he been furnished with escort?

Gen. HUMPHREYS. I know nothing of Mr. Hayden's surveys. Mr. Hayden, I suppose, can answer for himself. I have recently examined the maps and results of Mr. King's surveys; and if he were here he could give you a very interesting account of them. I mean those portions that are in an unfinished condition. But inasmuch as they are incomplete, and as gentlemen engaged in scientific investigations do not like to have their unfinished partial results made known, I prefer to abstain from any statement in regard to them, except that I was very much impressed by the admirable manner in which he has executed his duties, and that I consider his work as of very high order.

The CHAIRMAN. What reports has Mr. King published beyond the two volumes on botany and mining?

Gen. HUMPHREYS. Nothing else. It will be perhaps a year or eighteen months before the other volumes are printed. They are in course of preparation.

The CHAIRMAN. Do you know the cost to the Government of the printing of those volumes?

Gen. HUMPHREYS. I made a statement on that point to the Committee on Appropriations eighteen months ago. I think that the cost of engraving, printing, binding, &c., is

from \$10 to \$12 a volume. One volume was much more expensive than the other. I recollect that it was stated that they had cost some \$24 or \$25 a volume; and I had the matter examined into and found that the cost was less than half of that amount. The first volume cost about \$10 or \$12, and the second one, which was on botany, I think cost much less. The other volume, mining, was an expensive one. The plates are expensive, but are very useful.

The CHAIRMAN. Do you recollect what geographical and geological reports have emanated from your Department within the last five years?

Gen. HUMPHREYS. I would prefer to send you a written statement on that head.

Mr. BRADLEY. By whom are the plans arranged? From whom are the orders issued for those several expeditions emanating from the War Department before they go out each year?

Gen. HUMPHREYS. That's always done by consultation between myself and the officer who is to have charge of the expedition, and the arrangement is then put in writing, and I go with it to the Secretary of War and explain the whole project to him. As much of it as meets with his approval is adopted, and orders and instructions are issued on that. It is always arranged in advance precisely what the force shall consist of, who shall be employed upon it, the names of all the principal gentlemen to be engaged in it, and the manner in which the survey is to be conducted.

Mr. BRADLEY. There seems to have been a difficulty in the field between two expeditions, the one conducted by Doctor Hayden and the other by Lieutenant Wheeler. What I want to get at is whether the original plan before Lieutenant Wheeler left last spring was agreed upon, that he was to go over the territory which he did go over.

Gen. HUMPHREYS. Certainly. The first project was submitted some time in the previous year, on his return from the field. He then indicated what should be the next year's arrangement, provided an adequate appropriation were made, and when it became time to arrange the matter a more formal presentation of the subject was made.

The CHAIRMAN. What other geographical, topographical, and geological expeditions were out last year besides Lieutenant Wheeler's?

Gen. HUMPHREYS. There was one under Lieutenant Ruffner and another under Captain Jones. Lieutenant Ruffner's was under the orders of General Pope. Captain Jones is attached to the staff of General Ord. Captain Jones made an exploration running up from points on the Pacific Railroad to the Yellowstone basin, approaching it from the southeast and toward Fort Ellis. He discovered a route for a road from Fort Ellis in a very direct line, approaching the Yellowstone basin from the southeast. There were also some general examinations in geological and other subjects, including natural history, in connection with those expeditions.

The CHAIRMAN. These points were subsidiary?

Gen. HUMPHREYS. Yes.

The CHAIRMAN. Has there been any report yet published of those expeditions?

Gen. HUMPHREYS. Lieutenant Ruffner's has been published. Captain Jones's is not out yet. Besides those I have mentioned there are expeditions from time to time sent out to ascertain the best routes between military posts, and also for the purpose of building military roads in the Territories, and for surveying lines for them.

Mr. ORR. If this entire service was included in one department, and put under the charge of the Engineer Corps, in the War Department, would there be, in your opinion, any impropriety in also including under the Engineer Corps the subdividing of the public lands into townships and sections?

Gen. HUMPHREYS. That is a very large work.

Mr. ORR. What would be the difficulty of having it done by the Engineer Corps?

Gen. HUMPHREYS. Of course the general character of the work is such that it could be done by the Engineers, but at the same time it is a very extensive work; and although it is a kind of work that could be executed by the Engineer Corps, yet we could not spare more than a few officers for it, who could only take charge of some of the main lines.

Mr. ORR. Would economy be subserved by detailing officers of the Engineer Corps to do that kind of work?

Gen. HUMPHREYS. I am unable to say, as I have not examined the subject. We could only undertake such part as I have mentioned. The whole would be a very heavy task. These surveys are quite extensive, and then they would entail the issuing of patents as well as the sale of the lands. That would bring a great deal of labor upon the Engineer Corps and into my office, which I would rather not have added to it. We have been called upon by various departments of the Government for assistance in the work of marking great geodetic lines.

Mr. ORR. I understand that kind of work is now done by the Interior Department, under a contract.

Gen. HUMPHREYS. Yes; I believe the land-surveys are done by contract.

Mr. ORR. If officers who are already in that line of duty can be detailed to do that kind of work, would it not be more economical to the Government?

Gen. HUMPHREYS. I am unable to say, as I have no knowledge of the cost of the land surveys. They form a very extensive work, and I should not like to encourage the idea of the Engineer Corps undertaking any material part of it. We should expect more accurate

methods of survey to be more expensive than the present. There are certain lines in connection with it, such as the great meridian-lines and great base-lines, the establishment of some of which by refined methods would be of value in correcting the maps of the country. For instance, we have been requested to aid the geological surveys of the States of Wisconsin and Minnesota—the former by making connections between the lake survey and some of the principal meridian and base lines of the Land-Office, which are the governing lines of the land surveys.

In the operations of the War Department during a state of peace, as well as a state of war, a good map of the United States is an absolute necessity. The recent war demonstrated that, I think, to the satisfaction of the public. Now if some of the great guiding lines of the General Land-Office surveys could be fixed by refined methods of survey, and connected with the controlling points and lines of the surveys of the War Department, all the map-materials of those Departments and such others as are available would go far toward the preparation of a great map of the United States, and in this view I see grounds for the association of the works of the two Departments.

No. 6.—*Further statement of Lieutenant Wheeler.*

WASHINGTON, D. C., May 16, 1874.

The CHAIRMAN. Be good enough to give us a list of the reports and maps made by officers of the Engineer Corps within the last five years.

Lieut. WHEELER. I have communicated that request of the committee to the Engineer Department, and what is now before you [showing a collection of maps and reports] has been sent. Part of them refers to the work which I have in charge. Another part of them embraces Clarence King's work. The remainder consists of such maps and reports as have reached Washington from work performed by officers at the different headquarters and divisions of the Army. I will confine myself more especially to the maps and reports in connection with our own work.

Since 1869 there have been four field-seasons. I assume that there have been twenty-six months of field-work during that time, and about three months of traveling to and from. It will be seen that the time for office-work has been comparatively short—in fact, too short; and we find that we are obliged to decrease the number of months spent in the field from year to year.

Several maps have been made for the immediate use of the general commanding the department. One map, known as the reconnaissance map of 1869, has been published, and a preliminary report has been rendered to the commanding general—a very short report.

In 1871 a preliminary report was published, giving the skeleton of our operations and some of the business features. There was, also, a preliminary map published in connection with it, in order to carry on our office-work, so far as the reduction of the observations is concerned. The object is to make out a list of what is known as the table of camps and distances, so that the astronomical and topographical points may be correlated with one another.

There has just been issued an astronomical report—a forerunner of what is to come.

Our current work, so far as some of the features connected with the survey and business operations are concerned, is finally reported to the Chief of Engineers, and appears in his annual report. We have collected in our office manuscript for a portion of six volumes proposed in that annual report. They are to contain, in a condensed form, the results of the survey up to date. They will be in quarto form, and will contain some 1,600 pages of text, about 250 wood-cuts, and about 100 plates.

There is connected with the work an atlas publication, which has just now got fairly started. That atlas is entirely for our expedition. It is a topographical atlas. The "progress-map" is the index-sheet, which shows the materials gathered, and from which we have maps in various stages of prosecution. As those materials would fill the committee-room, I ask to be excused from bringing them here, but I will be very glad to exhibit them to members of the committee if they will visit our office on F street.

The CHAIRMAN. How many of these maps are in your atlas?

Lieut. WHEELER. These four, [showing them,] and then we have certain other allied sheets, making eight sheets in the atlas, and then we have materials in the hands of the lithographers for fifteen sheets; and we have materials on hand that will run the number up to twenty-seven sheets.

The expense of the work I consider as comparatively nothing, as most of this territory which we have covered is still in the possession of the Government; and as I suppose the Government would like to sell some of it as soon as possible. The Government can afford to expend one-eighth cent an acre for it, or a cent an acre even, which is just eight times as much as we have expended in the work.

The first complete map of the western country was got together under General Warren,

of the Corps of Engineers. Here [showing it] is the memoir accompanying it. The map is known as the Western Territory map. It shows great areas still unexplored instrumentally in the northern parts of Wyoming, Montana, Idaho, Washington Territory, Oregon, New Mexico and Arizona, Central Utah and Southwestern Colorado. Our work is far in advance of the work done by the General Land-Office. It is outside of it, both horizontally and vertically. It correlates with it.

The CHAIRMAN. What proportion of the unsold public lands yet remains unexplored, topographically, geographically, and geologically, west of the Mississippi River?

Lieut. WHEELER. That is a very hard thing to make a critical statement about. Every time that I have attempted to approximate it, I have considered that I knew less about it. I have no estimate to submit on that point.

The CHAIRMAN. Do you wish to say anything further in illustration of these maps?

Lieut. WHEELER. No, sir; only to renew my invitation to the committee to call at our office and examine the work on hand. These which I have submitted are specimens of the work performed; but the things in progress are very much more considerable than these.

Adjourned to May 18, at 9½ a. m.

No. 7.—*Statement of Mr. J. W. Powell.*

WASHINGTON, D. C., May 18, 1874.

The CHAIRMAN, (to Mr. Powell.) You are aware, having been present at the previous sessions of the committee, of the points on which the committee is seeking information. You are one of the gentlemen who have had charge of these exploring expeditions. Be good enough to give us some account of your explorations with reference to the matters contained in the resolution of the House and the message of the President.

Mr. POWELL. During the years 1867-'8-'9 I was engaged in explorations in Western Colorado and Eastern Utah, under the auspices of the Smithsonian Institution, and other scientific societies. In 1870 the Secretary of the Interior, Mr. Cox, requested Congress to give me a small appropriation for the exploration of the Colorado River and its tributaries, and I have been engaged in that work from that time to the present. I have prepared a statement of the *personnel* for each year, which I will submit to the committee.

Statement of the personnel of the Colorado River Exploring Expedition.

1870.

Permanent force.—J. W. Powell, in charge; A. H. Thompson, principal geographer; F. M. Bishop, topographer; Walter Graves, topographer; Jacob Hamlin, in charge of pack-train; Ashton Nebeker, teamster.

Three temporary employes.

From two to ten Indians employed from time to time as guides and hunters.

1871.

Permanent force.—J. W. Powell, in charge; A. H. Thompson, principal geographer; F. M. Bishop, topographer; S. V. Jones, assistant topographer; F. S. Dellenbaugh, geological artist and assistant topographer; J. F. Stewart, assistant geologist; E. O. Beaman, captain of boat.

General assistants.—W. C. Powell, F. A. Richardson, J. K. Hillers, A. J. Hatton, Jacob Hamlin.

Temporary force.—Thirteen persons were employed from time to time as general assistants.

A number of Indians were also employed as guides, hunters, and messengers.

1872.

Permanent force.—J. W. Powell, in charge; A. H. Thompson, principal geographer; F. M. Bishop, topographer; S. V. Jones, assistant topographer; F. S. Dellenbaugh, geological artist and assistant topographer; E. O. Beaman, captain of boat.

General assistants.—W. C. Powell, J. K. Hillers, A. J. Hatton, George Adair, Jacob Hamlin, George Riley, Nathan Adams, John Renshaw.

Temporary force.—Eighteen persons employed temporarily.

From two to twenty Indians were employed from time to time as guides, hunters, and messengers.

1873.

Permanent force.—J. W. Powell, in charge; A. H. Thompson, principal geographer; F. S. Dellenbaugh, geological artist and topographer; J. H. Renshaw, assistant topographer; J. K. Hillers, photographer.

General assistants.—Nathan Adams, Joseph Haycock, George Adair, Joseph Hamlin.

Temporary force.—Seven temporary employes.

A number of Indians were employed as guides, hunters, and messengers.

I also submit the following

Financial statement.

Appropriation for the fiscal year ending June 30, 1871.....	\$12,000 00
Appropriation for the fiscal year ending June 30, 1872.....	12,000 00
Appropriation for the fiscal year ending June 30, 1873.....	20,000 00
Appropriation for the fiscal year ending June 30, 1874.....	10,000 00
Value of rations furnished by the War Department, (estimated).....	8,212 50
Total.....	62,212 50
Property remaining on hand, valued at.....	\$4,105 00

A part of the instruments used were borrowed from the Engineer Department.

I wish next to show the committee, by reference to the map, the country in which I have been at work. The territory west of the Mississippi River has been traversed by a number of exploring expeditions within the last fifty years. Here [showing it] is a map prepared by the War Department, showing in red lines the routes which have been traversed by the various parties. From the data collected by these various parties, a list of which will be found in General Humphreys's letter accompanying the message of the President, the map before you had been prepared. This map shows a blank space [pointing it out] which none of the Government parties has penetrated, although two or three parties made the attempt. This region is traversed by cañon gorges and high cliffs that were deemed impassable. The various parties who attempted to cross this region made detours around it. This is the region which I was to explore and survey. The work has been completed. You have on the wall one of the preliminary maps of that region. It is but a tracing of the field-sketches; the computations for latitude, longitude, and altitudes are not yet completed, nor have the triangles been computed, so that it is not a final map. By comparing it with Lieutenant Wheeler's map on which he has indicated the region of country explored by his parties, it will be seen that he with his parties also passed over some of the same territory, thus duplicating my work in part to the extent of about 26,000 square miles. This lower part and this upper part [indicating on the map] he has not worked in, but this part of the territory [indicating it] he has re-explored, following me one, two, or three years.

The way in which my work has been done, the methods which have been used in it, and the general results obtained, are questions that have been brought up by the committee in their examination of other gentlemen. I made a short statement to Professor Henry of what I had done, who, in transmitting my report to the House of Representatives, makes these remarks.

"In the report herewith submitted, a general summary is given of the entire work. It exhibits a great amount of labor, and a series of results, not only of importance to science, but also to a knowledge of the country in its relations to agriculture and mineralogy. The report embraces a statement of what has been accomplished in the way of, first, *Topography*, as based on triangulation, including a description of the arable valleys, the supply of water, the extent of timber and of pasture land; second, *Geology*, including economic mineralogical products, such as coal, salt, and other minerals; third, *Ethnology*, comprising tribes, political organization, languages, manners, customs, mythology, poetry, arts, &c.; fourth, *Natural History*, including mammals, birds, reptiles, insects, and plants."

I first take up the topography, and explain the methods used, and state the extent of country which has been surveyed. Then there is a description of the rivers, cañons, mountains, valleys, &c. Then I discuss the hydrography; that is, I state what has been done to determine the quantity of water that can be used for irrigation; the extent of the forests and of the grass-lands. Then follows the geology. I explain the methods of study, the plan of the sections, the study of the eruptive beds, the lithology and the erosion. I also make a statement of what has been done in ethnography. I will make that part of my report to Professor Henry which is an answer to the questions of the committee, a part of my statement, for I have there made it as brief and explicit as it was possible for me to do. I will send this part to the clerk, if the gentlemen of the committee so desire.

[The professor was permitted to file it as a part of his statement.]

The extract is as follows:

TOPOGRAPHY.

The Colorado River is formed by the junction of the Grand and Green. These streams unite in latitude $38^{\circ} 11' 21''$ and longitude $110^{\circ} 7' 48''$, approximately.

The mouth of the Colorado River, as determined by Lieutenant Ives, is in latitude $31^{\circ} 53'$ and longitude 115° . The course of the river from its head, the junction of the above-mentioned streams, to the mouth of the Colorado Chiquito, is south 40° west.

From the mouth of the Little Colorado to the junction of the Rio Virgen with the main stream, the general course of the river is to the west. From this point its course is to the south, until it empties into the Gulf of California. This lower part of the river was explored by Lieutenant Ives in the winter of 1857-'58; and the district of country to the east between the river and the Rio Grande del Norte, and to the west between the Colorado and the Pacific, has been crossed by various exploring parties and military expeditions.

The maps made by these several parties, when compiled, give a general map of the country of great value in determining many of the important features, but unreliable in details, contradictory, and confusing.

That portion of the Colorado between the mouth of the Rio Virgen and the junction of the Grand and Green had never been mapped until the one made by the parties under my charge was constructed. The river had been seen at two points by Lieutenant Ives, and at another by Father Escalante, and such points approximately determined. Nor had that portion of the Green between its junction with the Grand and the crossing of the Union Pacific Railroad ever been mapped; but its position at three different points had been determined by Government explorers, viz, at the mouth of Henry's Fork, at the mouth of the Uintah, and at Gunnison's Crossing, on the old Spanish trail.

During the years 1867, 1868, and the first part of 1869, I was engaged with a small party of naturalists, volunteers like myself, in the exploration of the mountains of Central and Western Colorado about the sources of the Grand, White, and Yampa Rivers. After exploring a number of cañons through which these streams run, I determined to attempt the exploration of the great cañons of the Colorado. Boats were built in Chicago, and shipped by the Union Pacific Railroad, which was then running construction-trains, to the point where that road crosses Green River, and from thence in our boats we descended Green River to the Colorado, and the Colorado through the series of great cañons to the mouth of the Rio Virgen.

On starting we expected to devote ten months to the work; but meeting with some disasters, by which our store of rations was greatly reduced, we were compelled to hasten the work, so that but three months were given to it.

On this trip astronomic stations about fifty miles apart were made, and observations taken for latitude with the sextant, and also for longitude by the method of lunar distances. The meandering course of the river was determined by compass-observations from point to point, with the intervening distances estimated, thus connecting the astronomic stations. For hypsometric data a series of tri-daily barometric observations were recorded taken at the water's edge, and using this as an ever-falling base-line, altitudes on the walls and such adjacent mountain-peaks as were visited were determined by synchronous observations. The results of this hypsometry were used in the construction of the geological sections made along the course of the river. The course of the river and the topographic features of the cañons only were mapped. It should be remarked here that a portion of the records of this trip were lost at a time when three men, who had them in charge, were killed by Indians.

Having demonstrated the practicability of descending the river in boats, it was determined to make a more thorough survey of the series of cañons along the Green and Colorado Rivers, and of the more important side cañons, and also to include as broad a belt of country as it was possible from the river, and application was made to Congress for the necessary funds to carry on the work. The assistance asked was granted, and the work has been in continuous progress from July, 1870, until the present time.

It had been determined that it would not be practicable to perform the elaborate work projected, depending on such supplies as it was possible to take with us on the boats from Green River Station, but that it would be necessary to establish depots for supplies at a number of points along the course.

Between Gunnison's Crossing, on Green River, and the foot of the Grand Cañon of the Colorado, a distance of five hundred and eighty-seven and one-half miles, it was not known that the river could be reached at more than two points. One of these, at the crossing known as El Vado de los Padres, where Father Escalante had crossed the river in 1776, by following an old Indian trail; the other but a short distance below, at the mouth of the Paria River. This route had been discovered by Jacob Hamlin, a Mormon missionary. These were so near together that only one of them could be used as a depot for supplies.

The last part of the year 1870 was given to the exploration of routes from the settlements in Utah to the Green and Colorado on the east and Colorado on the south. These lines of travel were mapped by fixing astronomic stations with the sextant and connecting them by the methods usually adopted in a meandering reconnaissance.

Early in the spring of 1871 boats were provided at Green River Station. The latitude of this point was determined by observations with the zenith telescope, and the longitude by

telegraphic signals, with an astronomic station at Salt Lake City, previously established by officers of the United States Coast-Survey. The altitude of this point above the sea had also been determined by the railroad surveys, so that the altitude, latitude, and longitude of the initial point of the survey were fixed with a good degree of approximation.

In descending Green River, astronomic stations were established at distances averaging forty-five miles by river, or about twenty-five miles by direct lines, the instrument used being the sextant. At each of these stations the variation of the needle was determined. The river was again meandered by two observers, working independently, and their work compared.

The lines between stations on the river were used as a series of base-lines, the lengths, of course, only approximately determined, and an intricate net-work of triangles was projected to salient points on either side of the river. From a vast number of points thus fixed the surface contour of the country was sketched so as to include a belt from twenty to fifty miles wide, the parties making frequent trips from the river into the interior of the country. At each of these astronomic stations barometric readings were recorded in hourly series, and as we proceeded down the river tri-daily barometric readings were made, all referred to the water's edge. With the river as a base-line for hypsometric work, altitudes were determined by triangulation and by barometric methods, using both mercurial and aneroid instruments. Thus all of our altitudes in this region are related to the river.

Our time during the spring, summer, and fall of 1871 was thus occupied until we arrived at the mouth of the Paria, a stream entering the Colorado from the northwest, a little below the Arizona line.

Such was the character of the astronomic, topographic, and hypsometric work done up to this time, methods not absolutely correct, but giving valuable approximate results.

But the wonderful features of the Grand Cañon district had yet to be mapped, and it was determined to do the work in this region by more thorough methods. A general reconnaissance was made for the purpose of selecting a site for a base-line, and the valley of the Kanab was chosen. Then a point midway between the extremities of the proposed line was selected, and an astronomic transit mounted for the purpose of determining the meridian direction and fixing the extremities of the line. This accomplished, the alignments were made with a theodolite. The latitude of the northern extremity of the line was determined by an extended series of observations with the zenith telescope, and the longitude by telegraphic signals with the previously-mentioned astronomic station at Salt Lake City. The base-line was measured with wooden rods, leveled on trestles, and aligned by sighting on small steel pins in either extremity. The rods were trussed to prevent sagging and warping, thoroughly seasoned, oiled, and varnished, and the extremities were shod with small metallic cones, for the purpose of securing accurate contact. The rods were measured with a standard steel tape, at a temperature of 52°. Three rods were used, two always remaining in position as a protection against accidental movement. The leveling instrument was a plummet, or an inverted T, the base of which was the same length as the rods. Every hundred-feet of distance was marked off by a stake, in the top of which was inserted an iron wire sharpened to a point, and this point connected with the point at the end of the rod by a plummet, and each hundred feet of the distance was remeasured with the steel tape.

