ANNUAL REPORT

UPON THE

GEOGRAPHICAL EXPLORATIONS AND SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN, IN CALIFORNIA, NEVADA, UTAH, ARIZONA, COLORADO, NEW MEXICO, WYOMING, AND MONTANA,

BY

GEORGE M. WHEELER,
FIRST LIEUTENANT OF ENGINEERS, U. S. A.;

BEING

APPENDIX FF

OF THE

ANNUAL REPORT OF THE CHIEF OF ENGINEERS FOR 1874.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
18[illegible]

With the Compliments of

Lieut. George M. Wheeler,

Corps of Engineers,

U. S. Army.

ERRATA.

Page 116, second paragraph, for Palaeosyopsos, read Palaeosyops.
Page 116, seventh paragraph, for medium, read median.
Page 118, third paragrapb, for ^{m}.010, read M.010.
Page 118, eighth paragraph, for Ectoganus, read Esthonyx.
Page 123, fifth paragraph, for Hyposyus, read Hipposyus.
Page 123, eighth paragraph, for four molars, read three molars.
Page 124, eighth paragraph, for mandibular series, read preceding species.
Page 125, ninth paragraph, for sectional, read sectorial.
Page 128, seventh paragraph, for normal, read dermal.

ANNUAL REPORT

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[EXTRACT FROM THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR.]

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., October 20, 1874.

* * * * * * *

GEOGRAPHICAL EXPLORATIONS AND SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN IN CALIFORNIA, NEVADA, UTAH, ARIZONA, COLORADO, NEW MEXICO, WYOMING, AND MONTANA.

Officer in charge, First Lieut. George M. Wheeler, Corps of Engineers, having under his orders First Lieuts. R. L. Hoxie, W. L. Marshall, S. E. Tillman, and P. M. Price, Corps of Engineers, Second Lieut. A. H. Russell, Third United States Cavalry, and, during portion of the field-season, Lieuts. H. R. Brinkerhoff and L. H. Walker, Fifteenth United States Infantry, as escort officers, Acting Assistant Surgeons J. T. Rothrock, H. C. Yarrow, and C. G. Newberry, United States Army, who, in addition to their professional duties, were engaged in botanical, ornithological, and natural-history labors.

Active field-operations were in progress at the commencement of the fiscal year, the three main divisions of the expedition having departed from their rendezvous at Salt Lake City, Utah, Denver, Colorado, and Santa Fé, New Mexico, moving south into Arizona, connecting with work of former years, covering during the season an area of about 75,000 square miles, and disbanding at the close of the field-season in November and December.

Following the disbanding a sufficient number of the members to prepare the matured results returned to Washington, where they were engaged during the winter months, and where a small force of draughtsmen and computers are continuously engaged in elaborating the material gathered in the field.

In addition to topographical work proper the survey combines the establishment of numerous points astronomically; (an important feature in relation to many public and private interests;) observations in meteorology and hypsometry; investigations in geology, mineralogy, and natural history; and the gathering of many other facts upon subjects bearing upon the industries and resources of the regions traversed. A mass of useful information and results is thus constantly being accumulated and made available to the Government and the public.

By experience and improvements in methods and instruments, the value of the results is annually enhanced and the cost of the work amply repaid.

Final results in the astronomical and other branches of the work have appeared, and additional will be ready for the press and engravers before the close of the present year.

The expedition for the present field-season is well organized and equipped, and the officer in charge is sanguine of most satisfactory results. The field of operations lies in southern and southwestern Colorado, northern and northwestern New Mexico, and northwestern Arizona. Several primary astronomical stations will be determined in addition to astronomical observations in the field, and the astronomical observatory at Ogden, Utah, will be well advanced toward completion.

Lieutenant Wheeler submits estimates —

For continuing the exploration	$95,000
For engraving and printing the plates and atlas-sheets accompanying the reports of the geographical explorations and surveys west of the 100th meridian	25,000

His annual report and estimates are appended.

(See Appendix FF 1 and FF 2.)

Lieutenant Wheeler has also submitted a report of Prof. E. D. Cope, paleontologist, from his camp, on Galinas Creek, in the Rio Grande basin, including a description of new species of vertebrate fossils, and of an extensive series of deposits of the Eocene age, indicating the existence, in earlier geological time, of an extensive lake of fresh water in that part of New Mexico.

The collections made and to be made by this special party are likely to prove of unusual interest.

(See Appendix FF 3.)

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REPORT.

APPENDIX FF.

ANNUAL REPORT OF LIEUTENANT GEORGE M. WHEELER, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1874.

GEOGRAPHICAL EXPLORATIONS AND SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN, IN CALIFORNIA, NEVADA, UTAH, ARIZONA, COLORADO, NEW MEXICO, WYOMING, AND MONTANA.

Season's operations.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE ONE HUNDREDTH MERIDIAN,
Washington, D. C., June 30, 1874.

GENERAL: I have the honor to submit the following annual report upon geographical explorations and surveys west of the one hundredth meridian, in California, Nevada, Utah, Arizona, Colorado, New Mexico, Wyoming, and Montana for the fiscal year ending June 30, 1874.

Toward the close of the last fiscal year, the expedition of 1873 had taken the field in three separate divisions from Salt Lake City, Utah, Denver, Col., and Santa Fé, N. Mex.

The Salt Lake division, under Lieut. R. L. Hoxie, Corps of Engineers, crossed the Colorado River near the mouth of Paria Creek, emerging upon the mesa to the southward, in the vicinity of El Vado de los Padres; from thence making its way to the southward, joined the southern or main division, operating in the territory in New Mexico and Arizona but little known, lying between the thirty-fifth and the thirty-second parallel after it had completed the duties assigned to it in atlas rectangles 50 and 59.

Each division was accompanied by a small escort. These escorts were (with the exception of one corporal and six men, with Lieutenant Hoxie, detailed from the military department of the Platte, General E. O. C. Ord commanding) drawn from the military department of the Missouri, General John Pope commanding, the larger portion of the latter having been detailed from the military district of New Mexico, Col. J. Irwin Gregg commanding. These escorts were distributed among the several working field-parties, and were in numbers sufficient only for the protection of the lives of the members of the expedition and for guarding the public property. The necessary number of guides, packers, herders, laborers, &c., accompanied the expedition.

The Denver division, or Colorado party, under Lieut. W. L. Marshall, Corps of Engineers, was occupied for the entire season in Colorado, and completed most successfully the duties assigned to it in that field.

Executive reports submitted by Lieutenants Hoxie and Marshall are herewith.

Report of Lieut. R. L. Hoxie, Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF ONE HUNDREDTH MERIDIAN,
Washington, D. C., January 1, 1874.

SIR: I have the honor to submit the following executive report of operations under my charge during the field season of 1873:

The party to which I was assigned as executive officer in charge was organized at Salt Lake City, Utah, and consisted of Gilbert Thompson, topographer; Edwin E. Howell, geologist; William Somers, meteorologist; Alexander Brown, odometer recorder; one cook, one cargadore, and four packers, with an escort of one sergeant and five privates from the military Post of Beaver, Utah.

The party left Salt Lake City on May 30th, and operated, until September 7th, east of the Wahsatch Mountains, in Castle Valley, working its way southward to the Colorado River, over the western part of Castle Valley, the portion of country required to complete atlas sheets Nos. 50, 59, and 67, at that time preparing for publication.

On the 7th of September we crossed the Colorado River and proceeded by way of Oraybe and the Moquis Pueblos to Fort Wingate, N. Mex., whence, after refitting, we proceeded southward, co-operating with the other parties in New Mexico and Arizona Territories, and, returning at the close of the season, disbanded at Fort Wingate on the 25th of November.

During the three months' operations in Utah about fifteen hundred topographical and triangulation stations were occupied, and one thousand and twenty-five miles of meander lines measured, besides which numerous detours were made for the ascent of prominent points as triangulation stations. The latitude and departure of camp was computed each night, the meander lines of the day plotted, and the principal topographical features drawn upon the field-map. Sextant observations for latitude upon north and south stars, and observations on Polaris for magnetic declination, were taken at each camp. The meridian of Provo was connected with that of the observatory at Salt Lake City, time-signals having been sent over the wires of the Deseret Company, freely tendered to the expedition by the courteous action of D. Milton Musser, superintendent.

The cistern and aneroid barometers, with the psychrometer, were read at regular intervals in camp and at all points that would serve to indicate the relief of the country.

About six thousand square miles of a very difficult mountain and cañon country was mapped here.

The accuracy of the work depends upon the triangulation and the latitude-checks. The former was entirely upon natural objects, the peaks of the Wahsatch range, the Henry Mountains, Navajo, and prominent mesas, and made with the gradienta by Mr. Thompson, who has shown more than ordinary skill and energy in performing rapid and accurate work. We derived much assistance from Mr. Howell, whose investigations in geology were necessarily carried on in intimate connection with the topography.

The sextant observations were made entirely by myself, and the average probable error of the results is about ten seconds of arc.

More time was taken in this part of our field of operations than allowed by your instructions, but this was necessitated by the obstacles encountered. In the month of June we found the high passes of the Wahsatch Range blockaded with snow and mud, and the streams on the eastern slope were swift, cold, and deep, causing serious detentions.

Later in the season we had worked our way southward into the cañon country, in which progress was necessarily slow, and a scarcity of grass and water added to the difficulty of traversing the country. At this time two of my packers deserted with thirty-two mules, and caused a further delay of about twenty days. The time was usefully employed, however. The full working force kept the field as usual, and although I had not intended to give the time here, the work done in consequence could not well have been dispensed with. The recovery of the mules, with the men who ran them off, cost me a chase of four hundred miles, the return being accomplished in two hundred more, over the wildest part of a difficult country.

We encountered considerable hardship during this part of our season's work, being frequently without good water, and sometimes without any. At one time we subsisted for seven days upon hard corn, brought along for the mules, and taken from them when they could ill spare it.

It was not possible to sacrifice close work to the pressure of time, as the devious track which covered so much ground was forced upon us by the difficult nature of the country.

A portion of the results of this part of the season's work are already published in Atlas sheets Nos. 50 and 59, and Mr. Howell will report upon the geology and mineralogy of the country so far as observed by him.

From the crossing of the Colorado to Fort Wingate, the most direct route was taken and no attempt was made to map the country through which we passed. The trail was carefully meandered, however, the topography adjacent sketched in, and frequent bearings taken as checks upon prominent points, with the usual latitude-checks for the camps and the observations with cistern barometer, aneroid, and psychrometer. The primiary object here was celerity of motion, the survey recommencing at Fort Wingate. The length of measured meander line was about two hundred miles.

Soon after leaving Fort Wingate Mr. Thompson was detached by your order, with a small party, to carry a system of triangles over the ground covered by my own and the other parties then operating together in New Mexico. This work was successfully accomplished. Base lines were measured at Fort Tulerosa and Fort Bayard, and others located to be measured next season.

The work of my own party in this section of the country was conducted in the same manner as in Castle Valley during the earlier part of the season; but, having much more favorable conditions, better results were obtained.

About five thousand square miles were covered along the Atlantic and Pacific divide, in the section of country embraced in Atlas sheets Nos. 76, 83, 77, and 84.

This has been mapped and is ready to be transferred to the Atlas sheets.

Detailed reports of the geology and mineralogy of the region traversed will be submitted by Mr. Howell and Dr. Oscar Loew.

Very respectfully, your obedient servant,

R. L. HOXIE,
Lieut. of Engineers, U. S. A.

Lieut. GEO. M. WHEELER,
Corps of Engineers, U. S. A.

Report of Lieut. W. L. Marshall, Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE ONE HUNDREDTH MERIDIAN,
Washington, D. C., June 30, 1874.

SIR: I have the honor to submit the following executive report of the operations of the Colorado party of the expedition for explorations and surveys west of the one hundredth meridian, during the field season of 1873.

In accordance with the annual project, approved by the Secretary of War and Chief of Engineers, and pursuant to instructions from you, I organized the party at Denver, Colo., about June 1, 1873. Its *personnel* was as follows: First Lieut. W. L. Marshall, United States Engineers, executive officer and astronomer; Dr. J. T. Rothrock, acting assistant surgeon, United States Army, surgeon and naturalist; Prof. J. J. Stevenson, geologist; J. J. Young, topographer; Edgar Schroeder, assistant topographer; Prof. John Wolf, collector in botany; Bernard Gilpin, meteorologist, and a small escort of enlisted men from the Fifth Infantry. Including packers and employés the party numbered forty-two men. Later in the season we were joined by Mr. Louis Nell, chief of triangulation. Pending the organization of the main party, on the 8th day of June a small topographical party was sent out to define the bases of the mountains, or "hogsbacks," from the mouth of the Platte Cañon to Golden City, with orders to join the main party at Georgetown, Colo., on the 16th.

On the 17th of June, having received at Georgetown the necessary supplies, I sent the main party, under Dr. Rothrock, to encamp near Fair Play, in South Park, to allow the collectors in natural history an opportunity to make full collections in the several branches in that vicinity, and to establish a meteorological station at the permanent camp. My small party retraced their course to Idaho Springs, visited the mines at Central City and Black Hawk; thence, by way of Chicago Lake and Mount Evans, to Georgetown, making the necessary topographical stations. On June 22 the Atlantic and Pacific divide was crossed at the Argentine Pass, and from this date to July 4 the party worked about the heads of the Blue and Platte Rivers, in the cross range between Middle and South Parks, and in the Blue River range, making the ascent of Lincoln Peak and such other stations as were necessary to give a knowledge of the topography of this region.

Leaving the collecting party at Fair Play with orders to move camp to Twin Lakes, on the west side of the Upper Arkansas River, by August 1, the field party proceeded to survey the mountain-ridges bounding South Park, examined the country about the heads of the North Fork of the South Platte; the Kenosha range from Mount Evans to the Platte and Arkansas divide; this divide from the southeastern limit of South Park to the head of the South Fork of the South Platte River, meandering en route the principal roads and streams, and making the necessary stations upon mountain-peaks to check by triangulation the principal points of the survey. Wet Mountain Valley was visited, and the Arkansas River traced from near Cañon City to Granite C. H., at which place we arrived August 1, 1873.

During this interval, July 5 to August 1, Mr. Schroeder was employed with a small topographical party in collecting topographical data and in meandering roads and streams in South Park not traced upon the plats of the General Land-Office, and not visited by my own party.

From the non-arrival of supplies forwarded by the Quartermaster's Department from Cheyenne, a delay of several days was necessitated, which interval was spent in the immediate vicinity of Twin Lakes in collecting topographical details. A base was measured and an accurate trigonometric survey of the lakes made, and the topographical features relatively located from it. Two lines of soundings across either lake were made at the request of Prof. Stevenson.

On the 6th of August, having purchased the necessary supplies, the geologist and topographer were sent to visit the mines at Oro City, Colo., and McNutty gulches, and Homestrike Mountain, and to examine the country about Ten-Mile Creek, one of the tributaries of the Blue River; the western slope of the Blue River range; to meander Eagle River and its main branches, and to define the northern limit of the main or Saguache range west of the Arkansas River.

This party having accomplished its object, returned to the permanent camp at Twin Lakes on August 18. On the following day, still leaving the collecting party at Twin Lakes with facilities to extend the field of their investigation wheresoever they pleased, two topographical parties were dispatched—Mr. Schroeder, assistant topographer, to collect topographical data and meander the streams flowing into the Arkansas north of Lake Creek; to fix the water-shed and locate the heads of the middle branch of the Roaring Fork of the Grand River; while my own party crossed the divide at the head of Lake Creek, and from August 19th to September 3rd were engaged about the heads of the Gunnison River, and the southern tributaries of the Roaring Fork of the Grand River stations were made upon prominent peaks in the Elk Mountains, and also in the Saguache range at the heads of Chalk and Cottonwood Creeks, and the cañon of Taylor River traced to the junction of this stream with East River.