The ground selected for the site of the base-line was very good, being nearly level and quite smooth, and we found that the work could be done more rapidly than had been anticipated, the only delay being due to windy weather. When the wind was blowing briskly it gave a trembling motion to the rods, which rendered it impossible to make that correct alignment and accurate contact between the points which was desirable, and for that reason the work was carried on only during still weather. The line was found to be 48,099 $\frac{1}{2}$ feet in length. Then a system of triangles was expanded from the extremities of this line, so as to embrace all of the country from the Mar-ká-gunt and Pauns-á-gunt Plateaus on the north to salient points a few miles south of the Grand Cañon, and from the Leaver Dam and Pine Valley Mountains on the west to the Navajo Mountain beyond the Colorado on the east, and still farther to the northeast, so as to embrace the country from the Sevier River on the west to salient points immediately beyond the Colorado on the east, and as far north as the southern tributaries of the Dirty Devil River. The angles of these triangles were measured with a seven-inch theodolite. At the geodetic points mounds were built and flag-staffs erected, and in that clear atmosphere it was found that it was practicable to make the sides of the triangles from twenty-five to thirty miles long, and occasionally, when the artificial points were on very salient natural points, the sides of the triangle could be made much longer.

Six of the more distant and important geodetic points were used as astronomic stations, where observations were made with the zenith-telescope for latitude, for the purpose of checking any serious error that might occur in the triangulation.

From the points thus established a number of observations were made with the theodolite or gradientor, and from these observations a vast net-work of secondary triangles was constructed. Thus the position of all the salient topographic features was determined, courses of streams and lines of cliffs were meandered, and the position of the observer constantly checked on the determined points, and *pari passu* with this the topographical features were sketched. The great features were Marble Cañon and the Grand Cañon of the Colorado, and many salient points on either side of the great chasm were fixed by triangulation.

The following summer we descended through these cañons in boats, and fixed the course of the river and the topographic features of the cañon-wall by compass and gradient observations on the points thus previously determined. The same system of barometric observations carried on in the cañons above was continued through these cañons, and occasionally hourly observations of eight-day series were made.

The parties engaged in geodetic and topographic work carried with them barometers, and made a vast number of observations over the country traversed. All of these and all of those in the cañons were synchronous with a continuous series made at the northern extremity of the base-line in the valley of the Kanab, so that the altitudes along the river and on the walls of the cañons, and over all the country embraced in the triangulation, are referable to this hypsometric base. We have compared this base of altitude with other points whose altitudes have been approximately determined by other observers, as at the mouth of the Rio Virgen, Saint George, Beaver, Salt Lake City, &c.; but it is hoped that before this work goes on permanent record the altitude of Kanab above the level of the sea will also be determined by the levels of the railroad-survey which is now in progress.

We have one unbroken series of observations at this point, (Kanab,) of three months' continuance, and another of ten months, and several shorter series. These were tri-daily except that occasionally they were expanded into hourly series.

By the methods last described, an area of country has been surveyed embracing twenty-five thousand square miles, and by the less accurate methods first given, an area of country embracing twenty thousand square miles, making in all forty-five thousand square miles.

Preliminary maps have been constructed on a scale of two miles to the inch, but the final result of all this work will be shown in a series of maps on a scale of four miles to the inch, giving the topographic and geological features of the region surveyed.

Besides making a general map of the country, we have also made a statement of the hydrography of the country for the purpose of determining the amount of water that can be used for irrigation and the extent of country which can thus be redeemed for agriculture; the extent and character of the forests of the region embraced in the survey have been carefully noted in order that they may be ready for the maps.

The structural geology of the country also has been studied with care, especially the great facts of plication, faulting, erosion, and nonconformity. In a region of country in many places of naked rock and everywhere exhibiting escarpments of great magnitude, it is possible to trace with accuracy the geographic distribution of the beds, and this has been done with such care that we shall be able to indicate with great minuteness the surface exposure of all the great formations extending throughout the country which has been surveyed. It is hoped that this can be done on a map, the topographic features of which are indicated by contour lines. The material for such a map has been prepared.

Extensive beds of coal and salt have been studied.

During the continuance of the survey much time has been devoted to the ethnography of the country, and these studies have been extended to tribes beyond the limits of the country embraced in the survey. These studies have been directed to the languages, political organization, habits and customs, means of obtaining subsistence, industrial arts, mythology, demonology, poetry, and antiquities of the country.

Something has also been done in natural history.

Altogether more than 45,000 square miles of territory have been explored and surveyed, including more than a thousand miles of a river-survey in a deep gorge varying from a few hundred to more than 6,000 feet in depth, descending in that distance more than 5,500 feet, and beset with rocks and interrupted by cataracts, making the navigation both difficult and dangerous. The territory, as a whole, presents more obstacles to the explorer than any other portion of the territory of the United States, as it is traversed by deep gorges and set with long lines of cliffs, in many places forming impassable barriers to travel. Much of the country is also arid and destitute of vegetation.

THE CHAIRMAN. What is that report you have printed?

Prof. POWELL. It is a brief report to Professor Henry of what I have done, merely stating methods and amount of work performed. None of my final reports are yet published; they are yet in manuscript. I have the manuscript before me on the table, many thousand pages in all, ready for the examination of the committee, if the gentlemen wish to make such inspection.

I would like to be permitted to give a brief explanation of the methods of exploring the country which have been adopted by various parties in the field, in order that the committee may more fully understand the statement which is to follow; I have therefore brought a blackboard for the purpose of drawing diagrams for illustration.

[Professor Powell here explained to the committee by illustrations and diagrams drawn by himself on the blackboard three methods adopted in these explorations. The first is what he called the meandering method; astronomic stations are made and distances measured by an instrument known as the odometer or by counting the paces of a horse, or by estimating the distance by the eye, and explained the reasons why data thus obtained were unreliable. He farther stated the method by which the topography along the route thus traversed was sketched in the field, and explained the methods sometimes used to check this work by climbing hills and mountain-peaks on either side of the route which has been traveled, taking sights of the surrounding peaks.]

Prof. POWELL. This method is sometimes dignified with the name of triangulation, but it cannot be properly called a triangulation from the fact that even if all the peaks thus observed were visited so as to properly close the triangles, only the angles of the triangles would be observed and no side would be properly measured, and hence there would be insufficient data for the construction or computation of the triangles.

The second method is that founded on triangulation, the base-line of which is determined by astronomic methods.

[Here the professor again used diagrams for explanation, showing that the line should have as nearly as possible a meridian direction, and that the length of the line should rest on determinations of latitude rather than the longitude, and that whatever variation the line might have from the true meridian direction should be determined by azimuth observations, and the length of the line corrected therefor.]

Prof. POWELL. This method was used by Clarence King in the first part of his survey along the 40th parallel, but was abandoned by him for the reason that he did not consider that it gave results of sufficient accuracy for topographic and geological maps.

The third method is that finally adopted by Clarence King, by Doctor Hayden during the past year, and by myself in Northern Arizona and Southern Utah. It is a system of triangulation from measured base-lines. I will explain the method used by myself. It differs in some of its details from that used by Clarence King and Doctor Hayden.

[Here the professor, using diagrams on the blackboard, explained his method of measuring base-lines and from them expanding a system of primary triangles, the whole constituting a system of quadrilaterals within each of which a secondary system of triangles is carried on, thus fixing the position of all the salient topographic features of the country.]

In addition to fixing the horizontal position of the topographic features, it is necessary to determine elevations. There are mountains with intervening valleys, plateaus, and plains, and for the purpose of properly representing the topographic features of the country, it is necessary to collect a vast amount of data concerning the relative elevations of the several parts of the territory surveyed, and also to determine the slopes of mountains and the escarpments of plateaus.

By the first method which I have explained, the meandering method, various parties under the War Department have been working for many years. The methods have been improved from time to time, until exploring parties were sent out under the direction of Lieutenant Wheeler. These plans have been improved as far as possible, and made as nearly perfect as possible. Lieutenant Wheeler has performed a great amount of work in the region of country explored by him. His astronomic work ranks with the best that has ever been done in this country, and, perhaps, with the best that has ever been done in the world. The country has been traversed over more lines, that is the lines are not so far apart as those in previous explorations, so that Lieutenant Wheeler's work may be taken as the best example of that kind done in this country. The work has been pushed forward with great vigor, and has been checked very largely by the methods which I have explained; and I will again state that altogether it is the best work that has been produced in this country by that method. Lieutenant Wheeler has published in one of his sheets a map of the country, a part of which overlaps a district which I have surveyed, and with which I was familiar; and I wish to take up a point or two on his map, not so much for the sake of comparison as to show the committee why his map is so inaccurate as not to be available for geological purposes.

[Professor Powell here explained inaccuracies with regard to Pangwitch Cañon, a narrow gorge cut through great beds of eruptive rocks; also the failure of the map to show the proper topographic features at the head of the Sevier River and on the plateau to the east, and that the map would contradict the necessary statement which would have to be made in discussing the geological structure of that region of country. All this was explained by the use of diagrams on the blackboard. In like manner it was claimed that the map failed to show a line of peaks which separate the headwaters of the Sevier from the headwaters of the Kanab, and that as this line of peaks was well defined, and marked the position of a great fault where the edges of the beds had been thrown down and had been caught and flexed so as to stand at a high angle, the failure to indicate the line of peaks made it impossible to discuss the geological structure of the country by reference to the map. Again he referred to a plateau to the southwest, which was shown on Lieutenant Wheeler's map to extend over a great district of country where important coal-beds have been found, and if the topography indicated on the map was true these coal-beds would be buried more than 2,500 feet under sandstones, limestones, and shales, and it was stated in fact that this plateau did not extend so far to the southwest, and that the coal-beds cropped out on the sides of the hills, and many of them had been located and claimed by the settlers. He also stated that a line of volcanic peaks standing on an extensive bed of basalt had been entirely omitted from Lieutenant Wheeler's map.)

Prof. POWELL. What I have stated might do Lieutenant Wheeler injustice unless I state further that it is probable that he would not claim that this map was intended to represent accurately the topography of the country. He would probably claim that it was made from a meandering survey, and that it was only intended to represent the country adjacent to the line of travel, and to give a general impression of such regions included in the map as were somewhat distant from the route traveled, and that he merely intended to indi-

cate here in a general way that the country was broken and mountainous, and that he did not intend definitely to represent that the country had such contours as the maps, interpreted literally, would show.

The CHAIRMAN. I do not understand that sheet No. 59 was intended to be a geological map.

Mr. POWELL. No, sir; but it will be recollected that General Humphreys spoke of the necessity of having these maps for the discussion of the geology. This map is not colored for geology; but we must have such maps first and color them afterward. Now, if I were to attempt to put the colors on this topographic map, in order to represent geology, you see that my coloring of the map would be at variance with the actual topography.

* The question has been asked about the necessity of military escorts for these expeditions. I have worked in that country since 1867, and I have had no military escort with me. I think that escorts are not only unnecessary, but that they are invariably an obstruction to the rapid progress of the work. I can get along with the Indians by peaceable methods much better than by military methods. If I should go into that country with a body of troops I would thus take a hostile attitude, and would be compelled to fight my way among them, but in all that country I can go alone or with one or two men, or I can send out one or two men and they can travel anywhere without trouble. I have been studying Indian languages, and Indian habits and customs, having been specially instructed by Professor Henry so to do; and it would have been impossible for me to carry on those studies if I had had troops with me. Lieutenant Wheeler's experience with the Indians in that region of country will fully illustrate this matter. When his parties were in Nevada I was in Eastern Utah, two or three hundred miles away. One night, while in camp, I found that signal-fires were flashing from mountain-top to mountain-top across the country, and that the Indians were excited about something—they would not tell me what. Some time after that a party of Indians came to me and explained that when Lieutenant Wheeler's party was passing down into Southern Nevada the soldiers whom he had with him had killed one Indian, and had shot another in the face so as to cause blindness. The news of that was telegraphed, by signal, from mountain to mountain, not only over Nevada, but over Utah, Arizona, and New Mexico. It was known in a short time all over that country. I knew the fact that there was trouble shortly after it occurred, although I was two or three hundred miles away. Of course I did not know the circumstances, but I knew that there was trouble.

The subsequent year, when Lieutenant Wheeler passed through that country, as soon as his party took the field, delegations of Indians came to me from Panamint Mountain, near the California line, from Nevada, and from Utah, asking me whether the Government had sent out an expedition to kill the Indians. Some of them came two or three hundred miles, and for three months or more the Indians throughout the country were on the *qui vive*. They had out their scouts and watchmen on the mountain-tops. So I have no hesitation in saying that a party can work to much greater advantage without troops than with them.

The CHAIRMAN. Can an exploring party work without troops among the Apaches of Arizona?

Mr. POWELL. I should have no hesitation in going there without troops. The surveyor-general of Arizona states that his parties can work without danger. I know that they could not have done so some years ago. I should have no hesitation myself in going among any Indians. Of course I would want a little time to become acquainted with them, and to study their language, and to get on good terms with them. The only two bodies of Indians with whom we could have any trouble are the Sioux Indians to the north and the Indians of the southern plains. The other Indians are thoroughly subdued. They fully appreciate the utter hopelessness of contending against the Government of the United States, and they are everywhere asking for means and opportunity to become agriculturists. I know that to be true in regard to the Indians of Utah, Nevada, Oregon, Idaho, and California, for I have traveled over that region of country and taken the census of a great many tribes, and have prepared grammars and vocabularies of the language, and made studies of their arts, and customs, and religion. During these explorations of mine I have had from two to twenty or even thirty Indians employed, and I have often had from one to three or four hundred Indians encamped about me, and during that time I have no knowledge of their having ever stolen one cent from me.

Mr. HERNDON. Have you had any communication with the Comanches?

Mr. POWELL. No, sir; not to any great extent.

The CHAIRMAN. There are two points upon which you have not touched; that is, as to the advisability of confining these expeditions under one head—the War Department or the Interior Department; and secondly, the practicability of setting apart certain areas for the War Department surveys and for civilian surveys. Please explain your views on those points.

Mr. POWELL. I have no hesitation in saying that I think they should be under one Department; that is, all the surveys which are intended for scientific and economic purposes should have one direction and should be under one Department, else the work may be duplicated. But if the War Department thinks it necessary for military purposes to make

reconnaissances of the country, such as it has been doing, it may possibly be well to have that done; I do not know. The primary object of these surveys is two-fold: first, for scientific purposes; and secondly, for economic purposes. All of the region of country west of the 100th or 99th meridian, except a little in California, Oregon, and Washington Territory, is arid, and no part of that country can be cultivated, with the exceptions I have mentioned; no part of it can be redeemed for agriculture, except by irrigation. When every spring, and stream, and body of water in all that region of country is taken out and used, less than three per cent. of the entire area will be under cultivation, so that, under the best circumstances, I believe that of more than two-fifths of the whole area of the United States, not more than three per cent. can eventually be cultivated. Now, the extent and position of those areas that can be redeemed should be known. Already the land-surveys are being extended over broad districts of country which can never be settled, on which no drop of water can be had. Over the country which I have surveyed I have carefully noted the extent of the streams and the extent of the valleys that can be redeemed; and I have the data necessary for the construction of a map showing these facts. I have noted the extent of the grass-lands and also of the timber-lands. We have a monument placed in the vicinity of every one of these areas that can be used, from which monuments the land-surveys can run their lines and take in these small territories. I think that, over the region of country embraced on this map, the saving to the Government in the land-surveys of that area will more than pay the expense of my survey. Then, in addition to that, I have established the boundary-line between Arizona and Utah. The Secretary of the Interior put in an estimate for \$15,000 to have that boundary-line established; and I have already established it with far greater accuracy than those boundary-lines have been usually established between the Territories.

Surveys made for all these purposes should doubtless be under one Department; and it seems to me that as these surveys relate to the lands and to the mineral resources of the country, they should be under the management of the Interior Department. I think they should be made by civilians rather than by military men. Even in those under military management civilians do the work. I think that the history of all these explorations will show that the major part of the work was done by civilians, and I think that those who do the work and who are responsible to the scientific men of the country should have the charge and control of the work.

Now, as to the question of expense. Will civilian parties organized and controlled by civilians do the work as cheaply as parties organized under military management?

Suppose that I have a small party of five, ten, fifteen, or twenty men. I can send one, two, or three men if necessary to measure the summit of a mountain, to meander the course of a stream, to take a series of angles at a designated point, or to do astronomic work or any other labor which I wish to have performed; but if the party was under military management an expedition would be organized under officers, with an escort, a commissary, and perhaps a quartermaster's department, and an unwieldy body of men would be sent to do that which one, or two, or at most half a dozen men could perform quite as well, and where I would send only two or three men they might have ten, twenty, thirty, fifty, or even a hundred men to do the same work, and by reason of having so large a party more time would be consumed in performing the work.

The CHAIRMAN. The second point, as to the feasibility of dividing up this great area so that military and civilian parties can work together harmoniously and without conflict?

Professor POWELL. If different parties are to work in the field making surveys of the Territories, it should be so arranged, either by departmental orders or by act of Congress, that the parties should not enter the same field and thus duplicate the work. It is doubtless an unnecessary expense to have two parties pass over the same region of country. The military assume that they are going to do all this work anyhow, and say that what we do has no bearing on what they do. They say that they are going on to finish up this system of explorations; and that the work is to be continued indefinitely. If they cannot use our work for any of their purposes, I suppose they ought to have the field for themselves; but it seems to me that they should not take Territories which are occupied by other surveying-parties, unless there is some military necessity for it, of which I am not the judge.

Mr. CLYMER. This reconnaissance of Lieutenant Wheeler's was what you call on the meandering principle?

Mr. POWELL. So far as I am acquainted with his methods, they are, so far as his published reports show, and I know from personal observation that he simply used the meandering methods over that region of country which had been previously occupied by myself.

Mr. CLYMER. Are the results obtained under that process, however careful and accurate, of any value for scientific purposes—I mean for geological purposes?

Mr. POWELL. I think not. I could not use them. They are practically useless to me as a geologist.

Mr. CLYMER. By this method they obtain a general map of the country, which is valuable for military purposes, for roads, &c.?

Mr. POWELL. They are valuable for that purpose.

Mr. CLYMER. But for scientific purposes, geological purposes, you say you do not consider his results of value?

Mr. POWELL. They would not be to me in the discussion of the geology of the country.

Mr. CLYMER. How long have you been a student of geology?

Mr. POWELL. About 19 years. I should say, however, that I was in the Army nearly four years of that time, and my geological studies were very much interrupted.

Mr. CLYMER. Do you think it of value to the exact sciences that these military reconnaissances should be accompanied by persons to make scientific observations?

Mr. POWELL. That is a very delicate question. The gentlemen who accompany these expeditions are often men of ability.

Mr. CLYMER. I wish to see whether the results gathered by them, based upon a survey which you say is inaccurate, can be of any great value.

Mr. POWELL. They are not of great value to the exact sciences. They are of some value but not of that value they would have if the maps were accurate.

Mr. HERNDON. The idea which you intend to convey is this—that your system of exploration is more comprehensive and thorough than that adopted by the War Department. If that is true, does not your survey comprehend and explain all that the War Department is doing?

Mr. POWELL. I think it does, and much more thoroughly.

Mr. HERNDON. Cannot the War Department, by an examination of your maps and explanations, draw out all the information it needs without making an actual survey itself?

Mr. POWELL. I think it could, and with much more accuracy.

Mr. ST. JOHN. Could it do so, so far as determining and discovering routes of travel?

Mr. POWELL. We not only determine the general features of the country, but we determine the routes of travel with greater accuracy.

Mr. ST. JOHN. Would not your operations be confined to less spaces of country?

Mr. POWELL. My work will be confined to a very small area if I am sent out with \$10,000 or \$12,000 a year. I think that the same money used by the War Department in making these meandering surveys, which are no longer practically useful, would make a survey of the country based on triangulation.

Mr. HERNDON. What is the difference in the expenditure per annum of the party under Lieutenant Wheeler and your party?

Mr. POWELL. The work being different it is difficult to make the comparison. My expenses for four years have been \$12,000, \$12,000, \$20,000, and \$10,000. But I meandered the same country which Lieutenant Wheeler did, where we overlapped two years before him. I made that meandering reconnaissance as a basis for my work. Now, there are 26,000 square miles of country where we overlapped. He estimates his expense at a dollar per square mile for the civilian reconnaissance, independent of the military expense. I meandered that country at an expense of \$4,500.

Mr. CLYMER. That is about eighteen cents a mile?

Mr. POWELL. Yes; and the civilian division of his party cost, by his own estimate, \$26,000.

Adjourned to the 20th instant, at half past nine a. m.

WASHINGTON, D. C., May 20, 1874.

No. 8—*Mr. J. W. Powell recalled.*

The CHAIRMAN. Your explorations were under the auspices of the Smithsonian Institution?

Mr. POWELL. Yes.

The CHAIRMAN. How did it occur that they were under the Smithsonian Institution and not under the Interior Department?

Mr. POWELL. I don't know that I have a right to explain committee matters. A question was raised in the committee-room on appropriations concerning the collections. A member of the committee asked me what was done with those collections. I told him that they went to the Smithsonian Institution, and I said that if there was any question about it it might be inserted in the law. He said that he would have that attended to, and he made a memorandum of it. It seems that afterward seeing this memorandum that the collections were to go to the Smithsonian Institution, he accidentally sent my whole work there.

The CHAIRMAN. Then all your collections are in the Smithsonian Institution?

Mr. POWELL. Yes.

The CHAIRMAN. You have been four or five years engaged in this work?

Mr. POWELL. Four years for the Government?

The CHAIRMAN. All that time under the Smithsonian Institution?

Mr. POWELL. No, sir; three years under the Smithsonian Institution. The first year it was under the Secretary of the Interior.

The CHAIRMAN. To whom do you report?

Mr. POWELL. To Professor Henry. My collections are all at the Smithsonian Institution.

The CHAIRMAN. Have you published any reports yet ?

Mr. POWELL. I have published annually a report of progress simply.

The CHAIRMAN. Your extended reports are not yet published ?

Mr. POWELL. No, sir.

The CHAIRMAN. How many volumes have you prepared ?

Mr. POWELL. The first draught of three quarto volumes.

The CHAIRMAN. They are not quite ready for publication ?

Mr. POWELL. No, sir; not quite ready. I have had no appropriation to pay for the engraving of my maps. I can have my text ready if the maps are ready.

The CHAIRMAN. What is your view with reference to your own future operations ? Do you propose that they shall go on under the Smithsonian Institution, or under the Interior Department ?

Mr. POWELL. I think it would be well to have my work go under the Interior Department, perhaps, for the sake of preventing any conflict. But I wish to say that Professor Henry has very carefully controlled my work ; has examined my plans, and has treated me with very great courtesy. Personally I know of no person under whom I would rather serve than Professor Henry, but yet it might be well, in order to prevent any conflict between other civilian parties and myself, to have all placed under the Interior Department.

The CHAIRMAN. And you would be satisfied to have your surveys under the Interior Department ?

Mr. POWELL. Yes, sir.