On the 3d of September the party was joined by Mr. Nell, chief of triangulation, from Fort Wingate, N. M.

On September 5th, he was sent with orders to make triangulation-stations near the junction of the Eagle and Grand, at the northern extremity of the Saguache range, in the Blue River range, upon Gray's Peak and Mount Evans, connecting the former with the astronomical point at Georgetown; thence to proceed by the shortest road to Pike's Peak, which point had been located from a base measured near the astronomical station at Colorado Springs by Dr Kampf, making secondary stations *en route;* thence *via* the southern rim of South Park and the Platte and Arkansas divide to South Arkansas Creek, and thence to Fort Garland, making the necessary stations to give a connected system of triangles from the northern to the southern limit of our survey, from which points those occupied by Messrs. Young and Schroeder could be fixed. These orders were carried out by Mr. Nell, except that he was prevented by snow from actually occupying one of the main stations near the head of the South Arkansas, suggested to him. This point, though quite accurately fixed in longitude and latitude, must be occupied the coming season.

From September 5 to October 10 two parties were continuously employed in completing the survey of the drainage-areas of the upper Arkansas, and that part of the area drained by the Gunnison River which lies east of the one hundred and seventh meridian. From the 10th of October to November 4 a line-survey was run up the valley of the Rio Grande River to the San Juan mining district, but snow, which fell to the depth of 13 inches on the 15th, 16th, and 17th of October, prevented any further work in this region at high altitudes and effectually prevented any main stations on mountain-peaks. The Las Animas River was headed, and a line run down this stream connecting with Mr. Nell's trail from Fort Wingate, thence *via* the Pagosa Hot Springs, Tierra Amarilla, and the head of the east branch of the Chama, and the San Antonio River to Fort Garland.

The streams tributary to the Rio Grande from the west and its main South Fork had meanwhile been meandered by a small party. The Sangre de Christo range south of Fort Garland as far as the New Mexican line was also surveyed by Mr. Young. The interval from November 4 to November 14 was employed by Mr. Nell in measuring a base near Fort Garland and expanding it to his triangulation-stations.

A small party under the direction of Dr. Rothrock was dispatched on November 9 to Denver *via* Wet Mountain Valley, the Hardscrable Mines at Rosita, the Coal Mines at Cañon City, Colorado Springs, and mouth of Platte Cañon, to define the limits of the foot-hills and meander certain roads and streams. This party arrived at Denver December 4th, 1873. The measurement of the base and the local triangulation about Fort Garland having been completed, the escort returned to its station and the supernumerary employés were discharged. My party left Fort Garland November 14, and proceeded, *via* the Aheyta Pass, to the east of the Sangre de Cristo range, headed the Cucharas, the Apishpa, the Purgatoire, and the North Fork of the Canadian River, made a triangulation station upon the Greenhorn Mountain; then proceeded *via* Mace's Hole, Red Creek, Cañon City, Oil Creek, the Cañon of the South Platte, North Fork of the South Platte, and Turkey Creek, to Denver, making the necessary topographical stations *en route*, and, with the lines already run by Messrs. Nell and Young, completing the survey of the foot-hills. On the 10th day of December the parties were disbanded at Denver, Colorado.

METHODS OF SURVEY.

The two peaks, Gray's and Pike's, were located from the astronomical stations at Georgetown and Colorado Springs, C. T., and the computed length and azimuth of the line connecting them were used as a base for our triangulation.

During the season thirty-six peaks, over 13,000 feet in height, were occupied, and many others of less altitude, which were fixed by triangulation processes. At the main points, the angles, repeated, were read from an instrument made by Stackpole, 8″ circle, graduated to read by vernier to 10″ of arc. At other important points a gradienta was employed. In addition to the mountain-work, nearly five thousand miles of roads and streams were meandered; the angles being read from a Casella theodolite and the distances measured by an odometer, checked by angles to fixed points, and by sextant observations made by myself for latitude. The area covered is nearly twenty-one thousand square miles.

METEOROLOGY AND HYPSOMETRY.

At all camps cistern-barometer readings were taken tri-daily when the camps were for an entire day or more, and at 7 a. m. and 9 p. m. when *en route*.

The altitudes of mountain stations were determined by cistern-barometer observations, referred either to our main camps or to the astronomical hourly stations, and by vertical angles from barometric and trigonometric bases.

At topographical stations along roads and streams aneroid readings were taken. The profiles of nineteen passes, eleven over the Atlantic and Pacific divide, and eight over subordinate ranges, were taken, and the slopes of many beds of streams near their heads determined.

GEOLOGY.

Prof. J. J. Stevenson, of New York, accompanied the party as geologist, and his report, already submitted, attests the ability and zeal with which he worked in spite of the necessarily limited facilities that could be afforded.

NATURAL HISTORY.

Dr. J. T. Rothrock and assistant John Wolfe were offered every facility and aid in my power in making collections in natural history, and the results, especially in botany, have probably never been equaled by any exploring or surveying expedition to the West. Nearly 12,000 specimens of plants from over 1,100 different species, and large collections in other branches of natural history, were gathered by these gentlemen, and are now being worked up.

To these and the other gentlemen of the party, for their efficient aid and exertions during the field-season, I desire to return my thanks.

Respectfully submitted.

W. L. MARSHALL,
First Lieutenant of Engineers.

Lieut. GEO. M. WHEELER,
Corps of Engineers, in charge.

The division moving out from Santa Fé accomplished during the season, with the assistance of the Salt Lake division, the survey of 11,000 square miles in the Territory of New Mexico, and 17,500 in Arizona, in a region possessed of remarkably interesting topographical features. The total area surveyed during the entire season was, approximately, 72,500 square miles. The degree of accuracy of the survey was considerably in advance of that of former years. The connecting station for astronomical signals of the main parties was at the Mormon observatory, Salt Lake City, until late in September, when it was transferred to the observatory constructed under the auspices of the survey, at Ogden, Utah. Several astronomical parties were remarkably fortunate in carrying out their observations at all points selected, which were twelve in number, making it notably an astronomical campaign of a single season, marked by the most successful results. The parties are again about to take the field to continue their labors in southern and southwestern Colorado, northern and northwestern New Mexico, and northwestern Arizona. The geographical area to be occupied is represented by Atlas rectangle No. 69, southwestern quarter of No. 61, western half of No. 70, and portions of No. 68. The equipments and preparations, notwithstanding the late date of commencing the latter, are better than ever before, and the addition of a few new members to the organization has established for each of the parties an efficient *personnel.*

The number of applications by young men, graduates of the several scientific schools of the country, besides gentlemen of professional note, has been much greater than heretofore, and it is believed will increase from year to year.

The following officers and civilian assistants have been connected with the survey during the season or portions thereof: First Lieut. R. L. Hoxie, Corps of Engineers, in charge of main field party No. 2, until the close of field operations; since that time in charge of the meteorological branch of office; Lieut. Wm. L. Marshall, Corps of Engineers, in charge of main field party No. 3, and of astronomical work in the office, and since March 24 in charge of topographical branch; Lieut. S. E. Tillman, Corps of Engineers, reported for duty upon the survey on the 29th of August, and from that date until the close of field operations was in charge of main party No. 1, and of topographical branch of the office until March 24, when he was relieved and ordered for duty upon the observations for the transit of Venus; Lieut. Philip M. Price, Corps of Engineers, reported for duty on the 27th of June, 1874. Second Lieut. A. H. Russell, Third United States Cavalry, was connected with the work during the year until February 4, 1874, as acting assistant quartermaster, assistant commissary subsistence, and ordnance officer to the expedition. In addition to these duties he was in charge of a portion of main field party No. 1, during field operations, and afterward employed in the settlement of his accounts and reduction of his topographical work, until relieved. Lieut. H. R. Brinkerhoff, 15th United States Infantry, was detailed as escort officer to the expedition, in which capacity he served until July 5, 1873, when he was relieved by Second Lieut. L. H. Walker, Fifteenth United States Infantry, who in addition had charge of a small party in its operations from Fort Wingate to Fort Tulerosa, New Mexico, until close of field operations.

Acting Assistant Surgeon J. T. Rothrock, United States Army, was on duty with the survey during the entire season; Acting Assistant Surgeon H. C. Yarrow, United States Army, from January 31, 1874, and on the 3d of February was assigned to the charge of the natural-history branch of the survey, in addition to his other duties. Acting Assistant Surgeon C. G. Newberry, United States Army, reported for duty on the 7th ot May, 1873, in compliance with instructions of the Surgeon General United States Army, and continued with the work until January 31, 1874, when he was relieved and his contract annulled.

Hospital Steward Theodore V. Brown has been on duty with the survey during the entire year until May 1st, when he was granted furlough for three months, with permission to go beyond the sea.

In the astronomical branch of the survey Civilian Assistants Dr. F. Kampf, William W. Marryatt, J. H. Clark, Professor S. H. Safford, and

Professor H. B. Herr have been engaged—Dr. Kampf during the entire year; Mr. Marryatt from July 1, 1873, to October 8, 1873, when his death occurred, at Bozeman, Montana; Mr. Clark from July 1 to April 1, 1874; Professor Safford for seven months; Professor Herr until August 25, 1873.

Assistants Louis Nell, Gilbert Thompson, J. J. Young, E. J. Sommer, Max E. Schmidt, R. J. Ainsworth, and, at times, Francis Klett and Edgar Schroeder have, under direction of the officers in charge, conducted field topographical work, and during the winter have been engaged in the reduction of their notes and plottings.

Assistant F. M. Lee has been employed during the entire year in the reduction of barometrical observations taken by the several parties.

In the reduction and presentation of topography Messrs. Weyss and Herman have been engaged during the whole year, and Messrs. Lang, Philp, and Aquirre a portion thereof.

In the natural-history branch Assistants H. W. Henshaw, George M. Keasby, and John Wolf were employed in making collections in the field, and Mr. Henshaw, during the winter, classified and arranged specimens collected.

Mr. T. H. O'Sullivan, photographer, secured forty-two landscape views and one hundred and four stereoscopic views, a portion of which will be published.

Mr. A. H. Wyant, artist, traveled with the photographic party, and made studies of some scenes in the Cañon de Chelle, one of which he proposes to put on canvas when his health will permit.

Assistants G. K. Gilbert, Prof. John J. Stevenson, E. E. Howell, and Oscar Loew were employed during the year in geological researches in the field, and compilation of results during the winter. Dr. Loew has made many interesting analyses regarding minerals, soils, &c. In the general duties pertaining to the work, both in the field and the office, I have been ably and faithfully assisted by Assistants W. D. Wheeler and J. B. Minick. I have again the agreeable duty of reporting the courtesies extended to the survey by the officers of the Western Union Telegraph Company, and the use of wires of that company over lines extending from Salt Lake City westward to Virginia City, Nev., eastward to Cheyenne, and thence southward to Santa Fé; and northward from Ogden, Utah, to Helena, Mont. Mr. Hibbard, the superintendent at Salt Lake City, made, with commendable zeal, all the arrangements necessary to carry out this extended programme, in which he was seconded by Mr. Woodward, manager at Denver, Colo.; as likewise the operators at Cheyenne, and at all the points from whence signals were sent and received.

The Atlantic and Pacific Telegraph Company extended also the free use of their lines. Messages for longitudinal difference were also sent over the lines of the Deseret Telegraph Company from Richfield, Utah, by Lieutenant Hoxie. Mr. Thomas Largey afforded the use of his lines from Helena to Bozeman, Mont., at reduced rates. We were thereby enabled to fix the geographical position of this important point agreeably to the wishes of Bvt. Maj. Gen. E. O. C. Ord, commanding the Department of the Platte, it being one of the extremities of the routes surveyed by Capt. William A. Jones, Corps of Engineers, from the Union Pacific Railroad to the head-waters of the Yellowstone, and beyond. Longitude connection was made between the observatory at Ogden, Utah, and that of the United States lake survey at Detroit, Mich.; Maj. C. B. Comstock, Corps of Engineers, detailing at the Detroit end of the line Assistant O. B. Wheeler for that purpose.

The officers of the United States Naval Observatory have, as heretofore, extended kind assistance to the survey.

The only casualty to be noted during the year has been the death, from fever, of Astronomical Assistant Wm. W. Maryatt, while engaged in carrying on his observations at Bozeman, Mont. This was one of the last stations to have been occupied by him during the season. He had gone forward, after having been very successful at the other stations, and was stricken down soon after reaching Bozeman, and, after a short and severe illness, died at that point. The survey lost a most valuable assistant, and the profession of astronomy an accurate, faithful, and zealous worker.

ASTRONOMICAL BRANCH.

The classes of astronomical work conducted by the survey have been of two distinct grades:

1st. Those at the main or primary station, where, by the most refined methods and use of the best class of instruments, the astronomical co-ordinates are determined with the utmost accuracy, and the meridian line of the point carefully established.

2d. At positions in the field, where, in order to carry out the scheme of survey, sextant latitude checks are required, and at other points where, the telegraph being accessible, the meridian is determined by comparing local times, the watch-errors having been obtained by sextant observations. The latter class of stations are more or less numerous, in accordance with the character of the area surveyed, and of the points within the same whose position can only well be determined by this means.

The others are at specifically-selected points near the fields of survey, and from which, measured and developed, bases controlling the triangulation can easily be laid out.

The main or primary points occupied during the season of 1873 were:

1. Georgetown, Colo.
2. Hughes, Colo.
3. Colorado Springs, Colo.
4. Labran, near Cañon City, Colo.
5. Trinidad, Colo.
6. Ogden, Utah.
7. Green River, Wyo.
8. Winnemucca, Nev.
9. Virginia City, Nev.
10. Bozeman, Mont.
11. Santa Fé, N. Mex.
12. Fort Union, N. Mex.

OBSERVATORY AT OGDEN.

A substantial observatory, of three rooms, with brick superstructure and stone foundations, has been built at this point. The walls are completed, but the dome and the middle observing-room are yet unfinished.

The co-ordinates of this position, as referred to the meridian established by the United States Coast Survey at Salt Lake City, and that of the United States Lake Survey at Detroit, Mich., have been determined. In the season of 1874 it is intended to exchange signals with the United States Naval Observatory at Washington, and resulting therefrom another check will be introduced. The several results will be discussed in the astronomical volume. The meridian of Ogden will then be assumed as the standard of reference for the future astronomical positions determined by the survey.

There are submitted results from the reports upon the determinations of the astronomical co-ordinates of the following main or primary stations: 1. Carlin, Nev.; 2. Battle Mountain, Nev.; 3. Austin, Nev.; 4. Saint George, Utah; 5. Fort Whipple, Ariz.; 6. Fort Fred Steele, Wyo.; 7. Laramie, Wyo.; deduced from observations made during the years 1871 and 1872.

CARLIN, NEVADA.

Geographical position—longitude, 116° 7′ 20.6″, latitude, 40° 42′ 26.67″

The astronomical station is situated west-northwest from Carlin, Nev., 344 feet from the track of the Central Pacific Railroad, and 1,406 feet from the Humboldt River, which is due south, and 550 feet from the railroad-bridge over a small creek entering the Humboldt from the south. The town has nearly 2,000 inhabitants, and is mainly located from east to west along the railroad-track.

Physical geography details.—The ground around the station is level to the east and west; at a distance of 2,000 feet south and north a gentle rise commences. At a distance of two or three miles some slight hills, not more than 500 to 800 feet above the station, are visible. The elevation of the monument above the level of the sea is determined approximately to be 5,000 feet.

Meteorological conditions.—No meteorological observations of a general or special kind were made during the time of observations. As far as can be seen from the diary of the observer, there was a great diurnal change of temperature, by which the rate of the chronometer was much affected.

Description of observatory.—The observations were taken in a common wall-tent, 10 by 10 feet, with an opening for the meridian line. The telegraphic instruments were placed in the northeast corner. The wires of the Western Union Telegraph Company were used for exchange of signals. The observer had no assistance but, Carlin being the starting-point for all parties, Mr. Francis Klett acted as recorder during the time he was present.

Description of instruments.—The astronomical instrument was a combined transit, made by Würdemann, numbered 16. It was of 26 inches focal length and 1⅓ inches aperture, and mounted on four pieces of redwood scantling 4 by 4 inches, which were planted in the ground about 4 feet, and fastened together above by board cross-pieces. For telegraphing, a switch-board was used, a description of which will be found in the report on Colorado Springs, Col. The observations were taken by eye and ear, using the sideral chronometer Negus 1344; for the exchange of signals, mean solar chronometer Hutton No. 288 was always used.

Points with which connections were made were with the United States Lake-Survey Observatory at Detroit, Mich., and the United States Naval Observatory at Washington, D. C.—Detroit receiving the signals sent from Carlin and Washington. Signals were sent on May 19, 23, and 24, 1871. Carlin was occupied by E. P. Austin; the observations at Detroit were conducted by Mr. O. B. Wheeler, assistant, United States Lake-Survey; at Washington, by Prof. John R. Eastman, United States Naval Observatory. The computations relating to Carlin and also the arrangement of the report were made by Dr. F. Kampf.

Instrumental values, &c.—The value of one division of the striding-level was 1.14″; the value of one division of the zenith-level was 2.70″; of one revolution of the micrometer screw, 80.86″. The wires of the

Western Union Telegraph Company were brought into the tent by a loop. By means of automatic repeaters the signals were sent to the connected stations—the repeaters being placed at Corinne, Cheyenne, Omaha, Chicago, Pittsburgh, and Philadelphia.

In relation to the personal equation, I have to state that, as far as it is known in this office, this value for the relative error of the observers has not been determined. Mr. Austin was in Washington in the spring of 1873 for this purpose, but no satisfactory results were obtained. The resulting longitude is therefore affected by this relative error.

OBSERVATIONS TO DETERMINE THE CLOCK-CORRECTION AT THE UNITED STATES NAVAL OBSERVATORY.

The instrument used in these observations is that known as the "meridian transit," which has been employed at the Observatory for many years, and is now situated in the east wing of the building. The description of this instrument may be found in the "Washington Astronomical and Meteorological Observations" for 1862.

The transit was employed in 1871, under the direction of Prof. M. Yarnall, United States Navy, in observing stars for the "General Catalogue;" and, as the observations for time used in the longitude work were made after the regular work with the instrument was finished for the night, the same observations for collimation were employed in reducing the time-stars as were used in the reduction of the regular work.

The system of transit-threads in this instrument is composed of five groups or sets. When the clamp end of the axis is east, the set which is first reached by a star in its transit at the upper culmination is known as set A, and the others as sets B, C, D, and E.

During the early part of 1871 the equatorial interval between each thread in the five sets and the mean of B, C, and D was found to be as follows:

Thread.	Interval.	Thread.	Interval.	Thread.	Interval.	Thread.	Interval.	Thread.	Interval.
	s.		*s.*		*s.*		*s.*		*s.*
A_1	37.897	....	....	C_1	3.183	D_1	15.146	E_1	30.003
A_2	35.972	....	....	C_2	1.654	D_2	17.589	E_2	32.647
A_3	34.308	B_1	19.216	C_3	0.014	D_3	19.110	E_3	34.153
A_4	32.745	B_2	17.563	C_4	1.639	....	....	E_4	35.820
A_5	30.205	B_3	15.069	C_5	3.221	....	....	E_5	37.693

The reduction for C^3 is $+ 0^s.014$ when the clamp end of the axis is east. The clock used is that known as the "mural clock," and is mounted against a stone pier in the transit-room. It is connected with the chronograph in the usual way, and closes the circuit at each second, except at the sixtieth second of each minute, when a small ivory lever on the axis of the escapement-wheel raises a very delicate spring, which forms a portion of the circuit, and prevents the closing of the circuit at that instant.

The observations of all except circumpolar stars were recorded in the usual manner by the chronograph, which is described in the annual volume for 1862.

In the reductions, whenever a broken set of observations occurred, each thread was reduced separately.

Instrumental corrections.—The corrections to the observed transit of a star were derived from the observed and computed errors c', n', and m'.

The error of collimation is represented by c'; the equatorial value of the distance between the line of collimation and the true meridian at the pole, by n'; and the distance between the line of collimation and the true meridian at the equator, by m'.

The quantities represented by n' and m' are used instead of errors of azimuth and level.

By means of a collimating eye-piece, the error of collimation and level was determined by reversing the instrument over a basin of mercury, and measuring with the right-ascension micrometer the distance between the central thread (c_3) and its image reflected from the mercury.

Denoting by—

c, n, and m the corrections obtained from the observed and computed errors c', n', and m';

$2\,\Delta$, the distance of the central thread *west* of its image when the clamp-end of the axis is east;

$2\,\Delta'$, the distance of the central thread west of its image when the clamp end of the axis is *west;*

p, the correction for the excess of the radius of the clamp-pivot$=0^s.008$;

r, the equatorial distance of the middle thread from the mean of sets B, C, and D$=0^s.014$;

a, the correction for diurnal aberration$=0^s.016$;

b, the level-correction;

α, the adopted place of the star;

α', the observed place of the star;

δ, the declination of the star;

φ, the latitude of the observing-station;

C', the approximate clock-correction; and

C, the clock-correction derived from the observation of each star—

and we have the following formulas, which have been employed in reducing the observations for time:

n was determined from the observations of circumpolar stars.

The quantities Δ and Δ' are given in revolutions of the micrometer-head, each revolution $=1^s.5865$.

$$c=\tfrac{1}{2}(\Delta-\Delta')-p-r-a \text{ for clamp east.}$$

$$c=-\tfrac{1}{2}(\Delta-\Delta')+p+r-a \text{ for clamp west.}$$

$$b=-\tfrac{1}{2}(\Delta+\Delta')-p \text{ for clamp east.}$$

$$b=-\tfrac{1}{2}(\Delta+\Delta')+p \text{ for clamp west.}$$

$$n=\frac{\alpha-(\alpha'+C'+c\sec\delta)}{\sec\delta}$$

$$m=-n\tan\varphi+b\sec\varphi$$

$$C=\alpha-(\alpha'+m+n\tan\delta+c\sec\delta)$$

In the column "Adopted right ascension" in the following table, the places of the clock-stars are those used at the observatory in 1871, some of the Nautical-Almanac places being slightly changed.

Date.	Number.	Object.	Seconds of transit over wires. I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Mean.		Instrumental corrections.	Observed place.	Adopted right ascension.			Clock-correction.
1871.			*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*m.*	*s.*	*s.*	*s.*	*h.*	*m.*	*s.*	*s.*
May 19	1	ε Bootis	1.5	3.3	6.1	19.6	21.4	23.2	25.0	26.8	40.4	43.1	44.8	39	23.20	+ 0.08	23.28	14	39	22.64	−0.64
	2	β Bootis	......	......	......	3.3	5.3	7.4	9.5	11.6	......	......	......	57	7.42	+ 0.15	7.57	14	57	6.94	−0.63
	3	β Libræ	46.6	48.2	50.8	3.1	4.6	6.2	7.8	9.6	21.6	24.0	25.5	10	6.17	− 0.07	6.10	15	10	5.42	−0.68
	4	μ^1 Bootis	15,0	17.0	19.9	35.4	37.2	39.1	41.3	43.2	58.4	1.6	3.6	19	39.25	+ 0.13	39.38	15	19	38.76	−0.62
	5	α Coronæ Borealis	......	......	......	32.8	35.5	37.0	49.5	52.4	54.0	56.0	58.1	29	15.70	+ 0.06	15.76	15	29	15.11	−0.65
	6	α Serpentis	37.7	39.3	41.8	53.8	55.3	56.9	58.6	0.2	12.2	14.6	16.2	37	56.96	− 0.02	56.94	15	37	56.29	−0.65
	7	ε Serpentis	......	......	......	21.9	23.5	25.2	26.9	28.5	......	......	......	44	25.20	− 0.03	25.17	15	44	24.60	−0.57
	8	δ Aquilæ	42.4	43.8	46.2	58.5	59.9	1.5	3.0	4.4	16.6	18.8	20.5	19	1.42	− 0.03	1.39	19	19	0.57	−0.82
	9	κ Aquilæ	39.3	40.9	43.8	55.4	57.2	58.8	0.5	2.2	13.9	16.5	18.2	29	58.79	− 0.06	58.73	19	29	57.93	−0.80
	10	γ Aquilæ	49.6	51.5	53.8	6.0	7.5	9.1	11.1	12.8	24.6	27.3	28.5	40	9.25	− 0.01	9.24	19	40	8.46	−0.78
	11	α Aquilæ	11.6	13.1	15.9	27.7	29.3	30.9	32.5	34.1	46.4	48.9	50.5	44	30.99	− 0.01	30.98	19	44	30.19	−0.79
	12	β Aquilæ	41.0	42.6	45.0	57.0	58.5	0.1	1.8	3.2	15.4	17.8	19.4	49	0.16	− 0.02	0.14	19	48	59.39	−0.75
	13	λ Ursæ Minoris	......	......	......	54.5	17.0	40.0	7.0	31.0	......	......	......	53	42.16	+14.87	57.03	19	53	56.20	......
May 23	14	η Herculis	......	......	......	......	......	......	6.3	9.7	11.9	14.0	16.5	38	27.51	− 0.13	27.38	16	38	30.23	+2.85
	15	κ Ophiuchi	13.2	14.6	17.0	29.5	31.1	32.6	34.2	35.8	48.0	50.4	52.1	51	32.59	− 0.16	32.43	16	51	35.20	+2.77
	16	d Herculis	......	28.3	31.3	45.6	47.6	49.5	51.5	53.4	7.8	10.8	......	56	49.55	− 0.13	49.42	16	56	52.28	+2.86
	17	a^1 Herculis	25.1	26.5	......	41.3	43.0	44.8	46.5	48.0	0.3	2.8	......	8	44.74	− 0.15	44.59	17	8	47.40	+2.81
	18	δ Ursæ Minoris	51.0	16.5	58.0	20.5	45.0	14.0	44.0	6.5	29.5	11.0	40.0	14	14.18	− 0.77	13.41	18	14	16.13	......
	19	δ Aquilæ	......	......	......	13.2	15.7	17.3	28.5	31.0	32.5	......	36.1	18	58.17	− 0.16	58.01	19	19	0.68	+2.67
	20	γ Aquilæ	46.6	48.1	50.5	2.7	4.5	6.1	7.7	9.2	21.5	23.8	25.6	40	6.03	− 0.15	5.88	19	40	8.57	+2.69
	21	α Aquilæ	8.4	9.8	12.2	24.5	26.1	27.7	29.4	31.0	43.0	45.7	47.1	44	27.72	− 0.16	27.56	19	44	30.30	+2.74
	22	β Aquilæ	37.8	39.3	41.7	53.9	55.4	57.0	58.6	0.2	12.2	14.6	16.3	48	57.00	− 0.16	56.84	19	48	59.50	+2.66
	23	τ Aquilæ	29.3	30.8	33.2	45.4	46.9	48.5	50.1	51.7	3.6	......	7.8	57	48.51	− 0.16	48.35	19	57	51.13	+2.78
May 24	24	α Serpentis	35.1	36.4	39.0	51.1	52.5	54.1	55.8	57.2	9.5	12.1	13.9	37	54.25	− 0.11	54.14	15	37	56.33	+2.19
	25	ε Serpentis	3.4	4.9	7.4	19.5	21.0	22.7	24.2	25.7	37.8	40.3	42.1	44	22.64	− 0.11	22.53	15	44	24.66	+2.13
	26	ε Coronæ Borealis	52.9	54.6	57.2	10.9	12.5	14.4	16.2	18.1	31.5	34.3	36.2	52	14.44	− 0.09	14.35	15	52	16.43	+2.08
	27	δ Ophiuchi	15.5	17.1	19.7	31.5	33.1	34.7	36.2	37.8	49.8	52.2	54.0	7	34.69	− 0.13	34.56	16	7	36.67	+2.11
	28	δ Ursæ Minoris	......	......	......	21.0	48.5	14.5	40.0	9.0	......	......	......	14	14.66	− 0.51	14.15	18	14	16.26	......
	29	α Lyræ	9.3	11.1	14.2	29.6	31.5	33.6	35.8	37.7	53.1	56.1	58.3	32	33.66	− 0.08	33.58	18	32	35.79	+2.21
	30	β Lyræ	55.4	57.3	0.3	14.5	16.3	18.4	20.3	22.3	36.4	39.4	41.5	45	18.37	− 0.09	18.28	18	45	20.43	+2.15
June 16	31	a^1 Herculis	29.7	31.4	34.1	46.3	47.9	49.7	51.4	52.9	5.3	7.8	9.6	8	49.64	+ 0.22	49.86	17	8	47.65	−2.21
	32	α Ophiuchi	40.6	42.7	45.2	57.3	58.9	0.5	2.3	4.0	16.0	18.6	20.2	29	0.57	+ 0.21	0.78	17	28	58.52	−2.26
	33	μ Herculis	......	......	......	25.0	26.5	28.2	30.1	32.0	45.5	48.2	50.0	41	28.35	+ 0.30	28.65	17	41	26.42	−2.23
	34	δ Ursæ Minoris	......	......	......	21.5	48.0	15.0	41.5	9.0	......	......	......	14	15.00	+ 4.92	19.92	18	14	17.67	......
	35	1 Aquilæ	......	......	......	11.8	13.3	15.1	16.7	18.4	30.2	32.9	34.3	28	15.04	+ 0.12	15.16	18	28	12.95	−2.21
	36	α Lyræ	13.5	15.5	18.9	34.2	36.1	38.0	40.1	42.1	57.3	0.7	2.7	32	38.10	+ 0.36	38.46	18	32	36.20	−2.26
	37	β Lyræ	59.7	2.0	4.9	19.1	20.9	22.9	24.9	26.6	41.0	43.9	45.6	45	22.86	+ 0.33	23.19	18	45	20.87	−2.32
	38	ζ Cygni	7.9	9.8	12.7	26.6	28.2	30.1	32.2	33.8	47.5	50.2	52.0	7	30.09	+ 0.31	30.40	21	7	28.08	−2.32
	39	1 Pegasi	50.0	51.8	54.4	7.1	8.7	10.5	12.2	14.0	26.6	29.2	31.1	16	10.51	+ 0.24	10.75	21	16	8.45	−2.30

Observed clock-corrections, United States Naval Observatory—Continued.

Date.	Number.	Object.	Seconds of transit over wires. I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Mean.	Instrumental corrections.	Observed place.	Adopted right ascension.	Clock-corrections.
1871.			*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*m.* *s.*	*s.*	*s.*	*h.* *m.* *s.*	*s.*
June 16	40	β Aquarii	29. 9	31. 5	34. 0	46. 0	47. 6	49. 2	50. 9	52. 5	4. 5	7. 1	8. 5	24 49. 25	− 0. 13	49. 38	21 24 47. 15	−2. 23
	41	ξ Aquarii	36. 9	38. 5	40. 9	53. 3	54. 7	56. 2	57. 8	59. 5	......	......	......	30 56. 27	− 0. 12	56. 39	21 30 54. 09	−2. 30
	42	ε Pegasi	34. 8	36. 5	38. 9	51. 0	52. 6	54. 2	55. 8	57. 4	9. 5	11. 8	13. 5	37 54. 17	− 0. 20	54. 37	21 37 52. 09	−2. 28

Nos. 2, 7, 13, and 28, set C.
14, set E.
16, B_1 and D_3 rejected.
17, B_3 and D_3 rejected.
19, sets D and E; E_4 rejected.
23, D_2 rejected.
33, sets C and D.
34, set C; cloudy.
35, sets C and D.
41, sets B. and C.