Mr. HERNDON. The question was asked you whether, inasmuch as your explorations were more comprehensive than those carried on by the War Department, yours would not necessarily answer for the military purpose. I wish to ask you, in extension of that question, whether your party cannot prepare a map for the military, comprehending precisely what the War Department wants, giving a topographical sketch of the country, the situation of the mountains, rivers, roads, &c., and furnish it to the War Department more economically and more exactly, under your method of exploring than it could be done by the War Department itself, or rather than has been done by the War Department.

Mr. POWELL. I have no doubt that we can. I think that we not only map the general features of the country with greater accuracy, but we also determine the roads themselves and indicate with greater accuracy the character of the streams.

Mr. HERNDON. What additional cost would be necessary in order to sketch a map for the military of the country explored by you, and only presenting those features which it is necessary for the military to have ?

Mr. POWELL. I think that our topographical maps, not the geological maps, would serve their purpose exactly, without any addition.

Mr. HERNDON. Then the expense would not be increased ?

Mr. POWELL. Not increased at all, except perhaps for the increased edition, the increased number of maps printed.

Mr. HERNDON. The entire cost incurred by the military in ascertaining these facts might be saved by your work, if the War Department would adopt it ?

Mr. POWELL. Yes, I think so. I have served as military engineer during the war, part of the time, and have some knowledge of what an engineer officer needs in the field. I believe that the work we do would be more valuable to the War Department than that which they do for themselves. I will say to the chairman, in further reply to his question concerning my reports, that my computations for latitude, longitude, and altitude, and the computation of my triangles are under way, but the work is not complete, and hence my maps are not drawn. I stated in my report that there was a preliminary map which I had before the committee the other day. But I wish to be understood that that is not a final map, but simply a preliminary map, traced from field-sketches, made as a working-plan for the office solely. My geological sections are partly constructed, but not all of them. The data is collected and tabulated for them, but the sections themselves are not yet drawn. I have had no appropriation for that purpose yet. My collections of natural history, fossils, &c., are at the Smithsonian Institution. A part of them are in the hands of specialists, but no appropriation has yet been made, and consequently no arrangement has been made for the special studies necessary for those collections. That should be stated, so that I may not be represented as claiming that I have done my work for a less appropriation than I really have.

The CHAIRMAN. What appropriation will be necessary in order to finish up your work, to bring up all the results thus far, and to put them into shape ?

Mr. POWELL. It will take about \$12,000 to complete my maps altogether. The geological sections, the ethnological report, the natural history report, and the report of physical geography, and the maps, will cost altogether for engraving, writing, preparation of sections, special studies of natural history, &c., about \$25,000 additional.

Mr. ORR. How long would it take you to get out the publications if you had the money ?

Mr. POWELL. About one year. The greatest drawback to the whole matter would be the actual time necessary for me to use. The writing of two of these volumes is in my own hands. I dictate to a stenographer, but there is a limit to the amount of work which a man can do. That is one question of delay, and another delay would be the engraving of the maps. Only one man can work on one plate.

The CHAIRMAN. Your maps are geological maps?

Mr. POWELL. My maps are topographic maps primarily. The topographic maps are used as geological maps, but there are more things added to them. The basis of the geological map is the topographic map.

Statements concerning methods of surveying for geological maps, by Jas. T. Gardner, geographer of United States Geological and Geographical Survey of the Territories.

I am superintending, under Professor Hayden, the geographical work of the survey of which he has charge. Five special branches of work are carried on in this department of the survey: astronomical, geodetic, topographical, hypsometric, and meteorological. In each of these the work is thoroughly organized and progressing. The principal part of the astronomy is done for us by the United States Coast-Survey; but the sextant and azimuth observations are made by myself. The geodetic work, also, I carry on with one computing assistant. The topographical work and part of the hypsometry is done by three topographers, three assistant topographers, and a draughtsman. The remainder of the hypsometric work and the meteorological is done by young assistants, mostly volunteers. I have for eleven years been engaged in topographical, geographical, and geological work in California, Arizona, Nevada, Utah, Wyoming, and Colorado. As a topographer on the State Geological Survey of California under Prof. J. D. Whitney, I made, in connection with Mr. Clarence King, assistant geologist, a series of experiments on the methods of surveying mountain regions, to produce maps suited to geological purposes. These experiments were continued from 1863 to 1867. We tried the meandering method—the method of a compass-triangulation resting on a meandered base; of an unsystematic triangulation, with a theodolite, the whole resting on an astronomical base; then the rectangular method of sectionizing as used by the General Land-Office; and, lastly, a regularly-developed system of well-conditioned and carefully-observed triangles resting on an astronomical base. This last was the best of all the methods tried, and the meandering was the poorest.

We found that the topography taken by the meandering method was utterly unreliable, except the minor details along the routes traveled.

Experience has clearly demonstrated that the topography must be taken from the peaks looking down on the country, not from the valleys looking up. It was while engaged in this work, under Prof. J. D. Whitney, that we conceived the plan and arranged the methods for the geological explorations of the fortieth parallel. When these plans were thoroughly matured, we came east. Mr. King, fortified with recommendations from many of the leading scientific men of the country, came to Washington, and, with the help of numerous friends, succeeded in getting from Congress a special appropriation for his work. In Congress, Senator John Conness, of California, took a very warm interest in the matter, both from the intrinsic merit of the cause and from personal attachment to Mr. King. It was at one time an open question as to what Department it was best to have this appropriation placed under for disbursement, and the War Department made certain concessions to Mr. King in order to secure it. Prominent among these was the promise that he should not have any officer placed over him, but should report directly to General Humphreys. Under no other consideration would this appropriation have gone to the War Department. When the survey was organized in 1867, I was placed by Clarence King in charge of the geographical work, to carry out the plans and methods we had previously determined upon. For consultation and advice upon these I was in the habit of going to Professor Hilgard, of the United States Coast-Survey, because our methods were much more nearly allied to those of the Coast-Survey than to those by which United States Engineer officers had always carried on their work in the West; these latter having always based theirs on the meandering method. In the primary triangulation of our belt the triangles were well proportioned, and arranged in quadrilaterals, having the proper relations to one another, all the angles of the triangles being observed with an instrument reading to five seconds. The first part of this system originally rested on an astronomically measured base, but it was found that the errors due to deflection of the plumb-line by the mountain masses rendered all astronomical work in those mountain regions liable to such large errors that we were obliged to come to the same system used by the United States Coast-Survey, of a carefully-planned net-work of triangles expanded from measured bases. Geographical field-work on the fortieth-parallel survey was finished in 1872. The maps were drawn and placed in the hands of the engraver a year ago, and two of the three members of the topographical staff are now with Professor Hayden. The geologists are engaged in writing the geological report and coloring the maps. The methods of surveying, scale and style of maps will be the same on Clarence King's survey and in the United States Geological survey of the Territories. The point that I wish to make in connection with the fortieth-parallel survey is, that, both in its plan, methods, and execution, it was the product of civilian brain and energy, and that its methods and results were entirely different from Lieutenant Wheeler's, which are published. I wish to say further that, although many military expeditions had carried their reconnaissances over the area which we traversed, we never found a piece of their work that was accurate enough to be incorporated into our maps. Where Mr. Wheeler has resurveyed and mapped several thousand square miles of our district, the topography is too inaccurate to be of use for geo-

logical purposes. The only surveys that we were able to use in connection with our own were the surveys of the General Land-Office over level country. Five of the military surveys mentioned in General Humphreys's list had preceded us at Salt Lake, and yet in 1869 it was found that, on their final resulting map, Salt Lake City was $10\frac{1}{2}$ miles too far west.

There are two very important reasons why the route-survey meandering method upon which the United States engineers based their maps, that I have seen, are not adapted to the purposes of a civil and scientific survey. The first is, that the survey being made by assistants marching along the valley roads, we get no measurements of the heights of the mountains, or very few. For instance, on Lieutenant Wheeler's sheet No. 50, covering 16,800 square miles, there are shown fourteen mountain ranges. In only five of these are the heights of any peaks given. On the whole map the elevations of only seven peaks are given. There are twenty-five wagon-road passes represented in these mountains, and the heights of only two are given. Only forty elevations are given in the whole sheet. In an area of similar size in Colorado we found it necessary for our work to locate and measure about 7,000 points.

This paucity of elevations is a necessary result of the route-survey method. Another and even more serious difficulty of this method is, that they march around large bodies of land, that are never entered, and these are included in the maps and represented as surveyed.

I find that, by taking Lieutenant Wheeler's published maps of the routes traversed by him, that in this area, shaded on sheet No. , as surveyed by him, are great regions, as large as Connecticut and Rhode Island together, that he simply marched around and looked into, but did not enter. One of these areas is about 6,000 square miles; another about 4,000 square miles; another about 3,000; another about 1,600, and several of 1,000 square miles. I need not say that such a method of surveying is not adapted to connected geological work, nor can its cost be compared with one where the ground is actually traversed by the surveyors. A large amount of the topography must necessarily be left to the imagination of the draughtsman.

This is clearly seen by comparing the southern edge of Lieutenant Wheeler's sheet 50 with the northern side of sheet 59, where the same part of the 39th parallel appears on the full length of both maps. The topography along this parallel should of course be the same on both maps, but the positions of some of the stream crossings, and mountain crests, exactly on the 39th parallel, differ on the two maps from one to two miles in longitude.

Many of the topographical features along the parallel are also so differently represented on the two maps that both cannot be right. Either one or both must be wrong.

When hostile Indians had possession of the country these surveys by military methods for military purposes were doubtless necessary, but they are no longer needed.

Of those western mountain regions there are now over 600,000 square miles where civilians can and do work without military escort.

The maps now most required are for civil and scientific purposes. A knowledge of the physical conditions and resources of the country, and of the physical laws which govern them, is now the power which man needs most for its subjugation. To gain this knowledge, and distribute it among the people of both hemispheres, is the object that Professor Hayden has in this survey.

He directed me to use in my department the most approved methods that our means would allow, saying that he wished the work done so that it would "not have to be done over again for a hundred years."

We do not agree with Lieutenant Wheeler that the country will have to be mapped every twenty years, owing to its rapid development. If the survey is based upon a properly-planned triangulation, expanded from measured bases and check bases, and if rough stone cairns or monuments are built on the prominent natural points, which serve as trigonometric stations, this mathematical basis of the maps need never be changed, and the points of reference will always exist by which any new settlements, roads, or improvements can always be located.

The mountain forms and streams, the natural features of the earth, are permanent, and if these are properly surveyed and represented they need not be changed. More detail may be added in parts where it is required, but this will only be in isolated spots. The plan of our geographical work in Colorado is as follows:

A base of about six miles in length was twice measured, with a steel tape under twenty pounds strain, and the temperature taken every five minutes. The base was leveled and duly corrected for temperature and level. The larger part of the base was measured on a straight railroad track. From this base, near Denver, a system of primary triangles was carefully expanded by observing upon signals erected for the purpose. All the angles of the triangles are repeatedly observed, and the quality of the work is determined by the test whether the three observed angles of the triangles when corrected for spherical excess sum up to 180° .

That by which they vary from 180° is error.

The mean error of our primary triangles in Colorado is $10.3''$. The angles are observed with an eight-inch circle graduated to $10''$ and reading easily to $5''$. The triangles are from thirty to seventy miles on a side, according to the nature of the ground. This net-work of large triangles was extended over 17,000 square miles.

By it 48 stations were located. These are the most prominent peaks of the country. The error of measurement of the distances between these peaks does not exceed two feet per mile. You will recollect that the allowed error in the chained lines of the land survey is 60 feet per mile. Some of the principal trigonometric stations were carefully located in latitude and longitude by the best observers of the United States Coast-Survey at our request. Azimuth observations are also taken at many of the principal points.

Inside of this primary triangulation, and checked by it, is a net-work of smaller triangles, whose angles are observed by the topographers with small theodolites. This secondary triangulation is constantly connected with the rectilinear surveys, and is only carried over such mountain areas as are not adapted to the land-survey methods.

Where the plains have been sectionized we use these chained lines instead of our secondary triangulation, checking by the primary triangulation the error of chaining long distances. The position of both our primary and secondary stations is better known than if each was determined by the most accurate astronomical methods. This I am prepared to prove, and shall demonstrate in the final official report.

These visited trigonometric stations are on the elevated points that best overlook the country. They average about eight miles apart through the mountain districts. From these many hundreds of other points are located horizontally and in altitude, and the topography is very carefully sketched, both with respect to its drainage, horizontal contour, and profile. Where it is necessary, the roads and trails are measured. By means of our secondary triangulations we have located all the mineral monuments of the region surveyed in Colorado, and have thus connected them with the rectilinear system of the valleys which can never be successfully carried over the mountains. I would call the attention of the committee to this fact, that the valuable mineral and agricultural lands of the mountains are in small and widely-separated spots, and though each spot may be often well surveyed by the rectilinear system, yet to connect these by chaining lines over the ridges, peaks, and cañons will be often impossible, and always very expensive and inaccurate, whereas by connecting each local survey with our trigonometric monuments, the whole may be bound together into one complete survey.

The cost of the trigonometric survey is about one-tenth of that of sectionizing the country. From these surveys topographical maps are made on a scale of two miles to one inch, showing the form of the country in horizontal contour lines two hundred feet apart in elevation. These contour lines are located instrumentally as often as possible and sketched by the eye between located points.

The advantages of these maps are, that the approximate elevation of every point on the map is easily read; that the steepness of the various mountain slopes and their forms can be given as accurately as they can be determined; and that the geological coloring when placed on the map is not obscured by black shading. From these maps, also, cross-sections of the country or profiles can be made in any direction for geological sections or other purposes. Upon them can be readily laid colors showing the distribution of agricultural, grazing, timber, mining, and perpetual snow regions; the distribution of plants, animals, &c.

They serve as the best possible basis for representing all the physical facts of the country.

I would wish to record as the result of my eleven years' experience on far western geological surveys that the only maps of the mountainous parts of that country which are suited to the purposes of geology and physical geography are those which have been made under the direction and according to the plans of civilian geologists.

This is also the testimony of all the geologists with whom I am acquainted. It is the experience of all the civilian organizations that it is neither necessary nor desirable to have any one accompany field-parties simply or mainly to direct the work of others. The geologist or topographer finds no difficulty in doing his large share of personal scientific labor besides guiding the general movements of the party. The energizing effect of a leader who is doing a large part of the practical scientific work is found most beneficial upon the others engaged. All are stimulated by his example. I agree with Professor Powell that a military escort is a very great incumbrance to the movements of surveying parties, besides being often a source of serious trouble. This was the result of our experience in the fortieth parallel survey.

JAS. T. GARDNER.

WASHINGTON, D. C., May 20, 1874.

Nos. 9 and 10.—*Statement of Mr. James T. Gardiner, first assistant and geographer in Mr. Hayden's expedition.*

Mr. GARDINER read the following statement:

The CHAIRMAN. Are the maps made in Clarence King's and Mr. Hayden's surveys sufficient, in your judgment, for the purposes of the War Department?

Mr. GARDINER. I should think that, with reference to the Fortieth-Parallel Survey, along some of the roads there were not sufficiently minute details for the use of the War Department. So far as Mr. Hayden's survey is concerned the details along the roads are taken,

or to be taken, (we have not completed all the road-work yet,) so that these maps will be sufficient for all the general purposes, civil and military, that I know of. I realize that, in military operations, it is often very necessary to know extremely minute details—the exact position of every spring and piece of pasture-land, &c.; but I think that, so far as that is concerned, General Sherman's plan is an admirable one, and that is, so far as I have understood it from the representation of many of his friends—that if it is necessary to march troops over a country, an engineer officer shall accompany each body of men in the march, and take these special notes along the road, which can easily be added to the general map.

The CHAIRMAN. In other words, all these details that are necessary may be put on a general map with little additional expense?

Mr. GARDINER. At a very small additional expense.

Mr. HERNDON. Have you been able to determine from the altitudes of this section of country which you have surveyed, the average depth of snow, the character of the plants, the amount of water, and the quantity of timber, according to the altitude?

Mr. GARDINER. We are gradually getting at that. The average fall of snow is a thing that has to be determined by observations extending over a number of years. We find it to vary immensely, but still we have already got an approximation to the average. We have got a good deal of data on that subject. It is very important to know the minimum amount of snow, so as to know what can be relied upon from the streams for irrigating purposes. Their value depends upon their minimum flow; and therefore we determine very carefully the regions from which perpetual streams will generally flow, and what is their probable minimum supply.

Mr. HERNDON. The object of my question is to see whether, in taking the altitudes of the vast section of country which you have surveyed, you have reached sufficient accuracy to ascertain the average depth of snow, the average volume of water that would flow from it, and the character of the plants, timber, &c.

Mr. GARDINER. We made a very large number of observations on that subject, but they differ very much within short ranges. As to the height at which land is arable, it differs. In a distance of sixty miles I have known it to differ from 500 to 600 feet; and, in one case, 1,000 feet. These differences depend upon local causes; and therefore it is more difficult to get at a general statement than you think. We have got together an immense amount of data on the question, but we cannot yet give a definite law in regard to it.

Mr. HERNDON. Do these close surveys, 200 feet apart, assist you in ascertaining these data?

Mr. GARDINER. Yes, sir; we could not accomplish our purpose without them.

Mr. HERNDON. These altitudes that are taken furnish the basis of work for you?

Mr. GARDINER. Yes; they furnish the basis of the work.

Mr. HERNDON. Is that true also in relation to the mineral lands—coal, gold, silver, iron, lead, &c.?

Mr. GARDINER. Yes, sir; that is also true in regard to them. There are some very peculiar facts which have come out with reference to the altitudes of the mineral deposits in Colorado.

Mr. CLYMER. Could those facts be shown with any degree of accuracy and value on maps made on a different principle from your own?

Mr. GARDINER. No, sir; only a rough approximation.

Mr. HERNDON. Do you think it is possible, from the data you have collected and from the close surveys of 200-foot altitudes, to approximate the altitude where mineral deposits cease to exist; that is, to reach an altitude beyond which no minerals are found?

Mr. GARDINER. No, sir; the result is the opposite way in Colorado. There the most valuable mines are found at the greatest altitude. It is a curious thing, and is probably due to the fact of the metamorphic changes of these rocks in high altitudes, where the dynamic action is great. The same rocks which lower down do not seem to have valuable mineral lode deposits, seem, in the higher altitudes, to contain scattered masses of ore.

Mr. Gardiner here submitted an abstract of the work done by the War Department in the survey of the Pacific Railroads, showing what portions of it were done by civilians. He also read the following extracts from a letter from Prof. W. H. Brewer to Hon. J. R. Hawley:

Extract from the letter of Prof. W. H. Brewer, of Yale College, (formerly first assistant on geological survey of California,) to Hon. J. R. Hawley, May 13, 1874.

“The reason why Army officers were formerly placed at the head of all explorations in earlier years have ceased to exist. Up to fifteen years ago West Point was almost the only school in the land that gave more than rather elementary instruction in engineering studies. But various engineering and scientific schools have since that time been greatly extended, (many of them indeed founded or fostered by the United States Government itself,) in which very nearly all of our best younger topographers have been trained, and West Point has educated none of our younger naturalists nor geologists now employed by Government on its surveys. Among the topographers I may mention Clarence King, Gardiner, Garnett, &c. I hear that it is claimed that the topographical processes used now by the Army engineers are ‘those of the 40th parallel survey.’ This is denied by those who are competent to

judge, but even if it be true it only illustrates stronger my point, as those methods were devised and introduced by civilians. I remember well that at the only meeting of the 'National Academy of Sciences' that I have attended, (at Northampton, Mass., in 1869,) when strictures were made on certain Army topographical work, several of the respected Army officers, who were (I think) members of the society, and were present, protested that such strictures and criticisms were unfair, *because the Army officers were not trained for that kind of work*; that they were military engineers, and not trained for geodetic surveys. And they were right.

"The results gained by the surveys made outside of the Army control have been *speedily and readily accessible* to persons outside of Washington. This has not been the common experience of persons living away from Washington in respect to the results of the most of the surveys made by the Army. Very much of this material is considered 'for use of the Department,' and is difficult of access to many who may wish to use it.

"It seems to me eminently impolitic to exclude from the scientific surveys of the country all the scientific men, except such as are allowed and will work under Army officers, who have not necessarily been trained in those departments, and often are notoriously lacking in sympathy for scientific pursuits. West Point does not claim to educate topographers, nor geologists, nor naturalists, nor even to train men to take charge of geodetic work. But Harvard, Yale, and other schools of science *do* claim to train men for just such work, requiring long courses of study in the necessary departments. And it has been under the impetus given by just these men that the work has been so well inaugurated and carried to its present shape. It is in fact these very men who have now forced the Army to do work as well. (I think they never claim to do it better.)"

COMMITTEE ON PUBLIC LANDS,
Washington, D. C., May 20, 1874.

No. 11.—*Statement of Hon. Columbus Delano, Secretary of the Interior.*

Hon. Columbus Delano, Secretary of the Interior, came before the committee in response to its invitation.

The CHAIRMAN. You have read the resolution under which this committee is acting. Be good enough to state your opinion whether or not the geological surveys should be under one Department of the General Government, and, if so, under which Department. Also, how far these geological surveys of Professor Hayden are available to the Land Bureau of your Department.

Mr. DELANO. The surveys made under the system which authorized Mr. Hayden to proceed, I consider valuable to the land system of the country and to the General Land-Office. The public lands may be classified first and generally as agricultural and mineral. The manner of their disposal is entirely different; that is to say, the agricultural lands are disposed of under one system of laws, and the mineral lands under another. And it is important for the Land-Office to know which are agricultural and which are mineral lands. The surveys and work of Mr. Hayden are valuable to the Land-Office in furnishing information in regard to the character of the public domain, of agricultural and mineral lands undisposed of. It is sometimes very difficult to determine what lands are agricultural and what lands are mineral, and the Land-Office is occasionally embarrassed by very difficult questions growing out of that subject. The public lands may also be classified as prairie-lands and timber-lands, and again as dry and swamp, and all the information touching their quality in either of those respects is important to the public interests. It is also important to the Land-Office to know (because thus the public may be informed) in regard to the general topography of the country embraced in the undisposed-of public domain. And to some extent I regard the exploration of Mr. Hayden as important and valuable to the Land-Office in all these particulars. I do not wish to say that all this information may not be obtained by such surveys and explorations when conducted by the War Department, with just as much accuracy and precision as they can be obtained by the surveys under the exploration of Mr. Hayden. I speak only of the results, and only of the value of those results to the Land-Office. I should therefore be sorry to see anything done which would prevent the continuation of the system of surveys and explorations such as is being carried on and has been carried on by Mr. Hayden.

The CHAIRMAN. State whether or not it is important to the Land-Office to have the control of surveys such as Professor Hayden's in the administration of the public-land policy.

Mr. DELANO. It seems to me the legitimate business of the Land Department to have the direction and control of surveys of the character to which I have alluded as connected with and belonging to the land system of the United States.

Mr. DUNNELL. If the results are reached to which you refer, and which have been reached by the explorations of Professor Hayden, they are none the less valuable because they may not have been controlled by the Land Department?

Mr. DELANO. Certainly not.