COLLIMATION.

May 19. 9. Image east $0^r.16$; clamp east.
Image west $0^r.19$; clamp west.
May 23. 9. Image west $0^r.17$; clamp west.
May 24. 9. Image west $0^r.19$; clamp west.
Image east $0^r.10$; clamp east.
June 16. 9. Image west $0^r.20$; clamp east.
Image west $0^r.42$; clamp west.
On the 23d and 24th the stars were very unsteady.

While observing on May 19 and June 16, the clamp was east, and west on the 23d and 24th of May.

The values of m, n, and c, used in the reduction, are as follows:

Date.	m	n	c
	s.	s.	s.
May 19	−0.143	+0.184	+0.102
May 23	−0.046	+0.088	−0.114
May 24	−0.010	+0.082	−0.110
June 16	−0.113	+0.242	+0.050

From the clock-corrections obtained from the observations the following corrections and rates were computed by the method of least squares, and have been employed to determine the error of the clock at the time of the interchange of signals on each night:

Date.	Sidereal hour.	Correction.	Hourly rate.
		s. s.	s.
May 19	14.0	−0.594±0.007	−0.034
May 23	16.0	+2.854±0.010	−0.039
May 24	15.0	+2.117±0.012	+0.016
June 16	17.0	−2.234±0.007	−0.012

UNITED STATES LAKE-SURVEY, DETROIT, MICHIGAN.

The dates of the observations are May 19, 23, and 24, and June 1, 3, 10, 16, 26, and 29, 1871. The observer at Detroit was Mr. O. B. Wheeler, assistant United States lake-survey, and the instruments used were the Troughton and Simms transit of 43 inches focal length, clock No. 184, Bond & Son, and chronograph No. 216, Bond & Son.

The stone pier upon which the transit-instrument was mounted is situated 321.0 feet west and 294.0 feet north of the southwest corner of the stone foundation of the Westminster church, on Washington avenue.

The reductions have been made by Messrs. Thomas Russel, C. F. Burton, and John Eisenmann, subassistants United States lake-survey. A preliminary reduction by high and low stars of May 19, 23, and 24, was made by Mr. Burton. Two reductions by the method of least squares, on different suppositions, were made, either of which would cause an extreme range of only $0^s.05$ from the preliminary reduction.

For the remaining dates, the high and low star reductions were made by Mr. Eisenmann, and the least-square reductions by Mr. Russel. The agreement in extreme cases was the same as above.

In the following tables are contained the abbreviations:

$C\Delta i$ = reduction to the middle wire;

Aberr = diurnal aberation;

$B\,b$ = level-correction;

$C\,c$ = collimation-correction;

t' = observed time of transit of a star, commonly the mean of five wires;

$t = t'$ the above corrections being made;

α = right ascension of a star;

$(\alpha - t)$ — (an assumed Δt) = the absolute termof the equations of condition;

a = deviation from the meridian, + when the instrument points east of south;

c = distance of the middle wire from the line of collimation;

ρ = hourly rate of the clock;

Δt = clock-correction, — when fast; + when slow.

NOTES.—On May 19, 23, and 24, $t=t'$, as above, except that the the collimation-correction is not included. On June 16, a=the deviation to be applied before the exchange of signals, and a' =that to be applied after the exchange of signals.

When $C\Delta i$ is omitted, t' = the mean of the several wires reduced to the middle wire.

Computation of clock-correction for Detroit, May 19, 1871.

Ill.	Star.	C Δ *i*	Aberr.	B *b*	*t'*	*a*	(*a*−*t*)	*v*
		s.	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
E.	Polaris, L. C	....	+.58	+2.01	13 11 24.75	13 10 59.40	−27.94	....
W.	Polaris, L. C	....	+.58	−2.23	11 29.60	....	28.55	....
	ζ Virginis	+.03	−.01	+ .06	28 39.41	28 08.37	31.12	+.02
	η Ursæ Majoris	+.05	−.02	+ .15	42 59.87	42 29.05	31.00	−.22
	η Bootis	+.03	−.02	+ .13	49 04.80	48 33.80	31.14	−.03
	τ Virginis	+.03	−.01	+ .12	55 37.29	55 06.13	31.30	+.13
	ρ Bootis	+.04	−.02	+ .25	14 26 48.85	14 26 17.67	31.45	+.17
W.	ε Bootis	+.03	−.02	+ .20	39 53.85	39 22.66	31.40	+.09
E.	β Bootis	−.04	−.02	+ .09	57 38.34	57 06.91	31.46	+.06
	β Libræ	−.03	−.01	+ .05	15 10 36.60	15 10 05.42	31.19	−.17
	μ¹ Bootis	−.04	−.02	+ .09	20 10.24	19 38.76	31.51	+.07
	α Serpentis	−.03	−.02	+ .07	38 27.62	37 56.27	31.34	−.08
	ε Serpentis	−.03	−.01	+ .07	44 55.94	44 24.62	31.35	−.12
	δ Ophiuchi	−.03	−.01	+ .07	16 08 07.94	16 07 36.60	31.37	−.15
	ζ Ophiuchi	−.03	−.01	+ .14	19 00 01.73	18 59 29.82	32.01	+.16
	ω Aquilæ	−.03	−.01	+ .11	12 18.40	11 46.62	31.85	−.13
	γ Aquilæ	−.03	−.01	+ .16	40 40.43	40 08.43	32.12	+.07
	α Aquilæ	−.03	−.01	+ .15	45 02.14	44 30.15	32.10	+.03
E.	β Aquilæ	−.03	−.01	+ .15	49 31.56	48 59.36	32.31	+.23

Normal equations.

$$+1965.223\,a + 3.671\,c + 167.496\,\rho + 70.250\,\delta\theta - 168.098 = 0$$
$$+3.671\,a + 3458.724\,c - 36.620\,\rho + 4.820\,\delta\theta + 31.768 = 0$$
$$7.496\,a - 36.620\,c + 104.196\,\rho + 2.170\,\delta\theta - 30.069 = 0$$
$$0.250\,a + 4.820\,c + 2.170\,\rho + 19.000\,\delta\theta + 3.510 = 0$$

$a=+0^s.09$

$c=-0^s.007$, lamp east.

$\rho=+0^s.1493$, rate per hour.

$\Delta t=-31^s.54. \pm 0^s.023$, at $15^h\,57^m$.

Computation of clock-correction for Detroit, May 23, 1871.

Ill.	Star.	C Δ *i*	Aberr.	B *b*	*t'*	*a*	(*a*−*t*)	
		s.	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
E.	Polaris, L. C	....	+.58	−1.56	13 11 55.87	13 11 02.14	−52.75	....
W.	Polaris, L. C	....	+.58	−3.78	11 59.76	....	54.42	....
	ζ Virginis	+.03	−.01	+ .12	28 50.01	28 08.36	41.79	−.15
	η Ursæ Majoris	+.05	−.02	+ .30	43 10.32	42 29.00	41.65	+.03
	η Bootis	+.03	−.01	+ .19	49 15.43	48 33.79	41.85	−.04
	τ Virginis	+.03	−.01	+ .17	55 47.91	55 06.13	41.97	−.02
W.	α Bootis	+.03	−.01	+ .26	14 10 29.69	14 09 47.92	42.05	+.10
E.	5 Ursæ Minoris	−.13	−.06	+ .52	28 35.24	27 54.47	41.10	....
	α² Libræ	−.03	−.01	+ .08	44 28.17	43 46.09	42.12	−.12
	ψ Bootis	−.04	−.02	+ .16	59 38.71	58 56.60	42.21	+.16
	β Libræ	−.03	−.01	+ .08	15 10 47.54	15 10 05.45	42.13	−.14
	μ¹ Bootis	−.04	−.02	+ .14	20 20.95	19 38.77	42.26	+.22
	α Coronæ Borealis	−.04	−.02	+ .11	29 57.40	29 15.13	42.32	+.19
	α Serpentis	−.03	−.01	+ .07	38 38.46	37 56.30	42.19	−.07
	ε Serpentis	−.03	−.01	+ .07	45 06.77	44 24.65	42.15	−.14
	ε Coronæ Borealis	−.04	−.02	+ .10	52 58.65	52 16.49	42.20	+.02
	d Sagittarii	−.03	−.02	+ .11	19 10 49.10	19 10 06.29	42.87	−.03
	ω Aquilæ	−.03	−.01	+ .18	12 29.52	11 46.73	42.93	+.17
E.	δ Aquilæ	−.03	−.01	+ .16	19 43.29	19 00.63	42.78	−.04
W.	κ Aquilæ	+.03	−.01	+ .13	30 40.48	29 58.00	42.63	−.24
	γ Aquilæ	+.03	−.01	+ .17	40 51.03	40 08.54	42.68	−.12
	α Aquilæ	+.03	−.01	+ .19	45 12.87	44 30.26	42.82	.00
W.	β Aquilæ	+.03	−.01	+ .20	49 42.12	48 59.47	42.87	+.03

Normal equations.

$$+\ 1972.912\,a - 8.095\,c + 168.577\,\rho + 70.62\,\delta\theta + 802.347 = 0$$
$$-\ 8.095\,a + 3477.516\,c - 3.731\,\rho + 6.26\,\delta\theta + 73.934 = 0$$
$$+\ 168.577\,a - 3.731\,c + 131.784\,\rho + 44.713 = 0$$
$$+\ 70.620\,a + 6.260\,c + 23.00\,\delta\theta + 51.740 = 0$$

$a = -0^s.38.$

$c = -0^s.02$, lamp east.

$\rho = +0^s.147$, rate per hour.

$\Delta t = -42^s.08. \pm 0^s.019$, at $16^h\ 04^m$

Computation of clock-correction for Detroit, May 24, 1871.

Ill.	Star.	C Δ i	Aberr.	B b	t'	a	$(a-t)$	v
		s.	s.	s.	h. m. s.	h. m. s.	s.	s.
W.	Polaris, L. C	...•...	+.58	−3.78	13 12 01.85	13 11 02.74	−55.91	......
E.	Polaris, L. C	....	+.58	−2.23	11 54.94	....	50.55	......
	ζ Virginis	−.03	−.01	+ .09	28 53.43	28 08.35	45.13	−.16
	η Bootis	−.03	−.02	+ .12	49 18.88	48 33.78	45.17	−.09
	α Bootis	−.03	−.02	+ .12	14 10 33.12	14 09 47.92	45.27	−.02
	ρ Bootis	−.04	−.02	+ .14	27 03.00	26 17.66	45.42	+.15
	ε Bootis	−.04	−.02	+ .14	40 07.97	39 22.66	45.39	+.08
E.	α^2 Libræ	−.03	−.01	+ .07	44 31.33	43 46.09	45.27	−.20
W.	β Bootis	+.04	−.02	+ .22	57 51.88	57 06.90	45.22	+.11
	β Libræ	+.03	−.01	+ .13	15 10 50.52	15 10 05.45	45.22	−.13
	μ^1 Bootis	+.04	−.02	+ .31	20 23.66	19 38.78	45.21	+.04
	α Coronæ Borealis	+.04	−.02	+ .31	30 00.16	29 15.14	45.35	+.10
	α Serpentis	+.03	−.01	+ .23	38 41.54	37 56.31	45.48	+.14
	ε Coronæ Borealis	+.04	−.02	+ .31	53 01.54	52 16.49	45.38	+.09
	β Scorpii	+.03	−.02	+ .14	58 43.04	57 57.84	45.35	−.12
	δ Ophiuchi	+.03	−.01	+ .20	16 08 21.86	16 07 36.65	45.43	+.01
	d Sagittarii	+.03	−.02	+ .07	19 10 51.83	19 10 06.32	45.59	−.18
W.	ω Aquilæ	+.03	−.01	+ .10	12 32.20	11 46.75	45.57	−.11
E.	γ Aquilæ	−.03	−.01	+ .08	40 54.43	40 08.57	45.90	+.04
	α Aquilæ	−.03	−.01	+ .08	45 16.21	44 30.29	45.96	+.08
E.	β Aquilæ	−.03	−.01	+ .07	49 45.57	48 59.50	−46.10	+.20

Normal equations.

$$+\ 1967.037\,a - .0675\,c + 163.305\,\rho + 72.460\,\delta\theta + 519.956 = 0$$
$$-\ 0.675\,a + 3458.511\,c + 11.019\,\rho - 1.480\,\delta\theta + 222.909 = 0$$
$$+\ 163.305\,a + 11.019\,c + 101.074\,\rho + 32.893 = 0$$
$$+\ 72.460\,a - 1.480\,c + 21.000\,\delta\theta + 24.870 = 0$$

$a = -\ 0^s.26$

$c = -\ 0^s.07$, lamp east.

$\rho = +\ 0^s.098$, rate per hour.

$\Delta t = -\ 45^s.28 \pm 0^s.020$, at $15^h\ 54^m$

Carlin, Nevada, May 19, 1871.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	m. s.
o Virginis	E.	11 53 46.09	+0.06	+ 9.70	−0.23	11 53 55.62	11 58 38.97	+4 43.35
ε Corvi	E.	58 29.58	+0.02	+ 17.65	−0 25	58 47.00	12 3 30.55	43.55
4 Draconis	E.	12 2 24.58	+0.12	− 55.78	−1.14	12 1 27.78	6 10.99	43.21
13 Comæ	E.	13 3.16	0.00	+ 4.95	−0.26	13 7.85	17 50.99	43.14
δ Corvi	E.	18 13.30	−0.04	+ 15.99	−0.24	18 29.01	23 12.86	43.85
β Corvi	E.	22 36.70	−0.07	+ 17.87	−0.25	22 54.25	27 37.80	43.55
21 Cassiopeæ, L. C.	W.	31 24.60	−0.20	+ 61.85	−0.85	32 25.20	37 7.33	42.13
32 Camelopardalis	W.	45 37.38	+0.56	−122.48	+2.22	43 37.68	48 20.57	42.89
θ Virginis	W.	58 20.47	+0.02	+ 13.21	+0.23	58 33.93	13 3 17.38	43.45
α Virginis	W.	13 13 26.94	+0.04	+ 14.61	+0.23	13 13 41.82	18 25.07	43.25
Virginis	W.	23 12.64	+0.07	+ 12.01	+0.23	23 24.95	28 8.37	+4 43.42

Mean correction for $12^h\ 40^m$ local sidereal time .... +4 43.254

Excluding polar stars .... +4 43.445

Normal equations.

$$0 = -\ 2.51 + 11.00\,\delta T - 0.57\,a' + 1.28\,c \qquad \delta T = +\ 0^s.254$$
$$0 = +\ 18.44 - 0.57\,\delta T + 68.94\,a' + 62.19\,c \qquad a' = -\ 0^s.058$$
$$0 = +\ 35.55 + 1.28\,\delta T + 62.19\,a' + 140.36\,c \qquad c = -\ 0^s.230$$

(To avoid large numbers, an azimuth of $+18^s.50$ was introduced: a', found by the method of least squares, gives the correction of the adopted azimuth; therefore, $a = +\ 18^s.442$.)

Carlin, Nevada, May 23, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
ζ Ophiuchi	E.	16 25 20.82	−0.02	+ 4.46	−0.01	16 25 25.25	16 30 4.89	+4 39.64
η Herculis........	W.	33 49.96	−0.22	+ 0.20	+0.02	33 49.96	38 30.22	40.26
ι Ophiuchi	W.	43 12.84	−0.17	+ 2.90	+0.01	43 15.58	47 55.84	40.26
κ Ophiuchi	W.	46 52.46	−0.18	+ 2.96	+0.01	46 55.25	51 35.16	39.91
ε Ursæ Minoris ...	W.	55 14.38	−0.72	−27.78	+0.08	54 45.96	59 25.94	39.98
α Herculis........	W.	17 4 4.77	−0.15	+ 2.58	+0.01	17 4 7.21	17 8 47.38	40.17
ω Draconis	E.	33 13.82	−0.63	− 7.35	−0.03	33 5.81	37 46.01	+4 40.20
Mean correction for $17^h\ 0^m$ local sidereal time								+4 40.060

Normal equations.

$$0 = -\ 1.90 + 7.00\ \delta T - 3.90\ a - 7.97\ c \qquad \delta T = +\ 0^s.060$$
$$0 = +\ 10.25 - 3.90\ \delta T + 27.26\ a' + 32.16\ c \qquad a' = -\ 0.353$$
$$0 = +\ 12.66 - 7.97\ \delta T + 32.16\ a' + 68.53\ c \qquad c = -\ 0.012$$

I introduced a preliminary azimuth of $+\ 6^s.00$; the azimuth of the instrument was $+\ 5^s.647$. The observations of η Draconis and ω Draconis differ so much that they had to be excluded.

Carlin, Nevada, May 24, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
γ Cephei, L. C	E.	11 29 21.72	+1.22	−4.18	+1.32	11 29 20.08	11 34 2.59	+4 42.51
β Leonis	E.	37 49.86	−0.55	−0.48	−0.31	37 48.52	43 29.27	40.75
γ Ursæ Majoris ..	E.	42 23.65	−0.97	+0.44	−0.52	42 22.60	47 3.00	40.40
ο Virginis	E.	53 59.94	−0.48	−0.57	−0.30	53 58.59	58 38.92	40.33
4 Draconis	E.	12 1 30.32	−1.84	+3.23	−1.48	12 1 30.23	12 6 10.58	40.35
β Corvi	E.	22 58.86	−0.24	−1.04	−0.32	22 57.26	27 37.76	40.50
21 Cassiopeæ, L. C.	W.	32 31.19	+0.34	−3.57	−1.11	32 26.85	37 6.05	39.20
32 Camelopardalis	W.	43 30.87	−2.68	+7.10	+2.90	43 38.19	48 19.81	41.62
θ Virginis	W.	58 37.92	−0.24	−0.77	+0.30	58 37.21	13 3 17.36	40.15
α Virginis	W.	13 13 45.64	−0.15	−0.85	+0.31	13 13 44.95	18 25.05	+4 40.10
Mean correction of chronometer excluding the polar stars, for $13^h\ 0^m$ local sidereal time								+4 40.372

Normal equations.

$$0 = +\ \ 4.22 + 10.00\ \delta t + \ 0.63\ a$$
$$0 = -\ 89.14 + \ 0.63\ \delta t + 82.97\ a \qquad a = -\ 1^s.072$$

Several other computations have been made, giving for the correction of chronometer no better result. The error of collimation was adopted to $-\ 0^s.30$.

Carlin, Nevada, May 24, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m.*
ε Serpentis	W.	15 40 45.54	−0.06	−1.25	+0.30	15 40 44.53	15 44 24.65	+4 40.12
ζ Ursæ Minoris ..	W.	44 1.61	−0.19	+6.32	+1.47	44 9.21	48 49.34	40.13
β¹ Scorpii.........	W.	53 19.06	−0.01	−1.95	+0.32	53 17.42	57 57.84	40.42
δ Ophiuchi........	W.	16 2 57.60	0.00	−1.48	+0.30	16 2 56.42	16 7 36.65	40.23
τ Herculis	E.	11 14.00	−0.17	+0.32	−0.44	11 13.71	15 53.70	39.99
η Draconis........	E.	17 36.72	−0.24	+1.61	−0.64	17 37.45	22 17.79	40.34
ζ Ophiuchi........	E.	25 26.92	−0.07	−1.67	−0.30	25 24.88	30 4.89	40.01
η Herculis	E.	33 51.10	−0.13	−0.07	−0.39	33 50.51	38 30.22	+4 39.71
Mean correction for $16^h\ 10^m$								+4 40.12

Normal equations.

$$0 = -\ \ 2.78 + 8.00\ \delta t - \ 0.86\ a \qquad \delta t = +\ 0^s.120$$
$$0 = +\ 24.99 - 0.86\ \delta t + 11.74\ a \qquad a = -\ 2^s.120$$

The error of collimation of the instrument is adopted as $-0^s.30$.

The following table contains the corrections of the chronometer and its rate, to obtain the correction for the time of exchange:

Date.	Local sidereal time.	Corrections of chronometer.	Hourly rate.
	h.	m. s.	s.
May 19, 1871	12.667	+ 4 43.445	− 0.034
May 23, 1871	17.000	+ 4 40.060	+ 0.009
May 24, 1871	14.508	+ 4 40.246	+ 0.009

For exchange, mean-solar-time chronometer Hutton No. 288 was always used. May 19, I find in the proper place only one comparison of Negus 1344 with Hutton 288:

	h.	m.	s.	h.	m.	s.
Negus... 1344	13	30	20.0	13	33	27.0
Hutton.. 288	9	21	20.0	9	24	26.5

Hutton 288, at $9^h\ 22^m\ 53^s.25$, is slow of local sidereal time $4^h\ 13^m\ 43^s.666$. In another place I find one comparison made May 19, in the morning, and one at nearly the same time May 20:

	May 19.						*May* 20.		
	h.	m.	s.	h.	m.	s.	h.	m.	s.
Negus...	0	32	12.0	1	41	31.0	1	44	34.0
Hutton..	20	25	21.50	21	30	29.5	21	33	32.0

Therefore, I find the rate of Hutton 288 from the morning to the evening of May 19, $+ 9^s.9785$, and from the evening to the next morning, $+ 9^s.9641$, both for one hour of Hutton 288. To reduce Hutton for the time of exchange, the mean $+ 9^s.9713$ is used.

For May 23 and May 24, one comparison was made before and after exchange.

May 23.

	h.	m.	s.	h.	m.	s.	h.	m.	s.
Negus... 1344	13	27	18.0	13	30	25.0	13	33	34.0
Hutton.. 288	9	2	24.5	9	5	31.0	9	8	39.5

And after exchange:

	h.	m.	s.	h.	m.	s.
Negus... 1344	16	12	10.0	16	15	15.0
Hutton.. 288	11	46	49.5	11	49	54.0

May 24.

	h.	m.	s.	h.	m.	s.
Negus... 1344	13	34	32.0	13	37	35.0
Hutton.. 280	9	5	37.5	9	8	40.0

After exchange:

	h.	m.	s.	h.	m.	s.
Negus... 1344	15	30	19.0	15	33	20.0
Hutton.. 288	11	1	5.5	11	4	6.0

From these comparisons and the rate given for Negus 1344, the following table for Hutton 288 is derived:

Date.	Hours on the face of Hutton's chronometer.	Hutton 288 behind local sidereal time.	Losing per hour on face of Hutton's chronometer.	Logarithm.
	h. m. s.	h. m. s.	s.	
May 19, 1871	9 22 53.25	4 13 43.666	9.9713	0.9987518
May 23, 1871	10 26 56.72	4 29 47.454	9.8478	0.9933402
May 24, 1871	10 4 52.25	4 33 44.496	9.8832	0.9948986

The logarithm is used to convert the chronometer-time of the means of the signals into sidereal time.

EXCHANGE OF SIGNALS.

Signals sent from the Washington Observatory.

On the 19th of May the first signals to Carlin were at intervals of one second, and were sent by so arranging the apparatus that the clock *broke* a *closed* circuit at each second. These signals could not be used at Carlin.

Afterward an attempt was made to send signals by causing the clock to *close* an *open* circuit, but these signals failed to get through.

So much objection was made at Carlin to the clock-signals that signals were sent, finally, at intervals of ten seconds, with an ordinary message-key, by breaking the circuit in coincidence with the beat of the clock as indicated by the sounder in the local circuit.

Similar signals were sent on the 23d and 24th of May.

On the 16th of June signals were sent, at intervals of ten seconds, directly from the clock, by switching the clock into the main line at the proper time to enable it to break the circuit at the desired second.

Signals sent to the Observatory.

Signals from Carlin and Austin were received on the Observatory chronograph.

Exchange of signals between Washington, D. C., Detroit, Mich., and Carlin, Nev.

MAY 19, 1871.—*Signals sent from Washington.*

Washington clock.			Detroit clock.			Carlin chronometer.			Washington clock.			Detroit clock.			Carlin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	35	0.00	17	11	30.75	10	44	45.20	17	37	30.00	17	14	0.90	10	47	15.00
		10.00			40.70			55.40			40.00			10.82			24.80
		20.00			50.77		45	5.30			50.00			20.85			34.90
										38	0.00			30.80			45.00
	36	0.00		12	30.77		45	45.60			10.00			40.82			55.00
		10.00			40.83			55.10			20.00			50.81		48	4.80
		20.00			50.86		46	5.60			30.00		15	0.82			14.90
		30.00		13	0.89			15.20									
		40.00			10.91			25.10	Mean, 17	36	52.94	17	13	23.78	10	46	38.06
		50.00			20.90			35.20									
	37	0.00			30.86			44.90									

MAY 23, 1871.—*Signals sent from Washington.*

Washington clock.			Detroit clock.			Carlin chronometer.			Washington clock.			Detroit clock.			Carlin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
18	35	0.00	18	11	45.19	11	28	48.30	18	37	50.00	18	14	35.11	11	31	37.90
		10.00			55.28			58.60		38	0.00			45.05			47.90
		20.00		12	5.23		29	8.50									
		30.00			15.27			18.50		39	0.00		15	45.18		32	47.70
		40.00			25.20			28.40			10.00			55.18			57.60
		50.00			35.19			38.40			20.00		16	5.00		33	7.60
	36	0.00			44.99			48.10			30.00			15.00			17.60
											40.00			25.00			27.60
	37	0.00		13	45.05		30	48.10			50.00			35.00			37.60
		10.00			55.80			58.60		40	0.00			45.20			47.60
		20.00		14	5.16		31	8.00									
		30.00			15.11			17.90	Mean, 18	37	30.00	18	14	15.15	11	31	18.02
		40.00			25.05			28.00									

MAY 23, 1871.—*Signals sent from Carlin.*

FIRST SERIES.

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	53	.....	17	29	.....	10	47	.....
		15.80		30	0.52			10.00
		21.20			5.84			15.00
		25.80			10.49			20.00
		30.90			15.69			25.00
		35.90			20.60			30.00
		40.80			25.52			35.00
		45.90			30.59			40.00
		50.90			35.61			45.00
		55.90			40.61			50.00
	54	1.00			45.69			55.00
		6.00			50.70		48	0.00
		......			......			......
	55	6.10		31	51.05		49	0.00
		11.20			56.05			5.00
		16.20		32	1.00			10.00
		21.30			6.00			15.00
		26.30			11.05			20.00
		31.50			16.15			25.00
		36.40			21.10			30.00
		41.30			26.00			35.00

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	55	46.20	17	32	30.90	10	49	40.00
		51.20			35.80			45.00
		56.50			41.20			50.00
	56	1.50			46.20			55.00
		6.30			51.00		50	0.00
		.						
	57	6.50		33	51.18		51	0.00
		11.50			56.20			5.00
		16.50		34	1.20			10.00
		21.60			6.40			15.00
		26.50			11.30			20.00
		31.40			16.18			25.00
		36.50			21.25			30.00
		41.40			26.00			35.00
		46.60			31.40			40.00
		51.60			36.39			45.00
		56.50			41.22			50.00
	58	1.70			46.40			55.00
		6.60			51.35		52	0.00
Mean, 17	55	44.24	17	32	28.97	10	49	37.97

MAY 23, 1871.—*Signals sent from Carlin.*

SECOND SERIES.

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
18	26	11.20	18	2	56.00	11	20	0.00
		16.20		3	1.00			5.00
		21.20			5.99			10.00
		26.20			11.00			15.00
		31.30			16.00			20.00
		36.20			21.00			25.00
		41.10			25.92			30.00
		46.40			31.28			35.00
		51.50			36.33			40.00
		56.40			41.17			45.00
	27	1.60			46.40			50.00
		6.30			51.00			55.00
		11.30			56.12		21	0.00
		16.50		4	1.50			5.00
		26.50			11.30			15.00
		31.40			16.25			20.00
		36.40			21.29			25.00
		41.30			26.00			30.00
		46.60			31.40			35.00
		51.80			36.60			40.00
	28	1.60			46.40			50.00
		6.50			51.26			55.00
		11.40			56.12		22	0.00
		16.50		5	1.29			5.00
		21.40			6.29			10.00
		26 40			11.29			15.00
		31.50			16.37			20.00
		36.50			21.27			25.00
		41.60			26.60			30.00
		46.60			31.61			35.00
		51.60			36.69			40.00

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
18	28	56.80	18	5	41.63	11	22	45.00
	29	1.70			46.81			50.00
		6.80			51.61			55.00
		11.60			56.41		23	0.00
		16.70		6	1.49			5.00
		21.60			6.39			10.00
		26.80			11.58			15.00
		31.60			16.45			20.00
		36.70			21.48			25.00
		41.70			26.51			30.00
		46.80			31.60			35.00
		51.80			36.64			40.00
		56.80			41.67			45.00
	30	2.00			46.80			50.00
		6.70			51.59			55.00
		11.80			56.70		24	0.00
		16.90		7	1.80			5.00
		21.70			6.50			10.00
		26.90			11.78			15.00
		32.00			16.80			20.00
		36.90			21.70			25.00
		41.90			26.70			30.00
		47.00			31.80			35.00
		52.20			37.00			40.00
		57.10			41.89			45.00
	31	2.30			47.18			50.00
		7.20			52'05			55.00
		12.10			56.95		25	0.00
Mean, 18	28	43.92	18	5	28.58	11	22	32.12

MAY 24, 1871.—*Signals sent from Washington.*

FIRST SERIES.

Washington clock.	Detroit clock.	Carlin chronometer.	Washington clock.	Detroit clock.	Carlin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
16	16	9	16 56 50.00	16 33 37.60	9 46 54.10
.....	.....	.....	57 0.00	47.80	47 4.20
.....	.....				
.....	.....	.....	58 0.00	34 47.82	48 4.20
54 30.00	31 17.90	44 34.30	10.00	57.76	13.90
40.00	28.00	45.50	20.00	35 7.70	23.70
50.00	37.69	54.20	30.00	17.69	33.60
			40.00	27.54	43.40
56	32	46	50.00	37.89	53.80
.....	•	.....	59 0.00	47.89	49 3.80
.....	33	.....			
30.00	17.70	34.00	Mean, 16 57 10.71	16 33 58.47	9 47 14.76
40.00	27.65	43.90			

SECOND SERIES.

Washington clock.	Detroit clock.	Carlin chronometer.	Washington clock.	Detroit clock.	Carlin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
17 1	16 37	9 51	17 4	16 40 47.86	9 54 3.00
	38	......	10.00	57.80	12.80
30.00	17.70	33.20			
40.00	27.70	43.00	5 10.00	41 57.89	55 12.70
50.00	37.79	53.30	20.00	42 7.79	22.60
2 0.00	47.85	52 3.20	30.00	17.70	32.60
10.00	57.89	13.20	......	......	.....
			50.00	37.71	52.60
3 10.00	39 57.89	53 13.10	6 0.00	47.71	56 2.60
20.00	40 7.62	22.30	10.00	57.90	12.60
30.00	17.60	32.80			
40.00	27.70	42.80	Mean, 17 3 49.44	16 40 37.21	9 53 52.33
50.00	37.76	53.00			

THIRD SERIES.

Washington clock.	Detroit clock.	Carlin chronometer.	Washington clock.	Detroit clock.	Carlin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
17 26 0.00	17 2 48.00	10 15 59.60	17 26 40.00	17 3 27.93	10 16 39.50
10.00	57.90	16 9.30	50.00	37.80	49.10
20.00	3 7.68	19.20			
30.00	17.85	29.30	Mean, 17 26 25.00	17 3 12.86	10 16 24.33

MAY 24, 1871.—*Signals sent from Carlin.*

FIRST SERIES.