Mr. DUNNELL. They would be just as valuable if they were secured in any other way?

Mr. DELANO. Certainly.

Mr. DUNNELL. You mean to say that the control of them is not so much the matter of importance as the results obtained from them.

Mr. DELANO. That is what I mean to say.

The CHAIRMAN. State whether or not it is desirable to have the control of them so far as to enable you to point out what portion of the country you desire to have explored, previous to the survey, but with a view to the survey.

Mr. DELANO. I certainly should think that desirable; that the Land-Office should be able to dictate, or at least to advise and direct to a greater or less extent, where, and how, and when these surveys should be made, because the Land-Office would necessarily know better how the public interest would require such surveys to be made.

Mr. HERNDON. Would it not follow that if this work is done under the War Department, or any other Department, the Land-Office might duplicate a portion of the same work from time to time, not having the benefit of published reports of the Department which had the control of those surveys?

Mr. DELANO. There would be danger that such an occurrence would happen; still I think that two Departments acting and co-operating in harmony and good feeling would be able to avoid any serious difficulties of that sort.

The CHAIRMAN. Would there be any difficulty between the War Department and the Interior Department as to setting apart areas of territory for a War Department survey, and for an Interior survey?

Mr. DELANO. It does not occur to me that there would be any difficulty of the sort.

The CHAIRMAN. Your idea is that the surveys could be carried on independently and harmoniously together?

Mr. DELANO. It seems to me that they could be. There is among the gentlemen who conduct and operate these surveys an *esprit de corps* which perhaps might bring them into friendly controversy, but I do not think it would lead to any serious difficulties between the Departments.

Mr. CLYMER. Maps are made upon two systems; the War Department maps being made on what is known as the meandering system, and those made by Professor Hayden's party being based on the line system, or triangulating system. Would the results obtained from the meandering system (which from all the information before the committee are certainly not very accurate) be of any specific value to your Department in determining the character of lands, whether mineral or agricultural lands, timber or plain?

Mr. DELANO. I do not think that I have sufficient technical and scientific knowledge to answer that question intelligently.

Mr. CLYMER. Then I will put this question: Would a map on which the location of Salt Lake City is 10 $\frac{1}{2}$ miles farther west than it actually is, be of any value to you in the Land-Office?

Mr. DELANO. That particular question I should answer negatively. I wish to say that I hope I have said nothing detrimental to the value of the work of the War Department.

The CHAIRMAN. No; we all appreciate its value.

Mr. DELANO. So far as I know it is very scientific and very valuable.

No. 12.

WASHINGTON, D. C., May 21, 1874.

Mr. Powell read to the committee the following letter:

CAMBRIDGE, MASS., May 18, 1874.

MY DEAR SIR: Some ten years ago I made, with the assistance of Messrs. Hoffmann, and D'Heureuse, a thorough examination of all the published work of the U. S. Engineer Corps, in the way of topographical surveys of the country west of the 104th meridian. My object was to construct a map of the Cordilleras, and for this purpose I worked over all the accessible material and carefully compared all the various published maps. I found the work of the Engineer Corps entirely valueless when anything like detail was required, because the topography had always been worked up on erroneous principles. I caused copies of all the engineer-work in Nevada to be made on a uniform scale, and then endeavored to make them harmonize with each other. It could not be done. Nothing whatever could be obtained in the State of Nevada which could be used even for a general map of the region on so small a scale as twelve or even twenty-four miles to the inch; the different mountain-ranges could not be recognized or identified, because there was no detail given of any of them, while the uncertainties of the longitude were greater than the width of the valleys between the ranges. I never could use a single line of the engineer-work in California for our geological purposes, while the land surveys in the valleys were an impor

tant and indeed an absolutely essential, assistance to us. In my opinion, all of the engineering in the Cordilleras is worthless as a finality, and only valuable as a preliminary reconnaissance to answer until something better can be had. The recently published maps made under the direction of Lieutenant Wheeler seem to me very bad, and entirely behind the present requirements of geographical science in this country. You are at liberty to use this letter in any way you may see fit.

Very truly yours,

J. D. WHITNEY,

Professor of Geology, Harvard University.

J. T. GARDNER, Esq.

Mr. Powell asked that the abstract of the work done in the study of the geography of the West, which had been presented yesterday by Mr. Gardner, showing the part that had been done by officers, and the part that had been done by civilians, be made a part of the record.

The chairman stated that the request would be submitted to the committee.

Lieutenant Wheeler said:

Mr. CHAIRMAN AND GENTLEMEN: When I was called before the committee, the other day, I supposed that this investigation would go no further than to call for certain statements as to facts, and as my position is so very humble under the War Department, being no more than a first lieutenant in the Corps of Engineers, I did not think it fitting for me to offer my opinion upon matters, and therefore I felt unwilling to put my opinion in evidence. But as things have proceeded in connection with this investigation, I have gained a little confidence, and now I desire to make some statements in refutation of others that have been made, and perhaps I shall venture some opinions in connection with them. I shall now read to the committee the statement which I have prepared.

Lieutenant Wheeler read as follows:

Mr. CHAIRMAN AND GENTLEMEN OF THE COMMITTEE:

I desire to say, in refutation of statements made before this committee by Doctor Hayden, that on the 9th instant I was summoned quite unexpectedly to give testimony in person, for the first time during my experience, before a committee of Congress. The character of the evidence adduced will, perhaps, be better understood years hence, when the issues involved shall have become less personal in their governmental relations. The questions that have been agitated, whether political or professional, whether touching details or opinions, are not those of to-day or to-morrow, as the equilibrium of principles underlying them may take years to reach. They have grown out of a resolution of the House of Representatives calling upon the President for information upon the subject of geographical and geological surveys west of the Mississippi River. Whether that message needed further examination before bringing it to the attention of the Committee on Appropriations, which has decided heretofore the propriety of continuing exploring expeditions, has been decided by the action of the House in referring the subject to this committee, which has summoned the heads of certain of these expeditions and others before it to give information.

Having been assigned to the charge of one of the latest and largest of the War Department expeditions I do not shrink from the most searching investigation into the policy, plan, and execution of these surveys, but I do shrink from a contact of the character that this examination has provoked with Doctor Hayden and Professor Powell. I am fully conscious, however, of the desire on the part of the committee to elicit intelligent information, and I have endeavored to answer with candor and directness.

From the wording of the resolution it would appear that the desire for information was all that could have prompted it. Unless there were sins to be covered, no objection could be made to it; and I will further state that the report of the Secretary of War, coupled with the views of the President, seem to solve the question so far as the War Department is concerned. One among a number of persons assigned by the War Department to carry out its duties in this sphere, I was apparently called before this body to answer for all its doings and all its policies. That position I have before attempted to explain. By a hasty examination of the reports accompanying the message of the President, it will be noted that Doctor Hayden and Professor Powell are placed in an apparent equal position with General Humphreys, the Chief of Engineers, in charge of one of the most important bureaus under this Government, which, unlike that proposed to be established by Doctor Hayden, critically supervises the disbursements, establishing between the Treasury Department and the disbursing officer an intervening scrutiny.

The statement Doctor Hayden has made, that the civilian side of the question has not been the author of the controversy, is certainly extraordinary. For the first time it would appear that there is a civilian side. What that means is more than is known to me. It might equally well be stated that I belong to the civilian side of the question, as upon the survey under my charge alone there are more civilian assistants than upon the one under Doctor Hayden; these assistants are in harmony with all persons on the work upon which they are engaged, and I protest against the antagonism implied as existing between the civilian and the Army officer.

The statements made by Professor Hayden pitting the civilian against the Army officer are invidious and unwarranted. As bearing upon the subject of a controversy, I will submit the following evidence.

CITY OF WASHINGTON,
District of Columbia.

Personally appeared before me, the undersigned, a notary public for the district aforesaid, H. C. Yarrow, M. D., and acting assistant surgeon United States Army, who, being duly sworn according to law, deposes and says that, while visiting Prof. F. V. Hayden in his office on one occasion during the winter of 1872 and 1873, a conversation was held in regard to surveys and explorations. Prof. Hayden spoke very slightly and abusively of Lieutenant Wheeler, and, in an emphatic manner, desired the deponent to inform him, Lieutenant Wheeler, as follows, as near as can be remembered: "You can tell Wheeler that if he stirs a finger, or attempts to interfere with me or my survey in any way, I will utterly crush him—as I have enough congressional influence to do so, and will bring it all to bear." Much more was said in this connection which has escaped deponent's memory. There was present when this conversation took place, Dr. Josiah Curtis, late assistant to Prof. F. V. Hayden.

H. C. YARROW.

Sworn and subscribed to before me this 20th day of May, 1874.

[SEAL.]

TERENCE DRURY,
Notary Public.

CITY OF WASHINGTON,
District of Columbia.

Personally appeared before me, the undersigned, a notary public for the district aforesaid, Dr. F. Kampf, who, being duly sworn according to law, deposes and says that he is an astronomical assistant to Lieut. George M. Wheeler, Corps of Engineers, in charge of explorations and surveys west of the 100 meridian, and that on or about the 25th day of June, 1873, while he, the deponent, was engaged in making observations at Georgetown, Colorado Territory, Prof. F. V. Hayden came to the observing tent for the purpose of making barometer comparisons, and that, in the course of conversation, the aforesaid Hayden expressed himself in the following manner: That if Lieutenant Wheeler was only out of the field, it would be an easy matter for him (Hayden) to absorb all western explorations and surveys, and that he would look out that no Army officer should ever have anything to do in that line of duty again; further, that he did not consider any Army officer fit to perform such duties, as the assistants of Army officers had to obey orders and instructions, while his assistants were at liberty to follow their own ideas, as they thought best.

DR. F. KAMPF.

Sworn and subscribed to before me, this 11th day of May, 1874.

[SEAL.]

TERENCE DRURY,
Notary Public.

Dr. Hayden speaks of his first appropriation: Attention is invited to the fact that altogether the "United States geological survey of the Territories" has had appropriated for it \$260,000. The area covered, judging from the statements, and for which map-material has been gathered, does not exceed 32,000 square miles. This estimate allows a little less than 20,000 square miles for the season of 1873, and a little less than 12,000 square miles in the Yellowstone region. The cost appears as \$8½ per square mile, or fully eight times the cost of the survey under my charge. Dr. Hayden estimates that his survey can cover 20,000 square miles per year. At this rate it would take fully seventy years to prepare the complete map of the Territory west of the 100th meridian, and more than one hundred years for the entire territory west of the Mississippi. At least eight or ten revisions of this entire map will be required ere this, and this revision will undoubtedly be made at the headquarters of the Army and in the Bureau of Engineers.

Dr. Hayden speaks of the interesting geyser region. I will explain how his attention was called to this section. In February, 1871, a report by Lieutenant Doane, of the Cavalry, was read before the Philosophical Society in Washington while Mr. Hayden was present. This report was both brilliant and graphic in its description of that region. It certainly has not been equaled since.

The map of the Snake River division in 1872, referred to as the greatest contribution to geographical knowledge during the past ten years, unfortunately is erroneous in its geographical positions. It has been necessary to send a special astronomical party to Bozeman, Mont., whose results, in conjunction with those of Captain Jones, of the staff of General Ord, will serve as the checks whereby this patch of topography can be placed upon the general map.

In December, 1872, the plan for the survey under my charge for the field season of 1873,

was laid informally before the Engineer Department and approved, provided moneys could be made available. At that time the party under Dr. Hayden had just returned from the Yellowstone, region, and, pursuant to an interview held with him during the winter of 1871-'72, the substance of which is here in evidence, it was believed that there need be no danger of conflict as to areas. The plan in manuscript was not formally laid before the Department until February 3. It had been understood since my connection with the Engineer Corps, that both law and custom placed the exploration and survey of the Western Territories in their hands; hence, in case of special legislation, the persons interested, by courteous etiquette, would naturally consult with the Engineer Department as to its operations before planning surveys similar in character that were likely to overlap. No organic law has withdrawn from the custody of the Engineer Department the exploration and survey of our unoccupied domain, and its archives contain more material bearing upon this subject than that of all the other departments combined. Since Dr. Hayden has stated that he had no right to enter into an agreement with Lieutenant Marshall and then accomplishing the fact, the violation thereof is all the more reprehensible.

When he states that he had no option as to changing his plan to prevent duplication of work, it has occurred to me that unless he had specific instructions to the contrary from the Secretary of the Interior, that he might occupy any portion of the territory spoken of in his letter of January 27, I object to the admission of the evidence of Professor Whitney, who is not officer or employé of the Government, and who, although undoubtedly acting in good faith, appears not to have been present at the interview when the agreement was made.

Judging from experience, it is believed that authority from the Secretary of the Interior should be obtained for the exact number of persons to be engaged upon the survey. This would preclude the guests who have been frequently invited, as evidenced by Dr. Hayden.

Dr. Hayden speaks of selecting the Territory of Colorado in 1873 in order to continue his work of 1869. It is understood that in 1869 no geographical work was done by him.

Dr. Hayden premises in his remarks that a scientific man is God-made, and that he cannot be manufactured at a military school. Following out this idea, perhaps there would be no need of schools at all, either military or civil, as they might hinder the spontaneous growth of scientific geniuses. With the utmost nonchalance he avers that were his work placed under the War Department that it would be put into the hands of an officer not over two years from West Point. By what remarkable intuition he has thus probed into the policy of the War Department it will be difficult to determine. Judging, however, from the precedent established by the sending out of Clarence King on the fortieth-parallel survey, it might be reasoned that if Dr. Hayden could prove to the War Department his fitness to carry on such a work, that he would be assigned to its charge. He has referred to Mr. Gardner, chief assistant, who for ten or twelve years has been engaged upon this work. I would call the attention of the committee to the fact that this person obtained the greater share of his training upon the fortieth-parallel survey, although at an earlier date he had been engaged upon the State geological survey of California. Were it not for this man, the most important part of Dr. Hayden's survey must fail. Whatever his capabilities or character may be, when the uncertainty as to the tenure of his official relations depends upon the will of one who cannot intelligently supervise his labors, the condition can better be imagined than described. A parade has been made of the fealty due to the citizen, whether friends or not of the members of the survey, who pay taxes to support its existence. Now, gentlemen of the committee, I wish to affirm that if a work is carried on that meets the economic necessities of one or more Departments of this Government—that in the present reduces or looks forward to a like reduction of expenditures in the future—then it has taken nothing from the pockets of any of your constituents or from those of any of the constituencies of this great land. This relation it is believed, the surveys directed under the War Department enjoy. He has stated that none of the old maps were suitable or sufficiently accurate for geological purposes. However true this may be, the statement tends, if it were not intended, to mislead. A hasty study of those different surveys by reference to the memoir compiled by Lieutenant Warren at the close of the Pacific Railroad survey, will satisfy one of the reason. Up to the present time, even, no complete geographical survey of that region has been put into organic form by a carefully-digested law. Heretofore specific objects, had demanded these surveys, and the compilation of their results gave to us the best and most reliable maps extant.

Congress has virtually, however, during its present session, legalized, by a specific appropriation, the further prosecution of the surveys west of the 100th meridian, that are intended to be carried on connectedly over that immense area. The matured plans for the grade of work connected with the different branches have been perfected and approved.

With this end in view, I began my labors in 1869, and it affords me no little pride and satisfaction to know that out of the labor of the survey under my charge may grow into form one of the largest geographical undertakings ever organized under any government.

The plausible statements of Dr. Hayden regarding "primary triangles and bases," network of triangles, &c., as well as statements regarding two-hundred-foot curves, need a little explanation. His calling upon Mr. Gardner to explain the features of triangulation, &c., confirms what I have had reason to believe is true, and that is, that here is a person in charge of a great geographical work, unable to perform, or intelligently direct, the astronomical, geodetic, or topographic portions thereof. These he must farm out to others; yet Congress

and the country hold him responsible, and I believe that he has not the power to interpret his responsibility. The map of two-hundred-foot curves, or conjecturally connected contours, issued of the 1871 survey, is fraudulent upon its face, and, when sent abroad, will create an erroneous impression as to the character of the work.

The only connected contour-maps made by this Government, so far in its operations, have grown out of the extremely minute surveys made for the sites of fortifications and of battle-fields, and from the plane-table sheets of the Coast-Survey and United States Lake-Survey. These are required for the plans and working-drawings of the engineer when constructions are to be made.

The contours of the map in question are conjectural, and not what they pretend to be. However useful they may be in geologic delineations, the map carries a misconception upon its face. This brings me to a subject that seems to be a very important one. By reference to the book of estimates for the coming fiscal year, it will be noticed that, in bulk, a little more than \$2,500,000 has been estimated for the various surveys, all gathering more or less topographical information. They are carried on under four different Departments. Each one of these Departments remains the custodian of its original information. Were the resulting maps to be duplicated, and by law forwarded to some one of the Departments that could be held most responsible for their accurate compilation, the maps of the entire country could be kept in constant revision. At the present time, the Engineer Department is the custodian, through its explorations and surveys, United States Lake-Survey, and River and Harbor Surveys, of the greater part of this information, yet not all.

Mention has been made of the greater sympathy between members of a purely civilian organization. I would submit that the utmost harmony prevails between the officers and civilians under my charge, and such I believe to have been the case in all of the different expeditions under the War Department.

The volunteered judgment as to the character of the work done by the War Department on the part of one who cannot even revise the work done by his own topographers, is, to say the least, assumption; but, as I never expect to be brought before a scientific tribunal where a man of such caliber will sit in judgment, his opinion need disturb no one.

Science has now become so prominent and popular that it may be well to call to the attention of the committee, for fear that it might pass unnoticed, two of its divisions that ought to act in harmony, and they usually do, except in cases of individual differences. These are the exact and allied portions. To the solution of problems in exact science, mathematical formulas may be applied, and to the results, the same criterion. The allied are outside of the pale of critical mathematical deduction, and depend upon facts and analogous reasoning for the establishment of their truths. To the latter class belong geology and natural history, to the former astronomy, geodesy, topography, and the hypsometric part of meteorology. All are integral parts of geography.

A question was asked the other day by a member of the committee (Mr. Clymer) that has led me to believe that there is a misconception as to the areas occupied by the survey of Doctor Hayden. The answer would allow the inference that his survey followed those of the public lands, using their maps as the skeleton; but such is not the case; they lie partly or wholly beyond and above, mostly preceding the settler and at higher altitudes.

Professor Hayden has published the following volumes and papers:

First, second, and third annual reports of progress for 1867-'68-'69, 261 pages, 8vo; entirely geological.

Fourth annual report of progress for 1870, (Wyoming and Nebraska:) 511 pages, 8vo; geological.

Fifth annual report of progress for 1871, (Montana and Nebraska:) 538 pages, 8vo, with sixty-four wood-cuts, two plates, and five maps, small; geology and meteorology.

Sixth annual report of progress for 1872, (Idaho and Nebraska:) 844 pages, 8vo, including sixty-eight wood-cuts, twelve plates, and five maps.

Final report of the geological survey of Nebraska during the year 1867; 264 pages, 8vo, with a colored geological map, and eleven plates of carboniferous fossils; geology, meteorology, and astronomy.

MISCELLANEOUS.

Lists of elevations in that portion of the United States west of the Mississippi.

Note.—Simply a compilation from Army, railroad, and other records. (See preface for proof of this statement.)

Meteorological observations during the year 1872, (Utah, Idaho, and Montana.)

Note.—Only partially the work of the survey.

Synopsis of the Flora of Colorado.

Note.—Based upon the collection made by Mr. Parry and fourteen other persons, including Doctor Hayden. Does not represent the labor of the survey, as very little was furnished by it. Refer to letter to the geologist in charge by Porter, and refer to article in the "American Journal of Science and Arts" for May, by Professor Eaton. Is not a report of the "geological survey of the Territories."

Catalogue of photographic negatives belonging to the survey.

Note.—Original, except many negatives contributed by persons not connected with the survey.

Synopsis of new Vertebrata from the Tertiaries of Colorado.

Quarto publications. Contributions to the extinct vertebrata of the western formation.

Note.—Based upon collections made by Doctor Van A. Carter and Doctor Corson, of the Army, and by Doctor Hayden. At least four-fifths of collection not made by Doctor Hayden. (See introduction by Doctor Leidy.)

Synopsis of the Acrididæ of North America.

Note.—Contains not only Hayden's specimens, but others. Some collected by Lieutenant Wheeler.

It is understood that there will also be published a number of other works of this description, containing the results of other men's labor, all assumed by Hayden, viz: Birds of the Northwest, by Doctor Coues and Muridæ of North America, by the same gentleman, based upon the Smithsonian collection principally.

14. *Synopsis of the Flora of Colorado*; by Thomas C. Porter and John M. Coulter. Washington, March 20, 1874; 8vo, pp. 180. A prefatory note by Dr. F. V. Hayden states that this is "intended to be a type of a series of hand-books of different branches of natural history * * * for the use of students all over the country." In the proper preface, which takes the form of a "Letter to the geologist in charge," Professor Porter enumerates the various collections on which the work is based, as Parry's, Hall and Harbour's, Bell's, Hayden's, Brandegee's, Porter's, Coulter's, &c., but omits Doctor Vasey, whose collection was among the largest of all, although no list was published. "The plan followed in the synopsis is that of Mr. Watson in his excellent catalogue, vol. 5 of Clarence King's report," giving characters of such orders, genera, and species as are not included in the several floras of the cis-Mississippi region. After returning suitable thanks to the botanists who have aided the authors of this synopsis, the writer adds: "References to the authorities consulted and used are to be found at the proper places in the body of the work." The synopsis enumerates about eleven hundred (1104?) flowering plants, and about two hundred and eighteen cryptogams. Several new species of phænogams are proposed, as *Clematis Scottii*, *Astragalus Brandegei*, *A. scopulorum*, *Rosa Arkansana*, *Erigeron glandulosum*, *E. Coulteri*, and *Senecio renifolius*, besides a couple of mosses (by Mr. Lesquereux, from Hall's collection) and a fungus by Mr. Peck. Hall and Harbour's plants are generally referred to by numbers, and Parry's are sometimes; but a search through the pages of the synopsis fails to discover any reference to Doctor Vasey's collection. Among plants collected by Vasey in the mountains of Colorado, and altogether omitted in this synopsis, are *Aster Canbyi*, Vasey, (No. 262;) *Aplopappus lanceolatus*, var. *Vaseyi*, Parry, (No. 273;) and *Artemisia arbuscula*, Nutt, (No. 308.) The last two are described in Watson's report, to which it will presently appear that the authors constantly turned for assistance. The characters given to the genera and species not contained in Gray's and Chapman's floras will be found exceedingly useful to students and collectors. Very many of the plants of Colorado have hitherto been described only in various rare and expensive works, or in the transactions of learned societies, so that ordinary students had practically no means of identifying their collections. It is much to be regretted, however, that the writers of this synopsis have by no means made the "references to authorities consulted and used," which it is said in Doctor Porter's letter that they have made. For example, the generic characters of *Brickellia*, *Townsendia*, *Macharanthera*, *Gutierrezia*, *Bige-
lovia*, *Aplopappus*, *Grindelia*, *Franseria*, *Heliomeris*, *Chenactis*, *Bahia*, *Tetradymia*, *Stephan-
omeria*, *Crepis*, *Macrorrhynchus*, *Orthocarpus*, *Monardella*, *Gilia*, *Collomia*, *Mirabilis*, *Abro-
nia*, *Sarcobatus*, *Calochortus*, *Lloydia*, *Leucocrocinum*, *Vaseya*,* *Eriocoma*, *Pleuraphis*, and *Beckmannia*, are taken with no alterations save those incidental to inaccurate copying (e. g., *Bahia*), from Mr. Watson's report, and with no word of acknowledgment in any instance. Even when, as in the cases of *Cercocarpus*, *Cleome*, *Tellima*, *Gayophytum*, *Jamesia*, &c., the reference "Benth. and Hook." is given, the writers have copied Bentham and Hooker only from Mr. Watson's sometimes amended and always modified translations. To make this plainer yet: In *Cercocarpus* Bentham and Hooker say, "cotyledones linearilongatæ, radícula." * * * * * Watson says, "elongated cotyledons, and inferior radicle." The authors of the synopsis copy Watson's words here, as elsewhere, and, indeed, there is no evidence that they have ever seen the original Latin. The same disingenuous borrowing appears most copiously also in the specific characters. To quote any considerable portion of the instances were a tedious task. The following examples will suffice: *Thlaspi alpestre*, *Claytonia Chamissonis*, *Cercocarpus parvifolius*, (an error in measurement is the only change,) *Sedum rhodanthum*, *Brickellia Californica*, *Solidago Guiradonis* and its variety, *Solidago pumila*, *Franseria Hookeriana*, *Antennaria alpina*, &c. These are examples of exact copying. The instances where the copying is as real, though the wording is slightly varied, are much more numerous. One cannot but wish, for the honor of American botany, that when Doctor Porter said that "the plan followed in the synopsis is that of Mr. Watson," he had added, "and much of the descriptive matter is also taken from the same work."