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	m.	s.	h.	m.	s.	h.	m.	s.
17	9	59.30	16	46	46.55	10	0	0.00
	10	4.40			51.70			5.00
		9.30			56.65			10.00
		14.40		47	1.76			15.00
		19.40			6.69			20.00
		24.50			11.81			25.00
		29.40			16.71			30.00
		34.20			21.51			35.00
		39.60			26.90			40.00
		44.70			32.00			45.00
		49.50			36.80			50.00
		54.50			41.88			55.00
		59.70			46.90		1	0.00
	11	4.60			51.91			5.00
		9.50			56.80			10.00
		14.60		48	1.90			15.00
		19.70			7.00			20.00
		24.70			12.00			25.00
		29.70			16.98			30.00
		34.60			21.92			35.00
		39.80			26.98			40.00
		44.60			31.87			45.00
		49.80			37.10			50.00
		54.80			42.00			55.00
		59.70			47.00		2	0.00
	12	4.70			52.00			5.00
		9.70			57.00			10.00
		......		49	......			......
		19.80			7.00			20.00
		24.70			11.95			25.00
		29.70			16.99			30.00
		34.70			21.99			35.00

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	m.	s.	h.	m.	s.	h.	m.	s.
17	12	39.70	16	49	27.00	10	2	40.00
		44.90			32.28			45.00
		49.70			37.10			50.00
		54.80			42.15			55.00
		59.80			47.15		3	0.00
	13	4.90			52.20			5.00
		9.80			57.13			10.00
		14.80		50	2.10			15.00
		19.80			7.05			20.00
		24.80			12.10			25.00
		29.80			17.15			30.00
		35.10			22.45			35.00
		39.90			27.15			40.00
		44.90			32.15			45.00
		50.00			37.30			50.00
		54.10			42.39			55.00
		59.90			47.20		4	0.00
	14	5.00			52.21			5.00
		9.90			57.10			10.00
		15.10		51	2.30			15.00
		19.80			7.10			20.00
		24.90			12.15			25.00
		29.80			17.15			30.00
		35.20			22.50			35.00
		40.20			27.50			40.00
		45.10			32.38			45.00
		50.40			37.30			50.00
		55.10			42.39			55.00
	15	0.10			47.21		5	0.00
Mean, 17	12	30.06	16	49	17.29	10	2	30.25

SECOND SERIES.

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	m.	s.	h.	m.	s.	h.	m.	s.
17	17	0.50	16	53	47.89	10	7	0.00
		5.70			52.81			5.00
		10.30			57.56			10.00
		15.50		54	2.79			15.00
		20.50			7.80			20.00
		25.30			12.53			25.00
		30.60			17.80			30.00
		35.30			22.61			35.00
		40.70			28.00			40.00
		45.70			33.00			45.00
		50.60			37.91			50.00
		55.70			42.90			55.00
	18	0.60			47.90		8	0.00
		5.60			53.10			5.00
		10.40			57.70			10.00
		......		55	......			......
		......			......			......
		25.70			12.88			25.00
		30.50			17.79			30.00
		35.60			22.90			35.00
		40.70			28.05			40.00
		45.70			33.00			45.00
		50.80			38.10			50.00
		55.80			43.10			55.00
	19	0.80			48.10		9	0.00
		5.80			53.10			5.00
		......			......			......
		......		56	......			......
		20.90			8.19			20.00
		25.90			13.20			25.00
		30.90			18.10			30.00
		36.00			23.22			35.00

Washington clock.			Detroit clock.			Carlin chronometer.		
h.	m.	s.	h.	m.	s.	h.	m.	s.
17	19	40.90	16	56	28.18	10	9	40.00
		46.00			33.21			45.00
		51.00			38.29			50.00
		56.00			43.30			55.00
	20	0.90			48.15		10	0.00
		5.90			53.19			5.00
		11.00			58.19			10.00
		16.10		57	3.33			15,00
		21.00			8.30			20.00
		26.00			13.70			25.00
		31.10			18.50			30.00
		36.10			23.55			35.00
		41.20			28.60			40.00
		46.10			33.49			45.00
		51.50			38.59			50.00
		56.20			43.70			55.00
	21	1.20			48.50		11	0.00
		6.20			53.52			5.00
		11.20			58.50			10.00
		16.20		58	3.50			15.00
		21.10			8.36			20.00
		26.40			13.72			25.00
		31.20			18.50			30.00
		......			......			.....
		41.30			28.60			40.00
		46.20			33.48			45.00
		51.30			38.59			50.00
		56.40			43.70			55.00
	22	1.30			48.60		12	0.00
Mean, 17	19	31.88	16	56	19.00	10	9	30.98

May 23, 1871, I find one more set sent from Washington to Carlin, but not recorded at Detroit:

h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
17	21	10.00	10	15	10.80	17	47	......	10	41	......	17	49	30.00	10	43	26.00
		20.00			20.80			40.00			36.10			40.00			35.90
		......			......			50.00			46.30			50.00			45.90
		40.00			40.40		48	0.00			56.20		50	0.00			55.80
		50.00			50.30			10.00		42	6.20			10.00		44	5.80
	22	0.00		16	0.20			20.00			16.20			20.00			15.70
								30.00			26.10			......			......
												Mean, 17	40	56.47	10	34	53.81

And one set sent from Carlin to Washington, on the same date, recorded only at Washington and Carlin:

h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
18	1	37.40	10	55	30.00	18	3	7.80	10	57	0 00
		42.30			35.00			17.60			10.00
		47.30			40.00			22.70			15.00
		57.20			50.00			27.60			20.00
	2	2.40			55.00			32.60			25.00
		7.30		56	0.00			37.40			30.00
		12.80			5.00			42.60			35.00
		17.60			10.00			47.50			40.00
		22.70			15.00			52.60			45.00
		27.50			20.00			57.80			50.00
		32.30			25.00		4	7.60		58	0.00
		37.50			30.00						
						Mean, 18	2	51.22	10	56	43.70

Deduction of the results for longitude.

Date.	Signals sent from—	Washington clock.	Correction of Washington clock.	Local sidereal time of the mean of the signals.	Detroit clock.	Correction of Detroit clock.	Local sidereal time of the mean of the signals.	Carlin chronometer.	Correction of the Carlin chronometer.	Local sidereal time of the mean of the signals.	Carlin west of—		Double-wave time for Carlin.		Final difference of longitude: Carlin west of—		Longitude of Detroit.
											Washington.	Detroit.	Washington.	Detroit.	Washington.	Detroit.	
1871.		*h. m. s.*	*s.*	*h. m. s.*	*h. m. s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m.*
May 19	W. to C.	17 36 52.94	−0.72	17 36 52.22	17 13 23.78	−31.73	17 12 52.05	10 46 38.06	+4 13 57.58	15 0 35.64	2 36 16.58	2 12 16.41	[1.30]	[0.77]	2 36 17.23	2 12 16.80	0 24 0.43
May 23	W. to C.	17 40 56.47	+2.79	17 40 59.26	....	......	....	10 34 53.81	+4 29 48.76	15 4 42.57	16.69	....	......	......	....	....	....
May 23	W. to C.	18 37 30.00	+2.75	18 37 32.75	18 14 15.15	42.40	18 13 32.75	11 31 18.02	58.02	16 1 16.04	16.71	16.71	......	......	....	....	....
May 23	C. to W.	17 55 44.24	+2.78	17 55 47.02	17 32 28.97	−42.30	17 31 46.67	10 49 37.97	51.18	15 19 29.15	17.87	17.52	......	......	....	....	....
May 23	C. to W.	18 2 51.22	+2.78	18 2 54.00	....	......	....	10 56 43.70	52.34	15 26 36.04	17.96	....	......	......	....	....	....
May 23	C. to W.	18 28 43.92	+2.76	18 28 46.68	18 5 28.58	−42.38	18 4 46.20	11 22 32.12	56.58	15 52 28.70	17.98	17.50	1.24	0.80	17.32	17.11	0.21
May 24	W. to C.	16 57 10.71	+2.15	16 57 12.86	16 33 58.47	−45.35	16 33 13.12	9 47 14.76	+4 33 41.59	14 20 56.35	16.51	16.77	......	......	....	....	....
May 24	W. to C.	17 3 49.44	+2.15	17 3 51.59	16 40 37.21	−45.36	16 39 51.85	9 53 52.33	42.68	14 27 35.01	16.58	16.84	......	......	....	....	....
May 24	W. to C.	17 26 25.00	+2.16	17 26 27.16	17 3 12.86	−45.39	17 2 27.47	10 16 24.33	46.40	14 50 10.73	16.43	16.74	......	......	....	....	....
May 24	C. to W.	17 12 30.06	+2.15	17 12 32.21	16 49 17.29	−45.37	16 48 31.92	10 2 30.25	44.01	14 36 14.26	17.95	17.66	......	......	....	....	....
May 24	C. to W.	17 19 31.88	+2.15	17 19 34.03	16 56 19.00	−45.38	16 55 33.62	10 9 30.98	45.26	14 43 16.24	17.79	17.38	1.36	0.74	17.19	17.15	0.04

	h. m. s.	*s.*
Carlin west of Washington...	2 36 17.25	±0.026
Carlin west of Detroit........	2 12 17.02	±0.075
Detroit west of Washington...	0 24 0.23	±0.076

Mean places of stars for 1871.0 used for determination of latitude of Carlin, Nevada.

No. of pair.	No. in B. A. C.	Declination.	No. of pair.	No. in B. A. C.	Declination.	No. of pair.	No. in B. A. C.	Declination.
		° ′ ″			° ′ ″			° ′ ″
	4526	25 1 2.73		4825	37 11 39.22		5234	18 32 30.71
1	4540	56 0 36.66	6	4841	44 11 57.58	11	5249	62 59 56.06
	4568	55 20 5.00		4885	42 55 27.50		5322	23 9 52.30
2	4594	26 21 2.56	7	4897	38 20 36.56	12	5348	58 54 37.13
	4640	29 17 1.25		4952	47 47 15.90		5385	36 49 12.83
3	4684	51 35 32.39	8	5000	33 34 10.00	13	5400	44 9 52.74
	4728	42 7 33.27		5071	....		5432	34 11 14.06
4	4758	39 23 16.50	9	5098	....	14	5463	46 37 18.00
	4804	50 25 22.70		5116	62 43 17.93			
5	4808	30 56 20.26	10	5146	18 5 14.96			

Observations for latitude.—Station, Carlin, Nevada.

Date.	No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
1871.					
May 17	4568	12 52.2	13.5	10.0	
	4594	24 66.3	8.0	15.0	
	4640	7 94.7	11.0	12.5	
	4684	31 72.6	15.0	8.3	
	4804	17 35.8	9.8	14.0	
	4808	15 25.6	14.8	9.2	
25	4568	12 92.7	17.2	13.0	
	4594	25 8.0	12.4	18.0	
	4640	7 53.0	14.8	15.3	
	4684	31 30.9	17.0	13.9	
	4728	19 16.9	15.0	18.0	Mistake in reading,
	4758	23 16.7	16.8	15.0	to be excluded.
	4804	18 32.0	16.0	16.2	
	4808	16 8.2	13.2	18.8	
26	4526	11 73.6	17.0	10.0	
	4540	28 74.9	12.4	14.7	
	4568	9 59.0	14.2	12.8	
	4594	21 83.2	15.7	12.5	
	4640	1 45.3	14.8	14.0	
	4684	25 26.9	12.8	16.3	
	4728	16 20.4	13.0	16.0	
	4758	20 65.7	16.0	13.9	
	4804	17 52.5	9.8	21.0	
	4808	15 20.8	19.0	11.8	
	4825	11 91.2	7.2	23.5	
	4841	12 88.3	21.3	9.6	
	4885	25 6.7	16.2	15.0	
	4897	18 53.5	11.3	20.2	
	4952	15 66.2	9.2	19.8	
	5000	12 99.2	16.9	11.7	
	5071	1 62.5	13.0	15.2	
	5098	26 51.6	13.0	15.4	
	5116	33 23.9	17.8	10.5	
	5146	6 18.7	9.0	19.2	
	5234	20 74.2	17.8	11.2	
	5249	15 20.0	9.7	19.8	

Date.	No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
1871.					
May 26	5322	32 51.6	13.8	16.4	
	5348	3 15.4	15.7	13.9	
	5385	9 64.8	13.2	16.2	
	5400	28 88.7	13.8	15.2	
	5432	4 41.7	16.2	13.2	
	5463	36 62.2	7.8	20.8	Must be 31^{t}.
27	4526	6 99.8	22.2	16.2	
	4540	24 6.0	17.8	20.5	
	4568	10 9.2	21.2	16.8	
	4594	22 22.8	15.8	22.7	
	4640	3 18.5	16.0	23.0	
	4684	27 8.0	20.0	19.5	
	4728	10 16.9	18.8	20.7	
	4758	13 78.9	17.5	22.0	Must be 14^{t} $58^{d}.9$.
	4804	13 22.2	18.0	22.0	
	4808	10 87.7	18.2	21.8	
	4825	14 9.3	19.0	21.2	
	4841	15 12.8	17.0	23.3	
	4885	19 69.4	18.8	22.0	Very faint.
	4897	13 5.0	17.6	23.0	
	4952	11 30.0	20.9	20.0	
	5000	8 52.9	13.7	....	Bubble beyond scale.
	5071	2 76.9	5.0	10.2	
	5098	27 51.0	2.3	13.0	
	5116	30 6.0	22.8	18.8	Mistake in reading,
	5146	3 54.7	20.7	21.3	excluded.
	5234	14 97.8	13.8	10.8	
	5249	9 75.9	0.0	21.0	Must be 9^{t} $45^{d}.9$.
	5322	32 87.0	12.0	9.8	
	5348	3 58.3	11.2	10.8	
	5385	5 11.1	18.3	15.7	
	5400	24 37.4	13.2	20.7	
	5432	4 36.0	14.0	23.0	
	5463	31 48.1	21.0	16.2	

Computations for latitude of Carlin, Nevada.

Date.	No. of pair.	Half-sum of declination.	Corrections. Micr. and ref.	Level.	Merid.	Latitude.
1871.		° ′ ″	′ ″	″		° ′ ″
May 17	2	40 50 37.68	— 8 11.00	— 2.36	....	40 42 24.32
	3	26 19.97	+16 1.70	+ 3.51	....	25.18
	5	40 53.23	+ 1 25.00	+ 0.95	....	19.18
May 25	2	40 50 39.29	— 8 11.49	— 0.95	....	40 42 26.85
	3	26 21.67	+16 1.69	+ 1.76	....	25.12
	4	45 29.14	— 2 61.68	— 0.81	....	[26.36]
	5	40 55.10	+ 1 30.50	— 3.92	....	21.68
May 26	1	40 30 55.63	+11 28.04	+ 3.17	....	40 42 26.84
	2	50 39.48	— 8 15.08	+ 3.10	....	27.50
	3	26 21.88	+16 3.18	— 1.82	....	23.24
	4	45 29.37	— 3 0.08	— 0.61	....	28.68
	5	40 55.33	+ 1 33.70	— 2.70	....	26.33
	6	41 52.30	+ 0 39.26	— 3.10	....	28.46
	7	38 5.52	+ 4 24.16	— 5.20	....	24.48
	8	40 44.81	+ 1 47.97	— 3.65	....	29.13
	9	59 17.83	—16 46.65	— 3.10	....	28.08
	10	24 17.32	+18 14.08	— 1.28	....	30.12
	11	46 13.38	— 3 44.13	— 2.36	....	26.89
	12	62 14.01	—19 47.47	— 0.27	....	26.27
	13	29 31.73	+12 58.04	— 2.97	....	26.80
	14	24 14.68	+18 20.25	— 6.75	....	28.18
May 27	1	40 30 55.82	+11 30.02	+ 2.23	....	40 42 28.07
	2	50 39.69	— 8 10.80	— 1.69	....	27.20
	3	26 22.09	+16 6.37	— 4.39	....	24.07
	4	45 29.61	— 2 58.75	— 4.32	....	26.54
	5	40 55.56	+ 1 34.83	— 5.13	....	25.26
	6	41 52.57	+ 0 41.85	— 5.74	....	28.68
	7	38 5.77	+ 4 28.69	— 5.80	....	28.66
	8	40 45.05	+ 1 52.05	— 8.50	....	28.60
	9	59 18.07	—16 40.59	—10.73	....	26.75
	10	24 17.55	—18 12.51	+ 2.30	....	[32.36]
	11	46 13.54	— 3 43.24	— 5.40	....	24.90
	12	62 14.30	—19 44.44	+ 1.76	....	31.62
	13	29 32.00	+12 59.01	— 3.31	....	27.70
	14	24 14.94	+18 16.85	— 2.83	....	28.96

Mean, 40° 42′ 26″.67 ± 0″.28.