DANIEL C. EATON.

* *Vaseya comata*, Thurber; Colorado, Vasey, No. 634. This species surely might have been credited to Vasey.

The belittling spirit evinced in volunteering inferential opinions as to the labors conducted by the War Department is in keeping with that general plan whereby a person like Doctor Hayden, who, having started as a collector of specimens in natural history under a War Department expedition in 1855, has, by jumping from one pretentious pinnacle to another, reached the hopeful ambition of receiving the position of head of a geological bureau under the Interior Department. Gentlemen of this committee, if you further legalize this man, may you not in twenty years from now have twenty like unto him, or twenty thousand if you please, and meanwhile your corridors may be thronged with ambitious parties, the would-be custodians of geographical or geological plans?

The statement made by Major Powell, that the War Department survey overlaps his by an area of 26,000 square miles, means nothing. As he has published no results, it is difficult to make a comparison. The map that was displayed here by him the other day when in my office was inspected and some of the main positions compared. His were found erroneous by distances reaching as high as 1½ miles. The main point upon that map was determined jointly by Major Powell's party and my own, the telegraphic exchanges having been made between his observer at Kanab and mine at Salt Lake City. I had never believed that there would be any duplication of importance with Major Powell, as I had understood that his survey would be confined to the Colorado River and its immediate areas. By a law of Congress he has been furnished from time to time with Army rations for his men at the expense of the War Department. I object to the reception by this committee of the statements made by Professor Powell as to the methods pursued by the War Department in their surveys, as he knows little or nothing about them, and, as he often stated to me, has no pretensions in the line of astronomy or topography. I will here remark that the system of survey established by myself during the past year elaborates both the so-called meander-method and the triangulation processes from measured bases rechecked at points by main astronomical determinations, and this will, in my opinion, prove to be the most perfect system that has ever been adopted for the survey of mountain areas.

Should it become at any time the policy of the Government to establish a minute topographical survey of its territorial interior by the most refined geodetic methods, then the survey under my charge, or for that matter, probably other surveys of the War Department could and would present well-digested plans to carry on the different branches of the work. The necessities of the times have not yet seemed to demand it. I hope at an early day that they will. Another point of vast practical importance is that it is not necessary to carry on as accurately in the desert regions surrounding Death Valley, for instance, a survey as carefully delineating the mountain forms as in the vicinity of a rich mineral district or a vast coal-field. The most intense practical study must be applied in adapting measures to ends in each new area selected.

Up to the close of the Pacific Railroad surveys the specific objects had usually been for the location of lines of travel. These were naturally along routes of least profile and through the lowest passes; hence the mountain-peaks were only occasionally ascended, and seldom was an entire mountain-range dissected. This has gradually changed in the surveys that have been prosecuted since the war; and in 1869 I established the value of routes of travel for the survey parties from north to south, so as to approach with greater ease the mountain-ranges nearly meridional in Southern and Southeastern Nevada. By slow and steady growth the work has gone on until it is claimed that the present organization is both more scientific and practical than any one yet prepared to cope with the obstacles to be met in the mountains of our western territory that extend in endless configuration toward the Pacific.

I understand that a written statement has been placed before the committee by Mr. Gardner, assistant to Doctor Hayden. I object to the receiving of his testimony—

1. Because of the belittling of a great subject by allowing assistants to answer when the person in charge ought to be held responsible.
2. Because it appears like a covert method of inquisitorial attack on the part of Doctor Hayden upon the scientific results of the War Department.
3. This man has proven false in his dealings with me, by practicing deception.
4. His action in leaving the survey of the fortieth parallel and joining Doctor Hayden, has been criticised as traitorous in its nature.
5. He has been guilty of relating to an officer, high in rank in the Engineer Department, a plan whereby he might fraudulently draw two salaries from the Government, as if engaged upon two surveys.

Hence, I do not consider that his evidence ought to be admitted.

[From Annual Report of the Chief of Engineers for 1873—Report of Clarence King, United States Geologist.]

On October 29, Mr. Emmons and I having met Mr. Wilson, we marched via Brown's Hole and Vermillion Creek to Uinta Cañon, and there made such sections as assured us that the ideas advanced by Hayden and others as to the silurian developments there were altogether erroneous. From Uinta Cañon we went north to the so-called Diamond Fields, remained there four days investigating them, and, having made my conclusions, returned in haste to San Francisco, leaving the party to march back to Fort Bridger, which they did, reaching there about November 13.

He also made excursions north of our actual northern map-boundary, in order to see if Hayden's alleged discoveries of the carboniferous were real. I ought not to characterize his

statements here, but Mr. Hague saw enough to forbid our accepting any data from that source. It was evident to us that either he or we were wrong, and we now feel that we have no reason to modify our opinions.

The CHAIRMAN. Have you any further information or statement that you desire to lay before the committee?

Lieut. WHEELER. I have placed in the hands of Mr. Clymer some facts regarding the expenditures of last year, and there will come in from the Department to-morrow morning, probably, the expenditures connected with the military portion of the service.

The CHAIRMAN. This is a statement of the expense of your expedition last year?

Lieut. WHEELER. Yes; that covers the expenses out of the appropriation up to the present time. It is taken from the official record. These expenses were paid from the appropriation. The other expenses will come in under special call from the Quartermaster's Department. I refer to the mileage of officers and some transportation expenses.

Mr. HERNDON. It was stated in the course of this examination that five expeditions under the War Department have made a survey of the section of country in which Salt Lake City is situated, and that, according to some recent surveys made by civilians, it had been ascertained that Salt Lake City was fixed under the surveys made by the military at 10 $\frac{1}{10}$ miles too far west of its actual position. Is that true?

Lieut. WHEELER. One of the determinations made by one of the parties that went west of the Missouri River in early days made necessarily erroneous longitudes, and, depending upon the chronometer, it appeared that Salt Lake City was placed a little less than 12 miles out of the way. It is true as to the number of expeditions having gone there, but it is untrue that prior to the time when civilians had entered this field that the location of Salt Lake City on the map was that much out of the way. I will lay before the committee a memorandum of the exact facts which I have in my office, and which will explain the whole matter.

Mr. HERNDON. What expedition, or what person, ascertained the fact and made it known that Salt Lake City was fixed on the map too far west by 10 or 12 miles?

Lieut. WHEELER. As nearly as I recollect, it was ascertained by Captain Simpson, in 1859.

Mr. HERNDON. Was he under the War Department?

Lieut. WHEELER. Yes. He was surveying for General Johnson when he went out on the Mormon expedition.

Mr. HERNDON. I believe you stated that you use the method now of triangulation and base-lines in making your surveys.

Lieut. WHEELER. Yes.

Mr. HERNDON. How long is it since you adopted that method?

Lieut. WHEELER. The method was not perfected until 1873. The policy prior to that had been to direct our surveys so as to cover a very large area for the lowest possible expenditure of money, which was with the expectation that it would not be the policy of the Government to enter into a more minute survey, or to make continued appropriations for so doing; not but that minute surveys could be established then, and not but that the Engineer Department could have done them if Congress wanted to have them done. But we were simply working from cause to effect, and struggling along to do just that which the money appropriated allowed us to do. I have myself been one of the pioneers in the work since the war, and we have other young officers of the corps who are growing up, and who will be ready to take my place very shortly. It is a matter of great professional pride with them, and this feeling is on the increase. Even in the instruction at West Point remarkable innovations have been made within the last three or four years as to the practical use of instruments, both astronomical and geodetic. The use of these instruments has been brought into the system of studies, that have been perfected very much in this regard since the close of the war.

Mr. HERNDON. You did not attempt, then, to make explorations for the purpose of geology?

Lieut. WHEELER. In 1869? No, sir, not at all. In that year there was about to be a change of troops from the southeast portion of Oregon and parts of Idaho into Arizona, and at that time the expense of moving troops to the California coast and down to the Colorado River and then into Arizona was very large. It would probably cost nearly \$125,000 to move a regiment between those points. Then the idea was mooted of getting up a route north and south, between the Sierras and Wahsatch. It was almost a blank upon the map when we started out in 1869. White pine had just been found the year previous; that is, for the first time prospectors had pushed across eastward from Washoe and had begun their prospecting up and down the country.

Mr. HERNDON. Is it not true that the explorations and surveys made by Mr. Powell and Mr. Hayden are more exhaustive than those made under the War Department; I mean more minute in detail?

Lieut. WHEELER. That is a question in regard to which I do not wish to give a professional opinion until after I have examined into their work from the start, and into its present condition. I do not consider that I would be justified in venturing to give an opinion on that subject till I had investigated it. I have seen Mr. Powell's map, but I have not seen Doctor Hayden's.

Mr. HERNDON. I believe you stated that in your expedition you have a number of civilians with you, and that perfect harmony exists between the Army officers and the civilians.

Lieut. WHEELER. Yes, sir.

Mr. HERNDON. About how many civilians do you have?

Lieut. WHEELER. I have presented a statement of the force to the committee.

Mr. HERNDON. You stated as your opinions inferentially, however, that Doctor Hayden did not have sufficient scientific information to conduct an exploring expedition of the character of that placed under his charge. What is your opinion on that point in regard to Mr. Powell? Do you think that he has sufficient scientific skill and information to conduct one?

Lieut. WHEELER. I do not wish to answer that question at all.

Mr. St. John objected to the question, and it was withdrawn.

Mr. HERNDON. You stated that you had not ascertained whether any portion of the work done by Mr. Powell was duplicated by yourself?

Lieut. WHEELER. O, yes; I know there has been some duplication. That is a matter entirely beyond the province of anybody connected with the surveys, as they have been under different Departments, and it is sometimes difficult to consult in advance with a view to defining the exact localities to be entered and surveyed. This might be done, however.

Mr. ORR. State if, in your opinion, the surveys, and the results found from them by Professor Powell and Doctor Hayden, and the maps which they have compiled, would be sufficient for all the purposes of the War Department, independently of your own surveys.

Lieut. WHEELER. I cannot give a judgment on that subject. I have not examined them sufficiently well to know; and there is this about it, that unless all these surveys are carried on under one comprehensive plan; unless the astronomical work is done in a certain way, and the triangulation work is done in a certain way, and the other work is done in a certain way, and unless the expeditions are directed in a uniform manner, the results, where areas conjoin, never can agree. And it is to that that the fact is due that the western territory map never could be compiled and give accurate positions, especially longitudinally. An officer of the corps of Topographical Engineers, who was engaged nearly five years in the work, and has as rare understanding of geography as any man in the country, I believe, had the utmost difficulty in reconciling the differences in the work; but he had the manliness to explain it in his memoir, and to give credit where credit was due. But there will be always disagreements; there will be always want of harmony, unless the plans are made and supervised by one central head who is responsible for all the work, and who can and will direct that all shall be carried out in one specific way. Now, I do not know that that belongs so naturally to the professors of geology and natural history. In my belief, the Government might send out exploring expeditions for geological purposes alone, and connect natural history with them, if you please, and might spend \$50 per square mile on each one of those sciences, and yet never exhaust the geology or natural history of a region. You never can exhaust the geography of a country. Upon the whole globe we only know but a few arcs of the meridian.

Mr. HERNDON. Who is the topographer and geographer to whom you allude?

Lieut. WHEELER. General G. K. Warren, Corps of Engineers.

Mr. HERNDON. I asked these questions because similar questions had been asked gentlemen on the other side, and I deemed it fair to get your opinion upon them.

The chairman asked Mr. Hayden whether he had any further information to impart to the committee.

Mr. Hayden replied in the negative, and said he would wish to lay before the committee certain testimonials by way of defense against the statements made by Lieutenant Wheeler, which testimonials were thereupon submitted to the committee.

Mr. Clymer suggested that, although the committee did not wish to widen the scope of this discussion, if Mr. Hayden, Mr. Powell, or Mr. Gardner desired to make any reply to what had been said by Lieutenant Wheeler, of a personal nature, they should be permitted, in justice to themselves, to do so in writing, to be filed with the committee on Saturday morning. He made a motion to that effect, which was carried.

Mr. Powell read to the committee an abstract from Lieutenant Wheeler's preliminary report for 1871, on page 88, to show that his survey was based upon the odometer.

Lieutenant Wheeler remarked that the committee would find that he did not claim to have perfected his triangulation methods, nor was it his duty or policy to have done so until the year 1873. There was no conflict whatever in his statements in that regard.

The investigation here closed, so far as applied to testimony, but with the understanding that statements by Mr. Powell, Mr. Hayden, and Mr. Gardner might be filed with the committee on Saturday.

No. 13.—*Statement of James T. Gardner concerning the personal charges brought by Lieut. G. M. Wheeler.*

Mr. Chairman and gentlemen of the Committee on Public Lands :

Questions concerning my personal character can be of little interest to you compared with those which affect methods and results of scientific work.

I shall therefore confine myself to a brief statement of what I suppose to be the facts alluded to in this charge of Lieut. G. M. Wheeler, leaving it to the committee to judge whether such charges were either warranted by the facts, called for by the circumstances of the debate, or respectful to the body before whom they were read.

Mr. Clarence King and myself have lived together since we were fourteen years old on terms of intimacy closer than those of most brothers. This relation still exists.

I received my appointment on the geological survey of the 40th parallel from him. All of the other assistants were appointed by him after consultation with me. Whether these appointments had to be approved by General Humphreys or not I do not know. We all felt that Mr. King was our leader, and that our allegiance was due him.

It was well known to all of us that it was through his personal exertions and personal friends that the money for our support was appropriated by Congress. It made little difference to us what Department disbursed it so long as they did not meddle with our scientific plans.

When the geographical work of this survey drew toward a close, the maps being mostly drawn and partly engraved, and the principal calculations being finished, Mr. King announced to me by word and by letter, now in my possession, that he intended to retire from the business of conducting western surveys.

As I proposed to continue in my profession, it was necessary to make arrangements for future work. For this purpose I came to Washington in January, 1873, and resided while here with my friend, Senator Edmunds, of Vermont, to whom many of the facts are known.

Mr. King's approval of my course in seeking further employment is expressed in a private letter which I will lay before the committee, if desired.

I conversed both with Professor Hayden and Lieutenant Wheeler about their ideas of how western work should be carried on, and became convinced that my scientific ideals and desires were much more in accord with those of Professor Hayden than of Lieutenant Wheeler.

Lieutenant Wheeler had not then offered me a position, nor had I committed myself to him in any way. Immediately after my conversation with Lieutenant Wheeler, Professor Hayden offered me the position which I now hold, and it was at once accepted. The next day Lieutenant Wheeler also made an effort in writing to secure my services. The note from Lieutenant Wheeler to myself, in which this is expressed, is marked "personal and private." I therefore lay it before the committee in a sealed envelope, which they may take the liberty of opening if the public good requires it.

I necessarily refused the offer, and, I fear, excited a very bitter personal feeling in so doing. Lieutenant Wheeler must have been laboring under the misconception that I would, of course, be very glad to accept a position under him. This misconception on his part seems to him due to deception on mine.

On communicating my decision to General Foster, then in charge of the division of surveys of the Engineer Bureau, he asked whether I intended to assist Mr. King in the supervision of the publication of the 40th parallel maps, while, at the same time, working for Professor Hayden. I told him that I did. "Do you expect to receive any pay for so doing?" he asked. I answered that I supposed so. He replied that there was a law against a person receiving two salaries from the Government. I then asked if there was no legal way in which I could be paid for the small amount of service which I should render Mr. King. He answered that such matters were left to the conscience of the disbursing officer. Inferring that he did not think that it would be morally right to take pay, I told him that if that were the case, I should do the work for nothing, as I felt in honor bound to see Mr. King's work through to the end. Professor Hayden agreeing to this, I have spent nearly three weeks this winter in assisting Mr. King in work that others could not do, and have still a report to write on the mathematical basis of the maps. In consequence of this extra duty I shall have little or no vacation from work for two years.

I have not received any compensation for my services to Mr. King since joining Professor Hayden; have no expectations of any; have never broached the subject to Mr. King, and never will.

Concerning my relations with Professor Hayden, I would like to say that all the plans of work in my department are constantly supervised and modified by him, and that nothing is done unless with his approval, which is given only after a full and intelligent discussion of the subject.

The geographical work is now so organized that it would go on without me if I were to be suddenly removed. I would repeat that the methods of work and organization used on the 40th parallel survey were developed while on the State geological survey of California, and that they were not changed except by substituting measured bases for astronomical ones.

JAS. T. GARDNER.

No. 14.—Statement of Doctor Hayden in reply to Lieutenant Wheeler.

WASHINGTON, May 22, 1874.

To the chairman and members of the Committee on Public Lands of the House of Representatives:

In looking over Lieutenant Wheeler's statement before the committee on the 21st instant, I see nothing that is really worthy of notice, that has not already been brought to your attention. I prefer to rest the case with the committee. In reply to the charge of incompetency, I beg to refer the committee to the letters and testimonials of some of the ablest scientific men in the land, who are best able to judge of the labor and results of the survey.

In conclusion I beg to say that the animus of Lieutenant Wheeler, in his statement before the committee, proves most clearly, what has generally been believed, that it is not the love of science, but of power, that has induced him to precipitate this conflict; and scientific men, all over the country, may well be filled with apprehension at the bare possibility of these officers gaining control of our national scientific work.

With great respect, I remain your obedient servant.

F. V. HAYDEN,
U. S. Geologist.

No. 14½—Statement of Lieutenant Marshall and Lieutenant Wheeler concerning agreement between Doctor Hayden and Lieutenant Marshall.

WASHINGTON, D. C., March 1, 1874.

Lieut. G. M. WHEELER, *Corps of Engineers:*

SIR: I have the honor to make the following statement concerning the overlapping of Government surveys in Colorado during the past field season.

In accordance with the annual project for 1873, approved by the Secretary of War and Chief of Engineers, I was placed in executive charge of party No. 3, known as the Colorado Party of your expedition for that year.

On my arrival at Denver, I found Doctor Hayden's parties organizing for their summer's work. As well as I could discover Doctor Hayden's plans, his area would be a rectangle whose longer sides would be parallels of latitude through Pike's and Long's Peaks.

Under the supposition that Doctor Hayden would carry out his original plan, as I understood it, I began my survey at Idaho Springs, my eastern limit $105^{\circ} 30'$, and had been at work about one month in and about the main chain of the Rocky Mountains, from Grey's Peak to Mount Lincoln, when I met Doctor Hayden and party near my eastern line in the northeast part of South Park, July 9, 1873. At his request the two parties camped together. In the afternoon Doctor Hayden and myself had a conversation in which I expressed regret that from a want of pre-arrangement between the heads of the surveys, Government funds should be unnecessarily expended in twice surveying the same area, and took the ground that he was responsible for it, inasmuch as it was well known that all systematic surveys of the War Department had been since 1868, and were still being prosecuted entirely along or south of the Union Pacific Railroad; whereas all surveys of his, in which geographical work was done, had been north of this line; that, in arranging our project for 1873, it was to be supposed he would still, for the sake of connection with work already done by him, confine himself to that country. To this he replied that he was unaware that the War Department intended to send a party into Colorado; that he had been unable to obtain an escort, and was therefore forced to select some territory where his small parties could work with safety, and had selected Colorado for this reason only.

After some further conversation I expressed a desire to put a stop to this double survey of the same area as soon as possible consistent with my orders, and told him that I should spend about twenty days in the survey of South Park, and the Platte, and Arkansas divide, and then move to the west of the Upper Arkansas River, and work in the main range of the Rocky Mountains. I took a map from Mr. Gardner, and indicated at his request, I think, the area I proposed to survey west of the Arkansas, and along the Atlantic and Pacific divide. Dr. Hayden then said that he had altered his original plans; had prolonged his rectangles to the south, and cut off a considerable area from the western side which he would not touch, and remarked that he would keep his parties about South Park, and the area previously reconnoitered by him several years before, for a short time, and then move them into the hog's back and foot-hills farther east, and said that he would do no work on the main range or west of the Arkansas headwaters, and that there would then be no interference of parties in that field. He reiterated again and again: "Mr. Marshall, I shall do no work in the main range." This in the presence of Prof. J. J. Stevenson, geologist to my party, and of Mr. Gardner of this expedition.

This I regarded as an agreement between Dr. Hayden and myself, and my operations were conducted accordingly; but on the 1st of August, when I crossed to the west of the Upper Arkansas and came to Twin Lakes, I found that Dr. Hayden with three of his parties were encamped a few miles farther to the west. A few days later, a fourth party of his (he had but five in the field) crossed the main range at the Cochetopa Pass, and worked west and north along the main chain. Thus, instead of doing "no work in the main range," he

had concentrated his entire expedition (save one party) upon my line in the very area he had announced his intention not to touch, or he had evidently twice changed his plans, each time taking in a larger tract of the area, which he knew I was instructed to survey.

As it was evidently useless, I held no further interview with Doctor Hayden, nor any further conversation with him upon the subject. He was present with full power to do as he pleased in the matter, while all I could do was to inform him of my instructions, without the power to alter the programme laid out for me, while the chief of the survey to which I was attached was so far to the south and in such remote section that before communication could reach him, and his decision in the matter be made known to me, the season would be so far advanced as to render any change on my part useless.