We conclude, therefore, that the longitude of Carlin station is 39° 04′ 18″.80 west of Washington, or 116° 07′ 20″.6 west of Greenwich, and the latitude = N. 40° 42′ 26″.67.

BATTLE MOUNTAIN, NEVADA.

Geographical position of station: Longitude, 116° 56′ 13″.50; latitude, 40° 38′ 18″.74 ±0″.21.

The astronomical station is situated near Battle Mountain, Nev., a town on the Central Pacific Railroad. The track of the railroad runs at this point in a nearly north and south direction. The astronomical monument is placed southeastward from the town, and 1,475 feet east of the track, and 1,166 feet from the public-school building. Battle Mountain has about 800 inhabitants. The astronomical station is but slightly elevated above the railroad-track; the place is level, but at a distance of one mile prominent hills and ridges, rising 3,000 feet above the station, are visible. The elevation of the station is determined to be, approximately, 4,500 feet above the level of the sea.

Meteorological conditions.—No detailed meteorological observations were taken at this station. From the diary of the observer it can be seen that it was cloudy almost always during the day, but clear at night. The observer lost much time waiting for the line to Detroit. On some days only very few observations for latitude were taken, after he had waited until late at night expecting to get the use of the wires for longitude-work.

Description of observatory and instruments used.—The construction of the observatory was the same as at Carlin, and a description of it will be found in the report for that station.

The same instruments for time-determination and exchange of signals were also used. For the latter purpose the wires of the Western Union Telegraph Company were employed. The observer, E. P. Austin, was assisted at this point by two enlisted men.

Points with which connections were made.—It was intended to connect Battle Mountain with Washington and Detroit, but it was impracticable to connect with Washington, and the exchange of signals was made with Detroit only, where Mr. O. B. Wheeler, assistant United States lake-survey, conducted both observations and computations.

An explanation of the signs and symbols used in the determination of time at Detroit will be found in the report for Carlin station. The observations made at Battle Mountain were reduced in 1873 by Dr. F. Kampf, and revised in 1874. The arrangement of the report was also made by him.

Instrumental values, &c.—The instrumental values are given in the report for Carlin station. The signals were sent by sound from Battle Mountain, and recorded by eye and ear. At Detroit they were sent by sound also, but recorded on a chronograph. By means of automatic repeaters at Corinne, Cheyenne, Omaha, and Chicago, the signals were transmitted direct to the connected stations.

It has been found impossible to get a better result for longitude. The observer used for temporary monuments pieces of wood buried in the ground, which proved too unsteady to give the most accurate results. These temporary monuments were replaced later by a sandstone pier.

Computation of clock-correction for Detroit, June 1, 1871.

Ill.	Star.	C i	Aberr.	B b	C c	t′	α	(α − t)	v
		s.	s.	s.	s.	h. m. s.	h. m. s.	m. s.	s.
W.	α Serpentis	+.03	−.01	+ .23	+ .11	15 39 04.91	15 37 56.36	−1 08.91	+.08
	ε Serpentis	+.03	−.01	+ .20	+ .10	45 33.21	44 24.71	08.82	− 02
	ζ Ursæ Minoris	+.16	−.07	+ .94	+ .51	49 56.06	48 49.16	08.44	......
	ε Coronæ Borealis	+.03	−.02	+ .24	+ .12	53 24.93	52 16.53	08.77	−.03
	β Scorpii	+.03	−.02	+ .10	+ .11	59 06.39	57 57.91	08.70	−.22
	δ Ophiuchi	+.03	−.01	+ .12	+ .10	16 08 45.31	16 07 36.71	08.84	−.06
	τ Herculis	+.04	−.02	+ .27	+ .15	17 02.15	15 53.74	08.85	+.08
W.	κ Ophiuchi	+.03	−.24	+ .21	+ .11	52 44.06	51 35.27	09.13	+.20
E.	δ Ursæ Minoris	....	−.24	..2.18	−1.76	18 15 23.94	18 14 17.23	06.89	......
	1 Aquilæ	−.03	−.01	+ .12	− .11	29 21.54	28 12.61	08.90	−.23
	ζ Aquilæ	−.03	−.01	+ .19	− .11	19 00 39.26	59 30.13	09.17	+.05
	ω Aquilæ	−.03	−.01	+ .19	− .11	12 56.11	19 11 46.95	09.20	+.06
	δ Aquilæ	−.03	−.01	+ .16	− .10	20 10.03	19 00 85	09.20	+.03
	γ Aquilæ	−.03	−.01	+ .19	− .11	41 17.97	40 08.78	09.23	+.04
	α Aquilæ	−.03	−.01	+ .19	− .11	45 39.61	44 30.50	09.15	−.05
E.	β Aquilæ	−.03	−.01	+ .19	− .11	50 08.92	48 59.71	09.25	+.04

Normal equations.

$$+151.98\,a + 0.96\,\rho - 6.88\,\delta\theta + 19.62 = 0$$
$$+0.96\,a + 42.91\,\rho \qquad - 3.57 = 0$$
$$-6.88\,a \qquad + 16.00\,\delta\theta + 13.45 = 0$$

$a = -0^s.17$

$c = -0^s.10$, lamp east.

$\rho = +0^s.087$, per hour.

$\Delta t = -1^m\,08^s.91 \pm 0^s.021$, at $17^h\,38^m$.

Computation of clock-correction for Detroit, June 3, 1871.

Ill.	Star.	C Δ i	Aberr.	B b	C c	t′	a	(a − t)	v
		s.	s.	s.	s.	h. m. s.	h. m. s.	m. s.	s.
E.	ε Coronæ Borealis	−.04	−.02	+.21	−.03	15 53 30.18	15 52 16.54	−1 13.76	+.32
	β Scorpii	−.03	−.02	+.10	−.03	58 11.40	57 57.93	13.49	+.08
	δ Ophiuchi	−.03	−.01	+.13	−.03	16 08 50.28	16 07 36.73	13.61	+.15
	ξ Ophiuchi	−.03	−.01	+.10	−.03	31 18.43	30 05.02	13.44	−.10
	ζ Herculis	−.04	−.02	+.19	−.03	37 40.56	36 27.16	13.50	−.10
	η Herculis	−.04	−.02	+.20	−.03	39 43.82	38 30.30	13.63	+.01
	α Ophiuchi	−.03	−.01	+.13	−.03	17 30 12.10	17 28 58.34	13.82	+.07
E.	δ Ursæ Minoris	....	−.24	+1.19	−.64	18 15 31.93	18 14 17.33	14.91	......
W.	δ Ursæ Minoris	....	−.24	+1.88	+.64	29.96	....	14.91	......
	1 Aquilæ	+.03	−.01	+.09	−.03	29 26.39	28 12.65	13.88	−.06
	ζ Aquilæ	+.03	−.01	+.09	−.03	19 00 44.14	59 30.17	14.11	+.06
	d Sagittarii	+.03	−.02	+.05	−.03	11 20.41	19 10 06.58	13.92	−.14
	ω Aquilæ	+.03	−.01	+.07	−.03	13 00.93	11 46.99	14.06	−.04
	δ Aquilæ	+.03	−.01	+.06	+.03	20 14.73	19 00.90	13.94	−.17
	γ Aquilæ	.03	−.01	+.16	+.03	41 22.71	40 08.83	14.09	−.10
W.	α Aquilæ	.03	−.01	+.21	−.03	45 44.57	44 30.55	−1 14.28	+.08

Normal equations.

$$144.49\,a + 3.96\,\rho - 3.72\,\delta\theta - 15.88 = 0$$
$$3.96\,a + 29.78\,\rho - 5.67 = 0$$
$$-3.72\,a + 15.00\,\delta\theta + 13.44 = 0$$

$a = 0^s.08.$
$c = 0^s.03$, lamp east.
$\rho = 0^s.201$, per hour.
$\Delta t = -1^m\,13^s.86 \pm 0^s.024$, at $17^h\,50^m$

Computation of clock-correction for Detroit, June 10, 1871.

Ill.	Star.	C Δ i	Aberr.	B b	C c	t′	a	(a − t)	v
		s.	s.	s.	s.	h. m. s.	h. m. s.	m. s.	s.
E.	α Bootis	−.03	−.02	+.13	−.03	14 11 09.32	14 09 47.84	−1 21.53	+.08
	ρ Bootis	−.04	−.02	+.15	−.03	27 39.02	26 17.59	21.49	+.10
	ε Bootis	−.03	−.02	+.14	−.03	40 44.04	39 22.60	21.50	+.09
	α² Libræ	−.03	−.02	+.07	−.03	45 07.50	43 46.10	21.39	−.19
E.	β Ursæ Minoris	....	−.05	+.42	−.10	52 30.36	51 16.30	20.33	......
W.	β Ursæ Minoris	....	−.05	+.71	+.10	36.95	....	20.51	......
	β Libræ	....	−.01	+.14	+.03	15 11 26.75	15 10 05.50	21.41	−.15
	μ¹ Bootis	+.03	−.02	+.28	+.03	20 59.72	19 38.74	21.30	−.06
	α Serpentis	+.03	−.02	+.18	+.03	39 17.67	37 56.38	21.51	.00
	ε Serpentis	+.03	−.01	+.18	+.03	45 46.17	44 24.74	21.66	+.15
	Ursæ Minoris	+.16	−.07	+.88	+.13	50 08.03	48 48.83	20.30	......
	β¹ Scorpii	....	−.02	+.11	+.03	59 19.29	57 57.97	21.44	−.17
	ζ Ophiuchi	+.03	−.01	+.13	+.03	16 31 26.46	16 30 05.08	21.56	−.02
	κ Ophiuchi	+.03	−.01	+.17	+.03	52 56.73	51 35.35	21.60	+.09
	ε Ursæ Minoris	+.24	−.10	+1.12	+.19	17 00 44.49	59 25.78	20.16	......
W.	α¹ Herculis	+.03	−.01	+.17	+.03	10 09.60	17 08 47.59	21.63	+.14
W.	η Serpentis	+.03	−.01	+.12	+.03	18 16 01.00	18 14 39.64	21.53	−.04
W.	51 Cephei, L. C	....	.29	−3.06	−.53	40 18.12	6 38 49.29	25.53	......
E.	51 Cephei, L. C	....	.29	−.65	+.53	14.64	....	.52	......
	ζ Aquilæ	−.03	−.01	+.06	−.03	19 00 51.88	59 30.32	21.55	+.04
	d Sagittarii	−.03	−.02	+.05	−.03	11 28.38	19 10 06.75	21.60	−.05
	ω Aquilæ	−.03	−.01	+.10	−.03	13 08.75	11 47.14	21.64	+.12
	δ Aquilæ	−.03	−.01	+.10	−.03	20 22.64	19 01.05	21.62	−.03
E.	κ Aquilæ	.03	−.01	+.10	.03	31 [illegible]	29 58.46	−1 21.54	−.06

Normal equations.

$$+296.13\,a - 38.83\,\rho + 17.03\,\delta\theta - 1.99 = 0$$
$$-38.83\,a + 69.42\,\rho - 12.35 = 0$$
$$+17.03\,a + 22.06\,\delta\theta + 11.92 = 0$$

$a = -0^s.03$
$c = -0^s.03$, lamp east.
$\rho = 0.009$, per hour.
$\Delta t = -1^m.21^s.34 \pm 0^s.017$ at $16^h\,42^m$

Battle Mountain, Nev., June 1, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
α Virginis	W.	13 17 5.98	+ 0.02	+ 3.23	+ 0 42	13 17 9.65	13 18 25.01	+ 1 15.36
ζ Virginis	....	26 49.52	+ 0.08	+ 2.66	+ 0.41	26 52.67	28 8.32	15.65
η Ursæ Majoris..	....	41 13.48	+ 0.26	− 1.02	+ 0.64	41 13.36	42 28.88	15.52
η Bootis	....	47 16.24	+ 0.18	+ 1.60	+ 0.43	47 18.45	48 33.74	15.29
50 Cap., L. C......	....	50 59.16	− 0.23	+12.11	− 1.31	51 9.73	52 25.27	15.54
τ Herculis	E.	16 14 39.59	− 0.36	− 0.61	− 0.60	16 14 38.02	16 15 53.75	15.73
α Scorpii	....	20 12.34	− 0.11	+ 4.17	− 0.46	20 15.94	21 31.80	15.86
15 Draconis........	....	27 10.04	− 0.54	− 5.44	− 1.15	27 2.91	28 18.51	15.60
α Camelop., L. C .	....	39 44.96	+ 0.14	+ 9.65	+ 1.01	39 55.76	41 11.40	15.64
ε Ursæ Minoris..	....	58 35.38	− 1.21	−20.12	− 3.04	58 11.01	59 25.98	+ 1 14.97
Mean for $15^h\ 0^m$ local sidereal time........								+ 1 15.52

Four different computations to find the error of chronometer were made. The error of collimation adopted from two computations = − $0^s.41$. The method of least squares gave an unsatisfactory result; the azimuth of the instrument was therefore computed from polar and south stars = + $4^s.09$. β Draconis is excluded in the above determination of time, as it gives a result differing too much from those of the other stars.

Battle Mountain, Nev., June 3, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
ζ Virginis	W.	13 26 52.96	− 0.16	+ 0.33	+ 0.32	13 26 53.45	13 28 8.31	+1 14.86
η Ursæ Majoris..	....	41 13.50	− 0.11	− 0.13	+ 0.50	41 13.76	42 28.85	15.09
η Bootis	....	47 18.44	− 0.12	+ 0.20	+ 0.34	47 18.86	48 33.74	14.88
50 Cassiop., L. C ..	....	51 9.85	+ 0.20	+ 1.50	− 1.02	51 10.53	52 25.39	14.86
α Draconis	....	59 41.45	− 0.35	− 0.49	+ 0.86	59 41.47	14 0 46.21	+1 14.74
Mean for $13^h\ 45^m$ local sidereal time........								+1 14.886

Normal equations.

$$0 = -0.23 + 5.00\,\delta t + 2.78\,a \qquad \delta t = -0^s.115$$
$$0 = -2.86 + 2.78\,\delta t + 10.33\,a \qquad a = +0^s.308$$

By preliminary reduction the error of collimation is found = − $0^s.32$; adopted error of azimuth = + $0^s.20$. The azimuth of the instrument found by the method of least squares = + $0^s.508$.