As far as I can see, then, this whole complication arose from—

1. The unorganized or unsystematic condition of our interior surveys, under several departments or heads instead of under one.
2. The frequent change of plan on his part and the evident desire of Doctor Hayden to inclose as much as possible of the area assigned to my party in his.

Very respectfully, &c.,

W. L. MARSHALL,
First Lieutenant of Engineers, United States Army.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL AND GEOLOGICAL EXPLORATIONS
AND SURVEYS WEST OF THE 100TH MERIDIAN,
Washington, D. C., March 12, 1873.

Respectfully forwarded to the Chief of Engineers:

The operations of the season of 1873 were in pursuance of the systematic plan that had been approved by the Chief of Engineers and the Secretary of War. When my project for this season was laid before the Engineer Department and approved, the party under Professor Hayden had lately returned from its scene of operations in the Yellowstone region. In a conversation held with Professor Hayden, at the Smithsonian Institution, he stated his intention of prosecuting further work in areas lying north of the Pacific Railroad; hence it was concluded that there need be no apprehension of complication between the surveys in regard to areas to be occupied by each.

The shifting of his field of operations and his subsequent inexplicable action, as shown by the within communication, appears as an unwarrantable disregard of the survey being prosecuted under the War Department in this region, which must have been known to him. Late in the season of 1873, a Coast-Survey party, supposed to have been working in connection with Professor Hayden, occupied stations at Colorado Springs and Trinidad, Colo., after the most elaborate determination of the astronomical co-ordinates of these points had been made by a party of the survey under my charge.

This, it is believed, was done notwithstanding the protest of the assistant in charge of the Coast-Survey party, who afterward made observations at these points. Such duplication of work, in pursuance of no uniformity of plan, and without systematic organization, looking toward the accomplishment of the most ample results, not only incurs a useless expenditure of the public funds, but lessens public confidence; and, if continued, is likely to prove discreditable to its immediate executors.

The project for the operations of the survey under my charge for the ensuing season was submitted to the Chief of Engineers and approved on the 11th instant, and embraces portions of Western and Southwestern Colorado, to complete unfinished rectangles; yet it is understood that Professor Hayden proposes to enter the same field.

A feeling of duty prompts me to suggest that some means should be adopted to prevent a repetition of such unnecessary duplications as those of the past year.

GEO. M. WHEELER,
First Lieutenant of Engineers, in charge.

No. 15.—*Statement of Mr. James T. Gardner concerning the alleged agreement between Doctor Hayden and Lieutenant Marshall.*

WASHINGTON, May 23, 1874.

Mr. Chairman and gentlemen of the Committee on the Public Lands:

Lieut. W. L. Marshall having submitted to you a written statement that I was present when the so-called "agreement" was made between himself and Professor Hayden, I wish to state to the committee that I remember the interview in which Mr. Marshall pointed out his route on my map; but that I have no recollection of any agreement on the part of Professor Hayden to confine himself to any special area, nor of any conversation with reference to making any such agreement; but that, on the contrary, Professor Hayden expressed himself that he did not consider that the two works conflicted, because they were so different in their objects, methods, and results. The first time I heard anything about this agreement was after we returned to Washington this winter. I was very much surprised that Lieutenant Marshall should make such a statement, and when visited this

winter by Prof. J. J. Stevenson, of New York, who is also spoken of as being present, I asked him if he recollected any such agreement, and understood him to say that he had no recollection or knowledge concerning it. Lieutenant Marshall must have misunderstood or misconstrued some part of the conversation, as I believe him to be a man who would not willfully make a misstatement.

Very respectfully,

JAS. T. GARDNER,
*Geographer of United States Geological and
Geographical Survey of the Territories.*

No. 16.—*Memorials of scientists in favor of the surveys under civilians.*

Dr. HAYDEN. I would ask the committee to allow the following memorials and letters from many of the most distinguished scientific men of our country to go on the record :

Memorial from the faculty of Yale College and other scientific men.

NEW HAVEN., CONN, May 12, 1874.

Hon. W. TOWNSEND,

Chairman of the Committee on the Public Lands :

SIR : The undersigned, being informed that a movement is now making before Congress to bring under the control of the War Department the scientific surveys carried on, and to be carried on, under the auspices and at the expense of the Government of the United States, to the end that the management of them shall be intrusted to Army officers, desire respectfully to express their conviction that the success of the movement would not be for the advancement of the public interests, but rather the contrary ; that the geological, geographical, zoological, and anthropological work which needs to be done in our as yet unexplored or partially explored territory is not such as constitutes the proper occupation of military officers, being neither what they have been trained to do, nor what the good of the country demands that they be trained to do, or employed in doing ; that, on the contrary, it belongs to specially educated civilian scientists, men who devote their life to this kind of work, and whose success in life and reputation depends on the way in which it is executed ; that such civilians have, from the necessities of the case, been employed to do the main scientific work in the reconnaissance surveys undertaken by the War Department, and that experience has shown them to work more successfully and more economically, and to obtain better results, when they themselves have the direction of the operations in which they are engaged, and when the War Department is only called on to furnish them needed protection in the regions now rapidly lessening, and soon to be no longer existent, when they are liable to meet with hostile interference.

NOAH PORTER,

President Yale College.

THEODORE D. WOOLSEY,

Ec. Prest. Yale College.

H. A. NEWTON,

Prof. of Mathematics, Yale College.

ELIAS LOOMIS,

Prof. of Nat. Philosophy and Astron., Yale College.

C. S. LYMAN,

Prof. of Astronomy and Physics in Yale College.

S. W. JOHNSON,

Prof. of Chemistry, Yale College.

A. E. VERRILL,

Prof. of Zoology, Yale College.

DANIEL C. EATON,

Prof. of Botany in Yale College.

JAMES D. DANA,

Prof. of Geology and Mineralogy in Yale College.

WM. H. BREWER,

Prof. of Agriculture in Yale College, formerly of California Geological Survey.

GEORGE H. BRUSH,

Prof. of Mineralogy in Yale College.

O. D. ALLEN,

Prof. of Metallurgy in Yale College.

JOHN E. CLARK,

Prof. of Mathematics in Yale College.

FRANCIS A. WALKER,

Prof. of Political Economy in Yale College.

S. I. SMITH,

Assistant in Zoology in Yale College.

W. D. WHITNEY,

Prof. of Oriental Languages, Yale College.

Memorial from Massachusetts Institute of Technology.

[Similar to the foregoing.]

This memorial is signed by J. D. Runkle, president; T. Sterry Hunt, Geo. A. Osborn, Samuel Kneeland, Robert H. Richards, Edward C. Pickering, C. P. Otis, Wm. Ripley Nichols, Alpheus Hyatt, Charles R. Cross, S. Edward Warren, Gaetano Lanzo, W. P. Atkinson, Geo. H. Howison, professors of the Massachusetts Institute of Technology, Boston, Mass.

Memorial from Harvard University.

[Similar to the foregoing.]

This memorial is signed by Charles W. Eliot, president; Wolcott Gibbs, Joseph Winlock, Sereno Watson, G. L. Goodals, Thos. G. Cary, S. F. Pourtales, H. A. Hagen, Josiah D. Whitney, Joseph Lovering, Alex. Agassiz, Josiah P. Cook, jr., John Trowbridge, Az. M. Pierce, Wm. H. Pettee, Jeffries Wyman, professors of Harvard University.

BOTANIC GARDEN,

Cambridge, Mass., May 13, 1874.

The undersigned entirely agrees in opinion with the prayer of the memorial addressed to the chairman of the Committee on the Public Lands, under date of May 12, and signed by Wolcott Gibbs and others, viz, that the explorations and investigations spoken of are best conducted and, in fact, for the most part, can be successfully prosecuted only by scientific men of special training. But as he does not know whether such expeditions and explorations have been, or may be, more economically conducted under the lead and responsibility of civilians than of military officers, he declines to indorse that statement in the memorial before him, although he would urge the propriety of adopting the course proposed.

ASA GRAY,

*Professor of Natural History in Harvard University,
late Pres't American Academy of Arts and Sciences.*

Extract from a letter of Prof. J. D. Dana to Doctor Hayden.

NEW HAVEN, May 15, 1874.

I will say, however, that if Congress should sustain the scheme of the War Department, it would be an immense disaster to the science of the land.

It would be as reasonable to put a geologist or naturalist at the head of the Army, or of a corps for war defenses, as to place scientific surveys of any kind under officers of the Army, or to make them subject in any way to the management of the War Department.

Hoping that no such folly may be perpetrated by our Government,

I remain yours, very truly,

JAMES D. DANA.

NEW YORK, May 8, 1874.

Hon. J. A. GARFIELD:

I write as president and on behalf of the American Geographical Society, to express the very earnest wish that the geological and geographical survey of the Territories under the direction of Doctor Hayden may be continued the present year. Nothing has contributed more to raise our character as a nation throughout the world, and especially in Europe, than these surveys.

Nearly every important country in the world is engaged in like surveys, and we have an unexplored field larger than any other civilized nation except Russia.

No survey has attracted abroad so much attention as that of Doctor Hayden, a fact which we know from our extensive exchanges; and none has been more worthy of it. It has been one of the most interesting, best conducted, and fruitful of our surveys. I do not wish to undervalue in any way the labor of the Engineer Corps. Indeed, I have always spoken of it publicly in the warmest manner. But it is to the interest of the country to have, also, surveys by practical geologists and geographers.

They do their work differently, and in some respects necessarily more effectually. The competition between both works admirably. It is impossible to overvalue the benefit in the future of these surveys to the nation. They are not only a mark of our high and advanced civilization, but the results that follow them are of the greatest value to the country, and no money, in my judgment, which Congress expends—and I am speaking of a subject to which I have given attention for years—is so well bestowed, or leads to more important results. I

again express the earnest wish that Doctor Hayden's survey may be continued; and in doing so I am only the mouth-piece of a society now comprising over one thousand persons, who may be taken as representing collectively in their views what is for the welfare and benefit of our country.

I am, dear sir, very respectfully

CHAS. P. DALY.

BOSTON, *May 9, 1874.*

DEAR SIR: No one who is acquainted with the scientific surveys and explorations conducted under the direction of our General Government for some years past, can fail to recognize their great scientific as well as practical value, or to admire the efficiency of the organization by which, in spite of formidable obstacles, they have been so successfully carried forward.

Of none of these surveys can such a judgment be more emphatically pronounced than of the various explorations which you have personally conducted, and of which the reports already published are among the richest contributions yet made to our knowledge of the geology, paleontology, and topography of the far West.

Where scientific work requiring such special training and experience as this is carried forward with acknowledged success, any change in its personal supervision would seem, to say the least, to be hazardous; and I therefore trust that nothing will be done by our Government to deprive you of that control of the explorations in your charge, under which they have been so brilliantly successful.

Yours, faithfully,

WILLIAM B. ROGERS.

Prof. F. V. HAYDEN.

PRINCETON, N. J., *May 4, 1874.*

MY DEAR SIR: I am sorry that my absence from town prevented my answering your note immediately, as I would have done in other circumstances. I was delighted by my visit to your office, which you so kindly opened to me, and by the full explanation which Mr. Gardner gave me on the method and results of your survey of last year.

The abundance of the information gathered during so short a space of time, and with a limited working-force, is in a high degree satisfactory. Your surveys in the previous years to this time have opened to the world that great book of the Rocky Mountains so long sealed to us. I sincerely hope that Congress will feel the importance of continuing them without a moment's interruption. Science, alike, and the immediate practical interests of the nation require it. I cannot but hope that a work so well begun will not be half thrown away by the want of the means necessary to render the materials already collected entirely available, and to procure those which are indispensable for its completion.

Very truly, yours,

A. GUYOT.

Dr. F. V. HAYDEN.

YALE COLLEGE, *New Haven, April 25, 1874.*

MY DEAR DOCTOR HAYDEN: There are few who know more than I do about the successful organization of your geological and geographical force as it exists at present; its devotion to its task, and the value of the results it is producing; and I should regard as a public calamity any transfer of the work it has undertaken to other hands. It is satisfying, and more, all the reasonable expectations of the lovers of scientific progress (both for science' sake and for the furtherance of practical ends) in this country and throughout the world.

Yours, very truly,

W. D. WHITNEY.

PHILADELPHIA, *May 6, 1874.*

The undersigned strongly recommends a continuance of the same plan in the employment of Professor Hayden, under the Department of the Interior of the United States, to conduct a geological and geographical survey of the Territories of the United States, as most conducive to the interests of the nation and to science in general.

A simple reference to the published reports of Professor Hayden, and the comparatively small expense of the survey, are, I think, sufficient evidence that the plan adopted is one of the most economical, and at the same time most prolific, in its results. The amount of information already given to the world, in the published reports of Professor Hayden, in the same time, I believe has not been exceeded by any one.

Respectfully submitted by—

JOSEPH LEIDY,
*Curator of the Academy of Natural Sciences of Philadelphia,
and Professor of Anatomy in the University of Pennsylvania.*

CAMBRIDGE, May 9, 1874.

MY DEAR DOCTOR HAYDEN: Your work has from the beginning commanded my most hearty sympathy and interest. I had great pleasure when in Washington a short time since of examining it in detail, and in renewing my acquaintance with your corps of assistants, several of whom were my pupils a few years since. I earnestly hope that you may be permitted to complete what you have so well begun, as I have heard but one opinion in regard to your work from those who are competent to judge of it. I am not, you know, myself a geologist, and cannot, of course, venture to express an opinion of your work based upon my own judgment; but from all that I hear I cannot doubt that your survey will reflect infinite credit upon your labors, and that it would be a grave mistake to put it into other hands.

Very cordially, yours,

WOLCOTT GIBBS.

COLUMBUS, OHIO, April 30, 1874.

MY DEAR SIR: If I am well informed, there is now pending in Congress a resolution to consolidate your survey of the Territories with that of the Engineers, and to put it under the direction of the War Department. Such a resolution should be opposed by all your might, as a true calamity to the scientific interests of the country; for the change would infallibly cause, if not the loss of all results obtained till now by your explorations, at least the abandonment of any kind of valuable scientific advantages for the future.

If I am not mistaken, you began already the geological survey of the Western Territories in 1853, and then determined the essential features of the country along the Upper Missouri, collecting specimens and materials to illustrate and support your conclusions. Since that time you have constantly followed the same kind of explorations, adding year after year new observations, new facts, new materials, all scientific, which, pertaining to the same kind of researches, have been examined, compared, determined, prepared for publication according to the plan which you had fixed in your mind from the beginning, and which comprised a detailed study of the geology or the natural history of the Western Territories. In following this plan without hindrance and according to your own views, you have brought these explorations to such a point of scientific attainment that, from the reports already published, we have on that wide extended country information more valuable to science, more applicable also to practical purpose, than those which are furnished by prolonged surveys of any of our thickly-settled States. The geological distribution has everywhere been clearly defined from the Missouri to the Rocky Mountains. The essential documents necessary for the acquaintance with the floras and the faunas of the West have been gathered, together with an immense amount of materials serving to illustrate geological determination by paleontological remains, either animal or vegetable: and, more, you have by and by successively attached to your survey the most learned specialists of this country, who could but be interested in your work by the earnestness of your purpose and of your proceedings. All the materials collected by yourself and your assistants in these long years of your explorations are now in the hands of these specialists. Part of the work is already done and has been given to the scientific world by your reports. The balance is far advanced or ready to be published; all this has been the result of a free action under scientific impulse.

The whole belongs to the Department which has approved and appointed you, and it should not be abandoned and lost without contest or protest. You well know, as every one does, that the value of your work is appreciated by science in Europe as well as, and, perhaps, better still than in America. Your reports have been quoted as an honor to the American Government. How and why should this work of yours be put in other hands, and under a new direction? Even supposing that you should be continued by the War Department at the head of the geological survey of the Territories, I do not believe that you would be able to pursue your plan of work as formerly, and consider that most of the work of these twenty years of explorations and the expense made for it would be lost. Science cannot prosper under military rule. The views and purposes of the military department and of the home department are as different and as forcibly distinct as might be those of mere business matters and of family affairs.

The one has by its explorations to look to practical facts, to lines and curves, to surface modifications, to all that which pertains to the building of railroads, the sectioning of lands, to the roads, to what might be demanded by the casualties of war expeditions, &c.

To this department, of course belongs, then, the direction of the engineer explorations. But the geological surveys, though somewhat depending on good maps, has nothing or very little to do with engineering, and still less with war. On the contrary, its researches, when pursued under military rule, are in constant antagonism with them, even mostly hindered by them, or put aside as useless or troublesome to the far more important work of the engineers. I say this, of course, in considering merely the general inclinations of the explorations of a War Department, or the point of view of the directors. It cannot be modified, and, therefore, true, earnest scientific researches cannot succeed in connection with military explorations, or, as I said, under military rule. Everybody knows this. Why, then, do I say it? Because I want to give expression to an opinion based upon what I know to be true from twenty-five years of American experience; because I want to impress still more upon yourself and your friends the necessity of resisting an attempt to a measure

which would certainly prove adverse to the interest of American science, destructive, indeed, of what is provided and acquired by long years of hard work. We should not retrograde. Your survey, as it has been conducted till now, has everywhere obtained a most honorable record. Let the work go on in the same way to the end. A single year of interruption would cause a loss or disregard of the materials obtained till now, which would be irreparable hereafter for science; and for the Government a loss of money far greater than would cost the continuation of the survey to a satisfactory close.

Yours, very truly,

L. LESQUEREUX.

Prof. F. V. HAYDEN.

No. 17.—*Statement of Lieutenant Wheeler as to the personnel and expense of his last expedition, character of specimens collected, work done, and needs of the Department.*

In order to more fully explain the character of the scientific *personnel* of the late expedition of 1873, the statement herewith will be based upon the number of officers and civilian assistants who served throughout the entire field-season, which shows as clearly as possible the relative proportion of officers and civilians, and their distribution among the different branches of the survey. This includes 4 engineer officers, 2 line officers, 2 medical officers, 1 hospital steward, 3 astronomical assistants, 7 topographical assistants, 3 meteorologists, (engineer soldiers,) 3 geologists, 1 mineralogist, and 2 collectors.

To illustrate the expenditure under the allotment for the fiscal year ending June 30, 1874, we will premise upon the amount already expended from the \$90,000. This amount is \$68,312.90.

The several expenditures making this total are—

1. Civilian assistants, in office and field.....	\$34,001 52
2. Civilian employes, in office and field.....	10,435 89
3. Transportation animals and forage.....	4,358 09
4. Material and incidentals.....	5,700 45
5. Subsistence in the field.....	4,686 39
6. Instruments and repairs.....	3,580 30
7. Contingencies, monuments, and making observations.....	5,550 26
	\$68,312 90

If this expedition had not been accompanied by the geologists, mineralogist, and collectors, there would have been saved from amounts expended for civilians, \$7,824. The increase of expenditures for items 3, 4, 5, and 6 has not exceeded probably 5 per cent., because of the addition of these assistants. This 5 per cent. equals \$1,275, or the saving that would have been made by the withdrawal from this expedition of the geological and natural history assistants would have been \$9,081, or 13 $\frac{2}{3}$ per cent. It is evident that this amount would not have organized and carried out a geological expedition that would have accomplished the same results. At the present time the number of persons engaged upon the survey has been reduced to 3 Engineer officers, 2 medical officers, 1 hospital steward, 2 astronomical assistants, Dr. F. Kampf and Prof. T. H. Safford, late of the Dearborn University, Chicago, Ill., 4 topographical assistants, (all of whom have had valuable field experience,) 3 draughtsmen, (one of whom has been in the service of the Government over twenty years,) 3 geological assistants, G. K. Gilbert, Prof. J. J. Stevenson, and E. E. Howell, 1 mineralogist, Dr. Oscar Loew, a pupil of Liebig.

In natural history there is one assistant, Mr. H. W. Henshaw. The clerical force of the survey consists of three persons. In the volumes, 6 in number, that await the will of Congress upon a small appropriation asked for their publication, there will be reports from the following persons:

Volume 1 will give the reports digested up to date of the several officers engaged upon the work, and of such geological and other assistants as have made examinations in a large number of mining districts visited.

Volume 2 will give the results of observations at the main astronomical stations, and also field-work which has been carried on altogether by the Engineer officers. This will give the geographical positions of fully two hundred principal points.

Volume 3, in preparation by Engineer officers of the survey, will include all the meteorological work, placed in the most condensed form, and illustrated by a variety of plates.

Volume 4 will contain reports of the several geological and mineralogical assistants who have been attached to the survey since its organization.

Volume 5 is to contain reports of certain eminent specialists who are to examine the vertebrate and invertebrate fossils collected by the survey.

Volume 6 will contain, besides the report from medical officers and civilian collectors belonging to the survey, reports from more than twelve eminent specialists upon the collections that have been made. The force in natural history has been very small, but it is be

lieved that the additions to the National Museum have been larger than those of any expedition yet organized under the Government. This I have been informed is the opinion of Professor Baird, of the Smithsonian Institution, given, too, while only a part of our collections had reached the National Museum.

List of specimens of natural history collected in 1873:

- 160 mammals.
- 150 butterflies.
- 500 beetles, about.
- 13 lots diptera or flies.
- 13 lots herniptera or bugs.
- 145 reptiles.
- 12 lots worms, leeches, larva, &c.
- 7 lots ants.
- 32 lots fish, about 500 in number.
- 55 lots shells, land and fresh water.
- 6 human crania.
- 50 lots grasshoppers, 500 in number.
- 24 lots neuroptera or dragon flies.
- 28 lots hymenoptera, bees and wasps.
- 26 lots spiders.
- 1,200 bird skins, skeletons, &c.
- 15,000 plants of 1,500 species.

Collection of ethnological material, bows, arrows, clothing, stone mills, &c.

Of the amount allotted for this year, \$15,000 has been set aside and will be expended in the publication of elaborate maps. Some of them are now completed, others are in the hands of the lithographer, and others in the hands of the draughtsmen, thus leaving \$75,000 spent only in last year's operations upon the survey work proper. It may be noticed that the expedition has consisted of from five to seven topographical or moving field-parties, five astronomical parties, three the entire season, and two others, acting for a part of the time. It operated in four political divisions, covering an aggregate area of 72,500 square miles. Several of the parties were engaged in Arizona and New Mexico, a territory infested by the Apaches, one of the most dangerous of Indian tribes remaining upon the frontier.

The civilian assistants act in complete harmony with the officers of the survey, and retain their places upon their own solicitation. Were they at any time dissatisfied, their term of service would cease. They, each and all, receive individual credit for their labors. They are all energetic and enthusiastic in their work.

An organization as a unit of a force has been proposed, and the grade of work has been finally determined upon.

The co-ordinates of the astronomic, geodetic, and topography of the triangulation with the meander method will hereafter, as it has in the year 1873, be continued in its present stage of excellence.

It may, however, take years to substantiate this plan, which in the most perfect manner applies all that is great and all that is little in science to the cause of geography. There will be continued improvement from year to year in the character of the geological work, because of increased facilities and further experience of the assistants.

The necessity of these geographical labors to the several bureaus of the War Department are numerous, and ramify through all their economic relations. In times of War, the War Department must have prepared and issued creditable accurate and practical maps.

The want of these during the rebellion was repeatedly and thoroughly proven. The delays experienced from the insufficient information prior to the movement of troops to the front was incalculable.

Some of the primal needs to the War Department in time of peace are—

1. For information relating to the safe and speedy transit of troops and supplies.
2. For the establishment of new military posts, to act as a nucleus to advancing emigration.
3. Of the trails leading to and through dangerous Indian country.
4. Of routes leading from one political division to another, for troops called out to sustain civil law.
5. New routes to be followed by regiments in exchanging stations from north to south.
6. For capacities of the surrounding country to furnish local supplies, &c.
7. Of the position of remote mining districts that need military protection or the near approach of organized military forces.

Congress has never limited the War Department to operations purely military, and the necessities of the War Department develop and combine all that is military and all that is civil relating to these surveys. The expense of the survey is founded upon the map, and the information now gathered will more than repay the Government inside of a few years through the War Department in the annual saving made in the cost alone of the transportation of troops and supplies.

The stimulus to the mineral and other industries, resulting from the publication of new and interesting facts and deductions, is entirely additional.

No. 18.—*Letter of General A. A. Humphreys stating publications made at various periods by the War Department.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., May 18, 1874.

SIR: There were sent to your committee on the 13th instant the following reports and maps, giving the results gathered by parties of exploration or survey west of the Mississippi, viz:

Geological Exploration 40th Parallel, Volume III, 4to, pp. 621, 37 plates, 14 maps, and atlas, and Volume V, pp. 525, 40 plates; King.

Memoir accompanying Pacific Railroad Report, 4to, pp. 115; Warren.

Exploration Yellowstone River, 8vo, pp. 174; Reynolds,

Reconnaissance Upper Basin of the Yellowstone, 8vo, pp. 43, Barlow & Heap.

Preliminary report explorations in Nevada and Arizona, 1871, royal 8vo, pp. 96; Wheeler.

Tables of camp distances, 1871 and 1872, royal 8vo, pp. 40 and six tables; Wheeler.

Geographical and geological explorations west of the 100th meridian, in Nevada, Utah, Colorado, New Mexico, and Arizona, 1873, pp. 11, map; Wheeler.

Astronomical operations, geographical and geological explorations and surveys west 100th meridian, in Wyoming and Colorado, 1872 and 1873, 4to, pp. 82; Wheeler.

Reconnaissance in the Ute country, 8vo, pp. 101, map, Ex. Doc.; Ruffner.

Reconnaissance Yukon River, (and map,) 8vo, pp. 115, Ex. Doc.; Raymond.

MAPS.

Territory of the United States west of the Mississippi River.

Military map of the United States.

Dakota Territory.

Nebraska and Dakota.

Kansas and Texas.

Indian Territory; Lieutenant Jackson, Seventh Cavalry.

Indian Territory; Engineer Bureau, War Department.

South and Southeastern Nevada.

Department of the Missouri—sheet 4.

Reconnaissance in the Ute country.

Wagon-road from Texas to Fort Yuma, Colorado.

Missouri and Yellowstone Rivers.

Yellowstone Lake and Valley.

New Mexico.

In addition, the reports and maps enumerated below are sent herewith to complete the list published since the close of the late war, viz:

Report of the exploration of Yellowstone and Missouri Rivers, 1859-'60; 8vo, pp. 174, map; Reynolds. (Hayden.)

Report upon the so-called Yellowstone expedition, 1870, 8vo, pp. 40; Ex. Doc.; Doane.

Report on the Yellowstone expedition, 1873; 8vo, pp. 17; Stanley.

Skeleton map of explorations and surveys; Wheeler.

Attention is respectfully invited to the following parts of the annual report of the Chief of Engineers for the year 1867, page 53; 1868, page 76; 1869, page 67; 1870, page 87; 1871, page 103; 1872, page 100; 1873, page 112.

There are many manuscript and partly engraved maps and reports in an unfinished condition at the offices of—1st, the survey of the 40th parallel, in New York City; and 2d, geographical and geological explorations and surveys west of the 100th meridian, in this city; 3d, also at the headquarters of the following military divisions and departments:

Military Division of the Missouri.

Military Division of the Pacific.

Military Department of the Platte.

Military Department of the Missouri.

Military Department of Dakota.

Military Department of Texas.

Military Department of Arizona.

Military District of New Mexico.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,

Brigadier-General United States Army, Chief of Engineers.

Hon. W. TOWNSEND,

Chairman Committee on Public Lands, House of Representatives.

No. 19.—*Letter of General Humphreys giving cost of Clarence King's volumes.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 3, 1872.

SIR: That part of section 1 of the act of March 3, 1869, authorizing the Secretary of War to have prepared and published a report upon the geological exploration along the belt of country in latitude 40°, and directing that the letter-press work be done at the public printing-office, was carried out so far as relates to the letter-press, by requisitions on the Congressional Printer in the usual form for 2,000 copies of the report, and when volumes 3 and 5 were printed, the usual requisitions for their binding.

The qualities of paper, type, binding, &c., were not indicated in these requisitions nor by any communications from this office.

As usual in the printing of reports, Mr. Clarence King, in charge of the exploration, was placed by me in communication with the printer, to arrange with him such details as to the form and manner of presenting the report as are usual. Mr. King, in his official communication to me upon the printing of the report, requested that it should be done in the same style and quality as the printing of Colonel Williamson's report on the barometer, the paper, &c., of which is good without being expensive.

The quality of paper used was not ordered from this office, either directly or indirectly; nor do I know whether it was suggested by Mr. King or by the printer, but I am confident that the kind of paper used and all other matters relating to the style of the book were authorized by the congressional Committee on Printing.

The engraving and printing of maps and plates is done under this office. The amount thus far expended has been:

For Vol. III and atlas, mining industry, engraving, lithographing, paper, and printing, for 2,050 copies of the volume and atlas.....	\$18,830 60
Cost per copy.....	9 18
For Vol V, Botany, engraving, lithographing, paper and printing for 2,000 copies of the volume.....	4,180 00
Cost per copy.....	2 09
In the cost of engraving, &c., of Vol. V, some of the engraving, &c., of Vol. IV is included.	
The cost per volume for maps and plates, taking Vols. III and V together, is therefore.....	5 63

I cannot say with precision what will be the cost of engraving, paper, and printing of the maps and diagrams for the remaining volumes. They will be very valuable maps, prepared from careful surveys, and will give the topography and geology in detail from the crest of the Sierra Nevada to the crest of the Rocky Mountains, comprising an area 800 miles in length and 100 miles in width. The engraving, paper, and printing for 2,000 copies of these may cost \$30,000; may even exceed that sum. Mr. King is now in California, and I cannot obtain detailed estimates from him in time for this communication. Assuming that \$30,000 will be the cost to complete the engraving, paper, and printing of the maps and diagrams of the report, the whole cost of the maps and plates for the 10,000 volumes will be \$56,000, or \$5.60 per volume.

I do not know what the cost of the paper, printing, and binding of the letter-press may be; it should not exceed \$5 per volume. The binding may indeed be omitted and the cost reduced to perhaps \$3 per volume. The volumes already published may therefore have cost \$10.60 per volume, and the remaining may cost \$8.60 per volume.

It has been stated in Congress that the cost of the volumes already published was \$25 per volume, which, from the preceding statement, it would appear is about double the actual cost.

Very respectfully, your obedient servant,

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

Hon. W. W. BELKNAP,
Secretary of War.

No. 20.—*Letter of Commissary of Subsistence concerning supplies furnished Doctor Hayden.*

OFFICE COMMISSARY-GENERAL OF SUBSISTENCE,
Washington City, May 13, 1874.

SIR: Referring to your letter of the 11th instant, requesting information as to the money value of Army supplies furnished by this Department to Professor Hayden since the year 1866, I have the honor to report that, prior to the issuance of General Order No. 81, of August 13, 1872, sales of subsistence stores to citizens employed with the Army, and to citizens under special authority from the War Department, were entered on the same abstract, and

that inasmuch as all the supplies furnished by officers of this Department to Professor Hayden were paid for at the time of sale, no separate account of the sale was kept. It is, therefore, impossible to furnish the desired statement for years prior to 1873.

In the month of May, 1873, subsistence stores to the value of \$353.33 were sold, for cash, to Professor Hayden, by Capt. A. K. Long, commissary of subsistence United States Army, at Cheyenne Depot, Wyoming Territory.

I have the honor to be, very respectfully, your obedient servant,
A. E. SHIRAS,
Acting Commissary-General of Subsistence.

To the Hon. SECRETARY OF WAR.

No. 21.—*Letter of Lieutenant Wheeler concerning the correction of the longitude of Salt Lake City.*

UNITED STATES ENGINEER OFFICE,
EXPLORATIONS AND SURVEYS WEST OF THE 100TH MERIDIAN,
Washington, D. C., May 22, 1874.

SIR: In order more fully to answer the question of Hon. F. Herndon regarding the authority that first settled upon the correct position of Salt Lake City, Utah, I have the honor to forward herewith the following information, obtained from the archives of the Engineer Department. It assigns most conclusively the credit of that determination to Capt. (now Col.) J. H. Simpson, of the Corps of Engineers.

When the United States Coast Survey were engaged in connecting meridians of that survey between the eastern and western coasts by telegraphic methods, an intervening station was put in by them at Salt Lake City, in Temple Square. This point has been used by our survey in 1871 and 1872.

In 1873 the survey under my charge constructed an observatory at Ogden, Utah. This has been connected with Detroit, Mich., and Salt Lake City, Utah, giving in this manner a check upon the Coast-Survey determination. At an early date another connection will be made between Ogden and Washington direct, and another check introduced.

This is done for the purpose of having one central meridian established with the utmost attainable accuracy, so that all others may be referred to it as a standard.

Very respectfully,

GEO. M. WHEELER,
First Lieut. Corps of Engineers, in charge.

Hon. W. TOWNSEND,
Chairman Committee on Public Lands.

No. 22.—*Letter of Lieutenant Marshall concerning the correction of the longitude of Salt Lake City.*

WASHINGTON, D. C., *May 22, 1874.*

SIR: The following report of Capt. (now Col.) J. H. Simpson, of the Corps of Engineers, in appendix D of his report to the Chief of Topographical Engineers, 1859, will give the desired information with reference to the longitude of Salt Lake City.

On page 2 of that appendix he says:

“In Frémont's second expedition, (1843-'44,) he makes the longitude of the summit of Fremont Island, in Great Salt Lake, west of Greenwich $112^{\circ} 21' 06''$. According to Stansbury's rigid triangulation survey of Great Salt Lake, Salt Lake City, (he does not give the point W. L. N.,) is east of this summit, $25' 09''$. This makes the longitude of Salt Lake City, as derived from Frémont's observations in second expedition, $111^{\circ} 55' 26''$.

“In Frémont's report of this expedition he remarks that ‘in this expedition it became evident that the longitudes established during the campaign of 1842 were collectively thrown too far to the westward.’ He therefore abandons his determination of his first expedition, and assumes as correct those of his second.

“In his third expedition (1845-'46,) he does not compare his longitudes with those of his previous expeditions, but instituting comparison myself, I find the result as follows: In this third expedition he makes one set of observations October 20, 1845, of the moving and moon culminating stars, at the present site of Great Salt Lake City, and determines its longitude to be $112^{\circ} 06' 08''$. That is, he makes the longitude of Salt Lake City, in this expedition, $10' 42''$ greater than in his second, or in other words moves collectively his positions back again *westwardly* $10' 42''$.

“Now our observations of the transit of the moon and moon culminating stars at Camp Floyd, Utah, consisting of five complete sets made during two lunations in the months

of March and April, 1858, give a resulting longitude for this point of $112^{\circ} 08' 07''$. Chronometrically I found Salt Lake east of Camp Floyd, $13^{\circ} 07''$. This gives a resulting longitude for Great Salt Lake City, according to our observations, of $111^{\circ} 55' 00''$, differing from Frémont's in his second expedition only $26''$, and from his determination in his third expedition, $11' 8'$. This result, I think, is corroborative of the accuracy of his longitude as determined in his second expedition, and of our own.

"I have been thus particular in giving the points of difference between Frémont's longitude and my own from the circumstance that they have been hitherto regarded as correct, and succeeding explorers have referred their longitudes to them as standards."

The various determinations of the longitude of Salt Lake City by officers of Topographical Engineers are these:

By Frémont's expedition.....	112° 06' 08'
(This seems to have been adopted.)	
By Frémont's second expedition and Stansbury's triangulation.....	111° 55' 26''
By Captain Simpson, 1859.....	111° 55' 00''

Why Frémont's position, as given by his third expedition, was taken in compiling the engineer map may be explained in the memoir of Lieutenant Warren. The determination of Simpson had not been made at the time the engineer map was compiled by Lieutenant Warren.

The two latter determinations are both much within the limits of the city, and I can see no reason why they are not absolutely correct for the points determined.

The determination by the most accurate method we have, *i. e.*, by telegraph, fixes the Mormon observatory in longitude $111^{\circ} 53' 47''$, which differs from the determination of Simpson, Frémont, and Stansbury by a distance of only a few squares of the city; if reduced to the position of their camps, where their observations were taken, perhaps not at all.

The methods employed by these early expeditions were those which must be employed by a party moving away from telegraphic connections, and compelled to traverse a very long route in a short time, as, for instance, from the Mississippi River to the Pacific Ocean in one season; that is, by chronometric methods, or by lunar distances, or, when a large transit-instrument can be carried, by moon culminations. These methods all give very rough approximations, and are now, as then, only resorted to from necessity.

It may then be said that Frémont, in his second expedition, (1843-'44,) and Captain Simpson, in 1858, were the first to determine with accuracy the position of Salt Lake City, as afterward verified by the Coast Survey.

I am, sir, very respectfully, &c.,

Lieut. G. M. WHEELER,
Corps of Engineers.

W. L. MARSHALL,
First Lieutenant of Engineers.

[Report of the Chief of Engineers for 1872.]

APPENDIX FF.

Letter of Col. J. H. Simpson, Corps of Engineers, relative to certain omissions in reports and maps of explorations.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., April 23, 1872.

GENERAL: Looking over the report just received of Mr. Clarence King, United States Geologist, of his exploration of the fortieth parallel, volume v, Botany, submitted to the Chief of Engineers, and published by order of the Secretary of War, under authority of Congress, I notice that he ignores the fact of the overland stage-road over the Great Basin of Utah having been first opened under the Bureau of Topographical Engineers by me, while chief engineer of the army of Utah in 1859. I also notice that, under the head of the *Cactacea*, by Dr. George Engleman, allusion is frequently made to the collections by his brother, H. Engleman, one of my assistants in that expedition, but not a remark as to my having had charge of the same, which I notice has not been the case with regard to the botanical discoveries made in other expeditions under other officers. I do not know that this was intentional, but the route explored and first opened by General Marcy and myself in 1849, along the South Fork of the Canadian, between Fort Smith and the Rio Grande, reports and maps of which were made by each of us and published by Congress, having been in a like manner ignored, I confess that I have felt hurt by these omissions, and think it due to myself and history that I should thus officially refer to them. Both of these routes were *original* routes, and as in the case of the Canadian route, in 1853, the officer of Topographical Engineers in charge—as I was informed by Captain Jones, Seventh Infantry,

who commanded his escort—made daily use of my reports and maps and actually traveled over the identical track we had provided for him. I have always thought that great injustice was done by him in thus totally ignoring, in his report and maps, all that Marcy and myself had done before him.

So in the case of the route over the Great Basin of Utah. Not a white man had traveled over it before my party did, and as I shortened Frémont's route between Great Salt Lake City and Carson City over two hundred miles, which others had attempted to do and failed, and I look upon it as the greatest feat, under Providence, of my life, I trust you will not regard me as being over-sensitive in what I conceive as an unjust imputation of my services and a disregard to the credit which should be accorded to an officer of the corps in his labors.

For a time my route over the Great Basin of Utah was laid down on the Bureau's map of the territory of the United States, and among the "authorities" given my name was omitted till I drew the attention of the Department to it, when the proper correction was made, *except that the date is still omitted*. It is true that my longitude of Salt Lake City differed so widely from all others (as much, I think, as twelve miles) as, I was informed, to cause this omission; but it seems to me that due credit might have been given me for the route, and the discrepancy referred to have been mentioned in a note. I was, however, made glad by the receipt of a letter from the Bureau when I was stationed in Baltimore, (1868-70, precise date not recollected,) informing me that the Coast Survey, after the most elaborate observations, had found my longitude of Salt Lake City correct, and all others wrong.

I repeat that it is mortifying to be obliged to refer to the above instances of omission of proper credit, but history and facts fully bear me out in all I have stated. I have always taken special pains in all my reports and publications to observe the golden rule, of doing to others as I would they should do to me, and I do not know that a single instance can be pointed out wherein I have claimed or assumed for myself what was due to another.

I am, very respectfully, your obedient servant,

J. H. SIMPSON,
Colonel of Engineers, U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

No. 23.—*Letters of General Humphreys concerning Clarence King's survey under the War Department.*

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., May 23, 1874.

SIR: It has just come to my knowledge that Mr. Gardner made the following statement to the committee: "Mr. King came to Washington, and with the help of numerous friends secured an appropriation for this work. It was a question for some time as to what Department the disbursement of the appropriation should be given. The War Department made certain concessions, among which was a promise that no officer should be placed over him. Under no other condition was this appropriation given to the War Department." So far as this statement has any reference to me, it is absolutely and unqualifiedly unfounded, and I believe it to be equally so in its application to Mr. Stanton, then Secretary of War.

There was no question of placing Mr. King under the orders of an officer, and that gentleman was and is incapable of committing so gross an impropriety as proposing such or any other condition. Certainly such a proposition would have led to an immediate cessation of all intercourse between us. It is impossible that Mr. King could have brought me the letter he did from Colonel Williamson, of the Engineers, and then have acted as Mr. Gardner states.

I returned to duty as an engineer officer in August, 1863, upon being appointed Chief of the Corps of Engineers, and I find, by reference to the records of my office, that it was in the January following that the subject of this geological exploration came up. After a personal interview with the Secretary of War concerning it, I addressed him a letter, a copy of which I inclose, and request you to read.

You will perceive that I felt some delicacy about resuming geographical explorations with funds appropriated during the war for "military surveys," of which we had a large balance on hand, and suggested either an appropriation for the resumption of geographical surveys, (not the geological survey of the fortieth parallel solely,) or an express authority to expend some of the balance mentioned, in that way.

My letter went to the proper committee of Congress, and this authority was granted. See page 457, Statutes at Large, sec. 3, act March 2, 1867. Note, too, the limits of the region upon which it was authorized to be expended. There is no limit north and south. And also note the limits of the region of which particular mention was made by me in my letter to the Secretary of War—limits which are indicated on the accompanying map.

[Statutes at Large, vol. 14, page 457.]

"SEC. 3. *And be it further enacted*, That the Secretary of War is hereby authorized to direct a geological and topographical exploration of the territory between the Rocky Mountains and the Sierra Nevada Mountains, including the route or routes of the Pacific Railroad: *Provided*, That the same can be done out of existing appropriations."

Mr. Gardner further states that this appropriation was given to the War Department under the condition that no officer should be placed over Mr. King. I cannot, of course, undertake to speak for Congress, but it is very certain that no such intimation ever reached me, and I am confident I should have learned something of it had such a condition been even hinted at.

It is certain that under appropriations of Congress the geographical explorations of the War Department were soon resumed, and have been continued to this day.

Very respectfully, your obedient servant,

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

Hon. W. TOWNSEND,
*Chairman Committee on the Public Lands,
House of Representatives.*

ENGINEER DEPARTMENT,
Washington, January 21, 1867.

SIR: In compliance with your direction to report upon the subject of a geological reconnaissance of the belt of United States territory through which is located the route of the Pacific Railroad by way of the Platte River, that is, the portion embraced between latitudes 38° and 43° and longitude 104° and 120°, and what fund, if any, is now available for such reconnaissance, I have to state that there is reason to believe that extensive coal-beds exist in the eastern portion of the region designated, which, of itself, is a sufficient reason for a geological examination of the belt in question, in view of the great scarcity of timber along the route.

The geology of the other portion of the belt is unknown, and its determination cannot fail to prove of material value to the interests of the Government and country. The examination would, moreover, tend to facilitate the development of its mineral resources and hasten its development.

I take this opportunity of inviting your attention to the subject of the renewal of the exploration of the unknown portions of the interior Territories of the United States, which were suspended during the war. There are large tracts in the Territories of Colorado, Utah, Nevada, Idaho, Arizona, and others, remaining unexplored, the examination of which would furnish results of great value in the military and civil operations of the Government.

The only appropriations for surveys intrusted to this Department are those for certain designated localities in connection with river and harbor improvements, and the general one for "surveys for military defenses." This last-mentioned fund has been expended for such reconnaissances as were needed by the immediate wants of military operations in the unexplored regions referred to, but has not been supposed to be applicable to the geographical explorations formerly made, of which geological examinations formed a part.

The yearly expense of making a geological examination of the belt designated in the first part of this communication would be about \$25,000. The work should be completed in two seasons, at a total expense of \$50,000.

I beg leave to recommend that an appropriation of \$50,000 be made for the remainder of the present and for the next fiscal year, to be applied to the general purpose of geographical explorations, (which include the geological examination specified, as well as others,) or that authority be obtained by legislation to expend the appropriation for "surveys of military defenses," in making geographical as well as military explorations of the United States' Territories between the Mississippi River and the Pacific Ocean.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Chief of Engineers.

Hon. E. M. STANTON,
Secretary of War.

No. 24.—*Statement of the personnel of the United States geological and geographical survey of the Territories, with statement of expenditures, Army transportation, &c.*

Personnel of the United States geological and geographical survey of the Territories at present:

F. V. Hayden, United States geologist in charge.
James T. Gardner, geographer.

James Stevenson, quartermaster and chief executive officer.
 Wm. H. Jackson, photographer.
 Wm. H. Holmes, artist and assistant geologist.
 Leo. Lesquereux, paleontologist.
 F. B. Meek, paleontologist.

Divisions.

FIRST DIVISION.

A. R. Marvine, assistant geologist, directing.
 G. R. Bechler, topographer.
 S. B. Ladd, assistant topographer.

SECOND DIVISION.

Henry Gannett, topographer, directing.
 A. C. Peale, assistant geologist.

THIRD DIVISION.

A. D. Wilson, topographer, directing.
 G. B. Chittenden, assistant topographer.
 F. M. Endlich, assistant geologist.
 Franklin Rhoda, computer.

GENERAL ASSISTANTS.

S. C. Jones, general assistant.
 F. D. Jackson, general assistant.

No. 25.—*Approximate statement of expenditures of the United States geological and geographical survey of the Territories for the present fiscal year.*

Scientists in the field and in the office.....	\$31,000
Transportation to and from the field.....	6,000
Provisions.....	5,500
Purchase of animals.....	10,900
Quartermaster equipments.....	3,600
Employés in the field.....	5,500
Instruments.....	2,500
Office-rent.....	2,100
Fuel and gas.....	400
Photographic material.....	2,700
Stationery.....	3,000
Specialists.....	3,000
Freight on collections, &c.....	1,500
Total.....	<u>75,000</u>

Value of property on hand.

Animals.....	\$10,500
Quartermaster stores.....	3,500
Instruments.....	2,500
Office-contents.....	6,000
Photographic material.....	2,500
	<u>25 000</u>

Having had a knowledge of the fact that at all military posts there are great quantities of condemned quartermaster's property, which is always sold to the highest bidder, at far less than its value, because of its uselessness to the Army, I applied to the Secretary of War for permission to obtain some of this property, which I was enabled to make use of on survey, as our marches are necessarily slow and careful. I also applied for permission to purchase such commissary stores as I might need for the use of my party, all of which to a certain extent was granted, under condition that I pay cost prices for the commissary stores, including transportation, and to pay for all loss or deterioration of quartermaster's property obtained. The annexed letter of the Quartermaster-General will show the circumstances and conditions under which such aid has been obtained from the War Department.

F. V. HAYDEN.

QUARTERMASTER-GENERAL'S OFFICE,
Washington, May 3, 1873.

Lieutenant-General SHERIDAN,
Chicago, Illinois :

Doctor Hayden, under authority of the order of the Secretary, as last year, asks that depot Quartermaster at Cheyenne be immediately telegraphed to allow him to have, on *same terms as last year*, army-saddles, pack-harness, tents, and camp equipage of any kind, which are not in condition to be issued as serviceable to the Army, but which his agent may desire as able to serve on the slow marches of the survey; also any mules *which are not fit for Army use, and which would be sold, but which he might be able to get some service out of, and even to recuperate, as was done last year.* This will not interfere with available Army transport, and yet last year this sort of aid saved his appropriation much expenditure, and the account was balanced by his paying the Quartermaster's Department less than three hundred dollars for deterioration, on his returning the property. There is always much about a depot of this character very useful to such an expedition, but which would not serve a military march. I request that you do this.

M. C. MEIGS,
Quartermaster-General.

True copy :

M. I. LUDINGTON,
Quartermaster United States Army.

Appropriations made to the United States geological and geographical survey of the Territories

1869	\$10,000
1870	25,000
1871	40,000
1872	75,000
1872, (engraving, &c.)	10,000
1873	75,000
1873, (engraving, &c.)	20,000
Appropriations Hayden's surveys	255,000

Abstract of the publications of the United States geological survey of the Territories.

ANNUAL REPORTS, (8vo.)

For 1869, on parts of Colorado and New Mexico, pp. 150, of which 99 are on geology, by F. V. Hayden; 30 on mines and mining, by P. Frazer, jr., and 25 on agricultural resources, by Prof. Cyrus Thomas.

For 1870, on Wyoming and parts of contiguous Territories, pp. 511, of which 188 are on geology, by F. V. Hayden; 96 on agricultural resources, by Cyrus Thomas; 177 of short special reports, by F. B. Meek, James T. Hodge, J. S. Newberry, Joseph Leidy, Leo Lesquereux, E. D. Cope, and R. S. Elliot; 30 of catalogues of specimens in natural history, by James Stevenson, S. R. Roberts, G. H. Horn, P. H. Uhler, Thomas C. Porter, and C. C. Parry, and an appendix of 12 pp. devoted to meteorology, by J. W. Beaman, with 22 wood-cut illustrations.

For 1871, on Montana and parts of contiguous Territories, pp. 524, of which 165 are on geology, by F. V. Hayden; 40 on mineralogy, &c., by A. C. Peale; 76 on agricultural resources, by Cyrus Thomas; 98 on paleontology, by Leo Lesquereux, E. D. Cope, Joseph Leidy, and F. B. Meek; 120 on zoology and botany, by Joseph Leidy, G. H. Horn, P. R. Uhler, Cyrus Thomas, W. H. Edwards, E. D. Cope, and Thomas C. Porter, and 25 pp. on meteorology and hypsometry, by J. W. Beaman; contains 72 illustrations.

For 1872, on Montana, Idaho, Wyoming, and Utah, pp. 844, of which 99 are on geology, by F. V. Hayden; 93 on geology, by A. C. Peale; 60 on geology, by F. H. Bradley; 40 on agricultural resources, by Cyrus Thomas; 111 on fossil flora, by Leo Lesquereux; 92 on paleontology, by F. B. Meek; 106 on extinct vertebrata, by E. D. Cope; 10 on archaeology, by Joseph Leidy and Cyrus Thomas; 88 on zoology, by C. H. Merriam, G. H. Horn, Cyrus Thomas, H. Hagan, and A. S. Packard, jr.; 45 on botany, by J. M. Coulter, S. T. Olmy, George Vasey, Leo Lesquereux, Henry Willey, and Charles H. Peck, and 26 on astronomy and hypsometry, by Henry Gannett; contains 68 wood-cuts, 12 plates, and 5 maps.

PAMPHLETS, (8vo.)

Supplement to the Annual Report for 1871, on Fossil Flora, by Leo Lesquereux, pp. 22.
Supplement to the Annual Report for 1871. Synopsis of the Vertebrata of Colorado; by E. D. Cope; pp. 19.

MISCELLANEOUS.

- No. 1. List of Elevations West of the Mississippi, first edition, 1872, pp. 31.
 No. 2. Second edition of above, 1873, pp. 47.
 No. 5. Catalogue of Photographs, 1874, pp. 83.
 No. 4. Synopsis of the Flora of Colorado, 1874, pp. 180.

BULLETINS.

- No. 1. On Paleontology of Colorado, by E. D. Cope, 1874, pp. 28.
 No. 2. 1874; pp. 77, of which 48 are on Paleontology of Cretaceous Period, by E. D. Cope, 4 on Paleontology of Tertiary Period, by E. D. Cope; 20 on Fossil Flora, by Leo Lesquereux; and 5 on the geography of Colorado, by James T. Gardner.

FINAL REPORTS, (4TO.)

- Profile Sketches, 1872, H. W. Elliot, 65 plates.
 Acrididæ of North America, 1873, pp. 258, by Cyrus Thomas.
 Extinct Vertebrate Fauna of the Western Territories, 1873, pp. 358, 37 plates, by Joseph Leidy.

MAPS.

1871. 1. Yellowstone Lake.
 2. Lower Geyser Basin of Firehole River.
 3. Upper Geyser Basin of Firehole River.
 4. Yellowstone National Park.
 (Above by A. Schönborn.)
 5. Parts of Idaho, Montana, and Wyoming Territories. (Preliminary maps for field use.)
 1872. 6. Lower Geyser Basin of Firehole River. (Scale, six inches to the mile.)
 7. Upper Geyser Basin of Firehole River. (Scale as above.)
 8. Henry's Lake, Idaho.
 9. Shoshone Geyser, Basin, and Lake.
 10. Parts of Idaho and Wyoming about the heads of the Snake River. (Scale, five miles to one inch.)
 (Above maps by G. R. Bechler.)
 11. Parts of Montana and Wyoming about the heads of the Yellowstone, Gallatin, and Madison Rivers. (Scale, four miles to one inch.) Drawn by Henry Gannett from field-notes by A. Burck.
 12. Part of Colorado, based on the United States land-survey. 1873. Compiled for field use.

Besides the publications already issued by the survey, there are a number either completed or in an advanced state of preparation, which will probably appear during the coming year.

OCTAVO.

1. The annual report for the season of 1873 is now ready for publication. It will comprise about eight hundred pages of text, with three hundred illustrations, sections, maps, &c.
 2. The meteorological observations for the year 1873, and a third edition of "Lists of Elevations," much enlarged, are now ready for the press.
 3. A volume of about eight hundred pages, 8vo, on the ornithology of the Northwest, is now passing through the press at the Government Printing-Office—400 pages already printed.

QUARTO.

4. The supplements to the volume of profiles and sections, one containing 52 plates of scenery, and the other 37 plates of hot springs, geysers, &c., have been printed by the Albertype process from the photographs.
 5. The Vertebrate Fauna of the Cretaceous Formations of the West. About three hundred pages of text, and 40 plates. The latter are already engraved.
 6. The Fossil Flora of the West. Two volumes ready—60 plates engraved.
 7. Fossil Invertebrata of the Western Territories. Ready for publication—50 plates engraved.

Besides the above there are several volumes in preparation, which will require about two hundred plates. There are also several maps, and many geological sections.

Abstracts of reports of work done under the War Department, showing what portion was done by civilians.

ABSTRACT.

Preliminary report of Lieut. G. M. Wheeler, in charge of explorations west of the 100th meridian.

BY LIEUTENANT G. M. WHEELER.

Outline of movements of parties, pp. 15 to 20.

Statements of what the astronomical report will contain, p. 21

Topographical: plan of work, pp. 21 to 22.

Physico-geographical: A general description of certain areas traversed, pp. 22 to 24.

Meteorological: Plan of work, p. 24.

Natural history, mineralogy, magnetic observations, photography: Merely the general statement that a large amount of work has been done, p. 25.

Means of communication: Merely states in general terms that roads should be built here and there, pp. 25 to 26.

Indians: pp. 27 to 29.

Sites for military posts: A few remarks, p. 29.

Influence of climate: A few remarks, p. 20.

Agricultural and grazing lands: Nothing, p. 31.

Mines: List of questions concerning mines to be answered in the report. Eighty districts are reported on, of which the reports on 15 are by G. K. Gilbert, (civilian,) geologist; 13 by Lieutenant Lyle; 9 by Dr. Hoffman, naturalist and surgeon; 4 by topographical parties, and 1 by Mr. Klett, (civilian,) Lieutenant Wheeler's private secretary.

The rest, presumably, by Lieutenant Wheeler, who disclaims being either a mining engineer or a geologist.

Most of the reports consist of the numbers and names of mines, data concerning the yield, cost, assay, &c., obtained from their owners, or workers, the population, water, timber, accessibility, &c.

In a few cases the geology of the locality and the character of the ore are stated, pp. 32 to 59.

Maps: A list of those to be made, p. 59.

Estimates of expenses for the next year, pp. 60 to 62.

By Lieutenant Lockwood; Itinerary, pp. 62 to 76.

By Lieutenant Lyle: Itinerary, pp. 76 to 90.

By E. P. Austin, (civilian,) astronomer: Statement of the field-work done, pp. 91 to 92.

By G. K. Gilbert, (civilian,) geologist: Purely a statement of what his final report is to contain.

Maps, by Louis Nell, (civilian,) chief topographer: It is, with the exception of the so-called "Mining Report," merely a statement, in the most general terms, of what had been done, or is to be done, without giving a result of any kind, pp. 92 to 96.

There is no scientific work in the book, if we except the maps by Mr. Nell.

(B.)

A statement showing the proportion of the reports of surveys, under charge of military officers, which have been made by civilians:

1. Red River of Louisiana, by Lieutenant Marcy, contains 320 pages; 152 itinerary by officers; 168 (including all the scientific portion) by civilians.

2. Stansbury's report Salt Lake Valley contains 495 pages, 303 itinerary by Stansbury, 192 (including all the scientific portion) by civilians.

3. Sitgreaves's expedition to Zuni and Colorado Rivers contains 198 pages, 29 itinerary by Sitgreaves, 169 (including all the scientific portion) by civilians.

Mexican Boundary Survey, by W. H. Emory, contains 2 vols., 997 pages of text, 258 itinerary by officers, the rest, 739, by civilians, which includes all the scientific matter except the mathematical, which is contained in the 258 pages by the officers.

Volume 1, Pacific Railroad Survey, 12 vols., 13 parts, chiefly by Governor Stevens, contains 651 pages, no scientific matter.

Volume 2 contains 545 pages, 334 itinerary by officers, 211 pages (including all the scientific matter) by civilians.

Volume 3 contains 451 pages, 249 itinerary by officers, 127 chiefly by civilians, (including meteorology,) 175 pages of natural history, all by civilians.

Volume 4 contains 498 pages, 283 itinerary by officers, 210 (including all the scientific portion) by civilians.

Volume 5 contains 455 pages, 57 itinerary by officers, 398 pages (including all the scientific portion) by civilians.

Volume 6 contains 503 pages, 198 itinerary by officers 305 (including all the scientific portion) by civilians.

Volume 7 contains 427 pages, 79 itinerary by officers, 348 pages (including all the scientific portion) by civilians.

Volume 8 contains 750 pages, all by a civilian, (Professor Bain.)

Volume 9 contains 1005 pages, all by Professor Bain.

Volume 10 contains 602 pages, zoology by Baird, Girard, and others.

Volume 11 contains maps, profiles, and sections; in all, except Pope and Stevens' work, the topography, maps, and drawings were made by civilians. Lieutenant Whipple's expedition (the topographical work) was made by A. H. Campbell, with William White, N. H. Hutton, and J. P. Sherburne as assistants.

Gunnison and Beckwith's expedition: R. H. Kern, topographer. Maps made by F. W. Egloffstein.

Williamson's expedition: Isaac William Smith, civil engineer and topographer.

Parke's expedition: A. H. Campbell, topographer; N. H. Hutton, H. Custer, and G. G. Gamer, assistants.

Williamson's expedition, (2d:) H. C. Fillebrown, D. C. Anderson, J. Young, assistant topographers.

Mexican boundary survey: General maps made by Thomas Jekyll, civil engineer under the supervision of Lieutenant Michler.

Volume 12. Part 1st contains 399 pages by Governor Stevens; part 2d contains 475 pages—76 by Governor Stevens, 399 (including all the scientific portion) by civilians.

Total number of pages, 7021; 2446 pages (including the portion by Governor Stevens) itinerary by officers; 4575 pages by civilians, which embraces all the scientific matter except the mathematical. Not a page of geology, paleontology, natural history, &c., by an officer.

There is not, so far as I can find, a single page of natural history, or of any scientific matter, to be found in any of the reports up to the present time by an officer of the Engineer Corps, except what is purely mathematical or meteorological, and in fact much of that has been done by civilians.

Expedition of Col. W. F. Reynolds, 1858-'59.

Topography by Hutton, Fillebrown, and Schonborn.

Meteorology by Warring and Lee.

Natural history by G. H. Trook.

Geology by F. V. Hayden.

Abbot and Humphreys.

"Report on the physics and hydraulics of the Mississippi River," &c., by Capt. A. A. Humphreys and Lieut. H. L. Abbot.

In this work were employed:

Officers from the Engineer Corps.—Capt. A. A. Humphreys, Lieut. H. L. Abbot, Lieut. G. K. Warren, Lieut. H. S. Putnam.

Civilians, (engineers.)—James K. Ford, Joseph Bennett, W. T. Thompson, George F. Fuller, Samuel Hill, G. C. Smith, James O. Rourke, Otto Sackendorff, Joseph Gorlinski, H. C. Fillebrown, W. E. Webster, C. L. Jones, J. T. Champneys, H. A. Patterson, Prof. C. G. Forshey, Wm. S. Smith, Wm. Forshey, Wm. H. Williams, J. J. Conway, A. A. Edington, J. D. Julian, C. A. Fuller, Mr. Vaughn, Mr. Gingny.

Summary:

In this work, which has been regarded as solely the work of the Army engineers, four Army engineers were employed, and twenty-five civilian engineers, seven of whom were in charge of parties.

Statement showing the number of civil engineers employed under the Engineer Department; also the proportion of the engineering work done by them, with their reports, which are included in the report of the Chief of Engineers for the year ending June 30th, 1871. (Report of the Secretary of War, Chief of Engineer's Report, 2d session Forty-second Congress, vol. 2d, 1871-'72:)

Survey of the mouth of the Oconto River, under D. C. Houston, major of Engineers, United States Army. Survey and report made by William F. Casgrain, page 121.

Survey of Two Rivers, Wisconsin, under D. C. Houston, major of Engineers, United States Army. Survey and report by William F. Casgrain, page 123.

Survey of Ahnepee River, Wisconsin, under D. C. Houston, major of Engineers, United States Army. Survey and report by William F. Casgrain, page 125.

Survey of Black River, Michigan, under O. M. Poe, major of Engineers, United States Army. Work and report by H. A. Ulfers, civil engineer assistant, page 177.

Survey of the head of the peninsula at Erie Harbor, Pennsylvania, under Walter McFar-

land, major of Engineers, United States Army. Work and report by Irvin Camp, civil engineer, page 202.

Improvements of the Illinois River, under Lieutenant-Colonel J. H. Wilson. Report and work by Robert E. McMath, civil engineer, assistant in charge, p. 272.

Improvements of the Illinois River, under Col. J. N. Macomb. Work and report by Robert E. McMath, civil engineer, page 274.

Improvements of the Rock Island rapids of the Mississippi River, under local charge of Bvt. Maj. Charles J. Allen, captain Corps of Engineers. Report by E. F. Hoffman, civil engineer assistant, made to Col. J. N. Macomb, page 259.

Preservation of the Falls of Saint Anthony, under Col. John N. Macomb, Corps of Engineers. Work United States Lake Survey, under Charles F. Powell, second lieutenant Engineers. Report of shore party for 1871, by H. Custer, page 998.

Meteorology of United States Lake Survey, by O. B. Wheeler, page 1008.

Report on determination of the constants of the primary base apparatus, used on the United States Lake Survey, by E. B. Wheeler, page 1003.

Report in relation to observatories and reductions for the determination of the difference of longitude between Washington, D. C., and Detroit, Mich., by O. B. Wheeler, page 1014.

Report on the dredging of Lake Superior, by Sidney J. Smith, page 1020.

Geological Exploration of the Fortieth Parallel. Reports by Clarence King, geologist, pages 1027 and 1030.

Survey of the Cumberland River, under G. Weitzel, major of Engineers. Work and report by S. T. Abert, civil engineer, page 469.

Survey of the Wabash River, under G. Weitzel, major of Engineers. Work and report by Fr. Stein, page 486.

Survey of the mouth of Sabine River, Texas, under C. W. Howell, captain of Engineers, U. S. A. Work and report by Gustave Dyes, civil engineer, page 542.

Survey of the channel through Atchafalaya Bay, &c., under C. W. Howell, captain of Engineers, U. S. A. Work and report by Gustave Dyes, civil engineer, page 555.

Survey of Coosa River, under J. H. Simpson, colonel of Engineers, U. S. A. Work and reports by Henry C. Fillebrown, civil engineer, pages 564 and 570.

Survey of Tombigbee River, under J. H. Simpson, colonel of Engineers, U. S. A. Work and reports by Henry C. Fillebrown, civil engineer, pages 574 and 575.

Survey of the harbor of Queenstown, Md., under William P. Craighill, major of engineers; work and reports by William Popp, assistant engineer; page 613.

Survey of the harbor of Cambridge, Md., under William P. Craighill, major of engineers; work and report by William Popp, assistant engineer; page 616.

Survey of the Wicomico River at and below Salisbury, Md., under William P. Craighill, major of engineers, United States Army; work and report by William Popp, assistant engineer; page 622.

Survey of the James River and Kanawha Canal, under William P. Craighill, major of engineers, United States Army; work and reports by William R. Hutton, civil engineer; page 634; and W. G. Turpin, civil engineer, page 650.

Survey of Providence River, Rhode Island, under G. K. Warren, major of engineers, United States Army. Work and report by Nathaniel E. Russell; page 730.

Survey of Pawtucket River, Rhode Island, under G. K. Warren, major of engineers, United States Army. Work and report by Nathaniel Russell, civil engineer. Page 736.

Survey of Pawcatuck River, Connecticut and Rhode Island, under G. K. Warren, major of engineers United States Army. Work and report by John H. Dager, civil engineer. Page 744.

Improvement of the Thames River, Connecticut, under G. K. Warren, major of engineers. Work and report by H. A. Judson, assistant engineer in charge of survey; page 750.

Improvement of the Connecticut River, under G. K. Warren, major of engineers. Work and report by T. G. Ellis, civil engineer; page 763.

Improvement of New Haven Harbor Connecticut, under G. K. Warren, major of engineers. Work and report by G. H. Mann, civil engineer; page 776.

Survey of the Housatonic River below Derby, under G. K. Warren, major of engineers, United States Army. Work and report by W. S. Edwards, civil engineer; page 785.

Improvement of Westport Harbor, Connecticut, under G. K. Warren, major of engineers, United States Army. Work and report by H. M. Babcock, civil engineer; page 802.

Survey of the Peconic River, Long Island, under G. K. Warren, major of engineers. Work and report by Nathaniel Russell, civil engineer. Page 815.

Survey of Narragansett Pier, Rhode Island, under G. K. Warren, major of engineers. Work and report by J. A. Judson, assistant engineer in charge of survey. Page 819.

Survey of Gloucester Harbor, Mass., under J. G. Foster, lieutenant-colonel engineers, Work and report by H. F. Bothfeld, civil assistant. Page 873.

Removal of Blossom Rock, under R. S. Williamson, major of United States engineers. Work and reports by A. W. Von Schmidt. Pages 929 and 937.

Washington Aqueduct Survey, under George W. Elliott. Work and report by Theodore B. Samo, assistant engineer. Page 955. And report and supplementary report, by Franklin Cook, engineer in local charge. Pages 294 and 297.

Survey for a canal route between the Illinois River, near Memphis, and the Mississippi River, near Rock Island, under J. N. Macomb, colonel of engineers, U. S. A. Report by Gorham P. Low, jr., civil engineer, assistant. Page 302.

Survey of Osage River, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers, U. S. A. Work and report by Desmond Fitzgerald. Page 323.

Survey of the Ouachita River, Arkansas, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers, U. S. A. Work and report by Justin Straszer, civil engineer. Page 338.

Survey of the Little Missouri River, in Arkansas, under Lieut. Col. W. F. Reynolds, Corps of Engineers, U. S. A. Work and report by Justin Straszer, civil engineer. Page 347.

Survey of Petit Jean River, Arkansas, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers. Work and report by Justin Straszer, civil engineer. Page 351.

Survey of Cache River, Arkansas, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers. Work and report by Desmond Fitzgerald, civil engineer. Page 354.

Survey of the Saint Francis River, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers. Work and report by H. L. Koons, civil engineer. Page 356.

Survey of Little Red River, Arkansas, under Lieut. Col. W. F. Reynolds, United States Engineers. Work and report by Justin Straszer, civil engineer. Page 362.

Survey of White River, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers, U. S. A. Work and reports by Alonzo Livermore, civil engineer. Page 306. Justin Straszer, civil engineer. Page 370.

Survey of Black River, under W. F. Reynolds, lieutenant-colonel, Corps of Engineers, U. S. A. Work and report by Justin Straszer, civil engineer. Page 374.