Battle Mountain, Nev., June 3, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
δ Corvi	E.	12 22 51.52	−0.02	+5.84	−0.33	12 42 57.01	12 23 12.00	+1 12.99
κ Draconis.......	....	26 55.48	−0.08	−9.99	−0.96	26 44.45	27 59.50	15.05
γ Virginis	....	33 49.00	−0.04	+4.43	−0.32	33 53.07	35 8.07	15.00
35 Virginis	....	40 59.21	−0.06	+4.02	−0.32	41 2.85	41 18.10	15.25
12 Canum Venat..	....	48 45.52	−0.14	+0.27	−0.41	48 45.24	50 0.39	15.15
θ Virginis	....	54 28.28	−0.12	+3.35	−0.33	54 31.18	55 46.32	15.0
Virginis	....	13 1 57.84	−0.10	+4.83	−0.32	13 2 2.25	13 3 17.30	+1 15.0
Mean for $12^h\ 40^m$ local sidereal time........								+1 15.09

Normal equations.

$$0 = +0.05 + 7.00\,\delta t + 1.90\,a \qquad \delta t = -0^s.01$$
$$0 = -0.02 + 1.90\,\delta t + 4.55\,a \qquad a = +0^s.003$$

The error of collimation is found by preliminary reduction.......... = − $0^s.32$
The azimuth was determined by δ Corvi and κ Draconis............. = + $6^s.70$
And by mean of the least squares the azimuth is given .... = + $6^s.700$

Battle Mountain, Nev., June 10, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
ζ Ursa Minoris ..	W.	15 47 41.85	−2.25	+0.40	+0.06	15 47 40.06	15 48 48.84	+1 8.78
δ Scorpii	....	51 35.88	−0.24	−0.13	+0.01	51 35.52	52 44.21	8.69
β^1 Scorpii	....	56 49.56	−0.29	−0.12	+0.01	56 49.16	57 57.97	8.81
Groom. 2320....	....	16 4 54.42	−1.43	+0.17	+0.03	16 4 53.19	16 6 2.00	8.41
τ Herculis	....	14 45.42	−0.83	+0.02	+0.02	14 44.63	15 53.76	9.13
α Scorpii	....	20 23.40	−0.24	−0.13	+0.01	20 23.04	21 31.88	8.84
Mean for 16^h 0^m local sidereal time								+1 8.84

Normal equations.

$0 = +0.59 + 6.00\,\delta t - 1.47\,a - 12.29\,c$	$t = -0^s.16$
$0 = +1.73 - 1.47\,\delta t + 13.47\,a + 13.71\,c$	$a = -0^s.133$
$0 = +0.36 - 12.28\,\delta t + 13.71\,a + 36.75\,c$	$c = -0^s.012$

From the preceding observations, the following table containing corrections of chronometer and adopted rates for Negus No. 1344 is derived.

1871.	*h.*		*m. s.*	*s.*
June 1,	15.0 local sidereal time:	cor. of chronometer,	+ 1 15.52;	adopted rate, + 0.011
June 3,	13.2 local sidereal time:	cor. of chronometer,	+ 1 14.99;	adopted rate, + 0.023
June 10,	14.8 local sidereal time:	cor. of chroaometer,	+ 1 8.84;	adopted rate, + 0.035

Before and after exchange, comparisons of Negus 1344 and Hutton 288 (mean solar chronometer) were made, as follows:

1871.	*h. m. s.*	*h. m. s.*	*h. m. s.*
June 1. Negus 1374	13 56 30.0	13 59 34.0	
Hutton 288	8 55 57.5	8 58 51.0	
After exchange:			
Negus 1344	15 57 56.0	16 00 59.0	16 4 6.0
Hutton 288	10 56 53.5	10 59 56.0	11 3 2.5
June 3. Negus 1344	14 5 2.0	14 8 5.0	
Hutton 288	8 56 25.0	8 59 27.5	
After exchange:			
Negus 1344	15 0 40.5	15 3 44.0	15 6 49.0
Hutton 288	9 51 54.0	9 54 57.0	9 58 1.5
June 10. Negus 1344	14 14 13.0	14 17 17.0	
Hutton 288	8 37 57.0	8 41 0.5	
After exchange:			
Negus 1344	15 38 24.0	15 41 26.0	
Hutton 288	10 1 54.0	10 4 55.5	

From these comparisons the following table for mean-time chronometer Hutton 288 is derived.

Hutton 288.

	Hutton time.	Slow of sidereal time.	Losing per hour.	Log.
	h.	*h. m. s.*	*s.*	
June 1, 1871	8.95535	5 1 58.28	9.898	0.9955363
	10.99925	2 18.51		
June 3, 1871	8.96562	9 52.20	10.249	1.0106754
	9.91597	10 1.94		
June 10, 1871	8.65799	37 25.11	9.949	0.9977580
	10.06021	37 39.06		

Exchange of signals between Detroit, Mich., and Battle Mountain, Nev.

June 1, 1871.—*Signals sent from Detroit.*

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	22	40.25	10	3	49.83				10	5	......	17	26	20.05	10	7	29.00
		50.06			50.60	17	24	40.10			49.30			30.20			39.00
	23	0.35		4	9.80			50.20			59.10			40.20			49.00
							25	0.24		6	9.40			50.15			59.00
	24	0.21		5	9.80								27	0.21		8	9.00
		10.03			19.20		26	0.25		7	9.30						
		20.05			29.20			10.19			19.00	Mean, 17	25	3.92	10	6	13.03

SECOND SERIES.

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	52	40.29	10	33	44.80	17	54	50.10	10	35	54.40	17	57	0.05	10	38	4.00
		50.21			54.70		55	0.08		36	4.30			10.05			14.00
	53	0.21		34	4.60			10.18			14.30			20.10			23.90
		10.20			14.50			20.10			24.00			30.20			33.90
		20.15			24.50			30.20			34.10			40.10			44.00
		30.20			34.50			40.20			44.20						
		40.11			44.50							Mean, 17	55	10.14	10	36	14.26
							56	40.05		37	43.90						
	54	40.08		35	44.30			50.14			54.00						

Signals sent from Battle Mountain.

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	40	24.31	10	22	10.00	17	44	54.92	10	26	40.00	17	46	15.10	10	28	0.00
		29.50			15.00			59.95			45.00			20.05			5.00
		34.22			20.00		45	4.90			50.00			25.12			10.00
		39.31			25.00			9.92			55.00			30.25			15.00
		44.28			30.00			14.91		27	0.00			35.20			20.00
		49.45			35.00			19.90			5.00			40.50			25.00
		54.60			40.00			24.98			10.00			45.35			30.00
								30.10			15.00			50.30			35 00
	44	14.88		26	0.00			35.15			20.00			55.31			40.00
		19.69			5.00			40.40			25 00		47	0.20			45.00
		24.80			10.00			45.10			30.00			5.19			50.60
		29.90			15 00			50.27			25.00			10.30			55.00
		34.88			20.00			55.06			40.00			15.20		29	0.00
		39.92			25.00		46	0.20			45.00						
		45.00			30.00			5.18			50.00	Mean, 17	44	56.44	10	26	41.48
		49.75			55.00			10.06			55.00						

June 3, 1871.—*Signals sent from Detroit.*

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
16	41	......	9	14	......	16	43	10.12	9	16	28.80	16	45	20.05	9	18	38.40
		10.25			29.10			20.08			38.60			30.25			48.50
		20.00			39.00			30.10			48.60			40.12			58.50
		30.15			49 10			40.20			58.70			50.12		19	8.30
		40.25			59.10			50.29		17	8.60		46	0.40			18.50
		50.37		15	9.20		44	0.30			18.80						
	42	0.25			19.00							Mean, 16	43	37.70	9	16	56.24
							45	0.28		18	18.60						
	43	0.38		16	19.00			10.08			28.40						

SECOND SERIES.

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	0	0.25	9	31	16.50	17	2	10.20	9	33	25.80	17	4	20.20	9	35	35.40
		10.05			26.10			20.18			35.80						......
		20.13			36.20			30.15			45.80			40.18			55.50
		30.21			46.30			40.21			55.80			50.25		36	5.40
		40.11			56.00			50.13		34	6.00		5	0.20			15.20
		50.23		32	6.00		3	0.18			16.00						
	1	0.41			16.00							Mean, 17	2	24.19	9	33	39.83
							4	0.10		35	15.40						
	2	0.30		33	15.90			10.20			25.50						

Signals sent from Battle Mountain.

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
16	49	43.23	9	23	0.00	16	51	28.72	9	24	45.00	16	53	13.93	9	26	30.00
		48.30			5.00			33.45			50.00			19.05			35.00
		53.12			10.00			38.60			55.00			23.88			40.00
		58.20			15.00			43.70		25	0.00			28.80			45.00
	50	3.30			20.00			48.70			5.00			33.90			50.00
		8.83			25.00			53.59			10.00			38.85			55.00
		13.50			30.00			58.59			15.00			43.82		27	0.00
		18.61			35.00		52	3.85			20.00			48.90			5.00
		23.68			40.00			8.83			25.00			53.80			10.00
		28.68			45.00			13.81			30.00			59.10			15.00
		33.45			50.00			18.89			35.00		54	4.10			20.00
		38.60			55.00			23.78			40.00			9.34			25.00
		43.42		24	0.00			28.71			45.00			14.10			30.00
		48.41			5.00			33.74			50.00			19.20			35.00
		53.45			10.00			38.59			55.00			24.36			40.00
		58.55			15.00			43.60		26	0.00			29.20			45.00
	51	3.50			20.00			48.68			5.00			34.08			50.00
		8.82			25.00			53.70			10.00			39.15			55.00
		13.60			30.00			58.75			15.00			44.00		28	0.00
		18.70			35.00		53	3.71			20.00						
		23.70			40.00			8.95			25.00	Mean, 16	52	13.75	9	25	30.00

JUNE 10, 1871.—*Signals sent from Detroit.*

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	12	......	9	17	......	17	14	10.00	9	19	44.80	17	16	20.10	9	21	54.60
		10.10			45.10			20.15			54.90			30.10		22	4.50
		20.25			55.40			30.10		20	4.90			40.10			14.40
		30.20		18	5.40			40.10			14.90			50.15			24.20
		40.45			15.50			50.20			24.80		17	0.55			34.10
		50.20			25.10		15	0.10			34.60						
	13	0.20			35.10							Mean, 17	14	37.69	9	20	12.32
							16	0.43		21	34.60						
	14	0.25		19	35.10			10.10			44.40						

SECOND SERIES.

Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.			Detroit clock.			Battle Mountain chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
17	26	30.24	9	32	3.00	17	28	40.21	9	34	12.60	17	30	50.15	9	36	22.00
		40.00			12.70			50.21			22.50		31	0.00			32.00
		50.20			22.70			59.84			32.20			10.26			42.10
	27	0.20			32.70		29	10.12			42.40			20.10			52.00
		10.10			42.60			20.15			52.40			30.30		37	2.10
		20.12			52.50			30.21		35	2.40						
		30.10		33	2.60							Mean, 17	29	0.15	9	34	32.40
							30	30.21		36	2.20						
	28	30.27		34	2.60			40.18			12.20						

Signals sent from Battle Mountain.

Detroit clock.	Battle Mountain chronometer.	Detroit clock.	Battle Mountain chronometer.	Detroit clock.	Battle Mountain chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
17 19 26.69	9 25 0.00	17 21 6.93	9 26 40.00	17 22 47.29	9 28 20.00
31.75	5.00	12.08	45.00	52.38	25.00
36.60	10.00	17.20	50.00	57.30	30.00
41.80	15.00	21.86	55.00	23 2.46	35.00
46.90	20.00	27.08	27 0.00	7.42	40.00
51.84	25.00	32.01	5.00	12.49	45.00
56.88	30.00	36.82	10.00	17.45	50.00
20 1.92	35.00	41.90	15.00	22.50	55.00
7.15	40.00	47.18	20.00	27.55	29 0.00
12.10	45.00	51.92	25.00	32.41	5.00
17.03	50.00	57.25	30.00	37.48	10.00
22.00	55.00	22 2.15	35.00	42.40	15.00
26.90	26 0.00	7.24	40.00	47.62	20.00
32.00	5.00	12.45	45.00	52.55	25.00
37.00	10.00	17.25	50.00	57.50	30.00
41.96	15.00	22.50	55.00	24 2.72	35.00
46.95	20.00	27.35	28 0.00		
51.95	25.00	32.35	5.00	Mean, 17 21 44.66	9 27 17.50
56.98	30.00	37.32	10.00		
21 2.00	35.00	42.30	15.00		

Deduction of the results for longitude.

Date.	Signals sent from—	Detroit clock.	Clock correction.	Local sidereal time of the mean of the signals.	Battle Mountain chronometer.	Correction of chronometer.	Local sidereal time of the mean of the signals.	Differences of longitude.	Mean.	Double-wave time.	Final differences of longitude.
		h. m. s.	m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	s.	h. m. s.
June 1, 1871	Detroit to Battle Mountain.	17 25 3.92	−1 8.91	17 23 55.01	10 6 13.03	+5 2 9.65	15 8 22.68	2 15 32 33	......	.....	....
June 1, 1871	Detroit to Battle Mountain.	17 55 10.14	1 8.94	17 54 1.20	10 36 14.26	2 14.60	15 38 28.86	32.34	32.34	.....	....
June 1, 1871	Battle Mountain to Detroit.	17 44 56.44	1 8.92	17 43 47.52	16 26 41.48	2 13.02	15 28 54.50	33.02	33.02	0.68	2 15 32.68
June 3, 1871	Detroit to Battle Mountain.	16 43 37.70	−1 13.64	16 42 24.06	9 16 56.24	+5 9 55.45	14 26 51.69	32.37	......	.....	....
June 3, 1871	Detroit to Battle Mountain.	17 2 24.19	1 13.69	17 1 10.50	9 33 39.83	9 58.30	14 43 38.13	32.37	32.37	.....	....
June 3, 1871	Battle Mountain to Detroit.	16 52 13.75	1 13.67	16 51 0.08	9 25 30.00	9 56.91	14 35 26.91	33.17	33.17	0.80	32.77
June 10, 1871	Detroit to Battle Mountain.	17 14 37.69	−1 21.34	17 13 16.35	9 20 12.32	+5 37 31.87	14 57 44.19	32.16	......	.....	....
June 10, 1871	Detroit to Battle Mountain.	17 29 0.15	1 21.35	17 27 38.80	9 34 32.40	37 34.24	15 12 6.64	32.16	32.16	.....	....
June 10, 1871	Battle Mountain to Detroit.	17 21 44.66	1 21.34	17 20 23.32	9 27 17.50	37 33.04	15 4 50.54	32.78	32.78	0.62	32.47

Battle Mountain west of Detroit $2^h\ 15^m\ 32^s.64 \pm 0^s.06$.

Mean places of stars for 1871.0 used for determination of latitude of Battle Mountain, Nev.

No. of pair.	No. in B. A. C.	Declination.	No. of pair.	No. in B. A. C.	Declination.	No. of pair.	No. in B. A. C.	Declination.
		° ′ ″			° ′ ″			° ′ ″
1	4568	55 20 5.00	7	4825	37 11 39.22		5385	36 49 12.83
	4594	26 21 2.56		4841	44 11 57.58	13	5400	44 9 52.74
2	4605	55 4 38.28	8	4863	37 18 26.30			
						14	5432	34 11 14.06
	4640	29 17 1.25		4952	47 47 15.90		5463	46 37 18.00
3	4684	51 35 32.39	9	5000	33 34 10.00	15	5479	34 6 14.86
	4694	31 28 3.52		5072	33 23 49.53		5541	30 46 15.72
4	4701	50 4 5.00	10	5113	48 9 26.29	16	5549	50 24 52.85
	4723	29 42 34.42		5157	43 35 44.60		5596	49 10 53.84
5	4752	51 54 18.25	11	5178	37 3 21.00	17	5604	31 50 17.80
	4804	50 25 22.70		5252	21 22 3.96		5752	56 52 42.77
6	4808	30 56 20.26	12	5307	59 17 3.64	18	5798	24 23 49.00

Observations for latitude.—Station, Battle Mountain, Nev.

Date.	No. of star.	Micrometer-readings.		Level.		Remarks.
		t.	d.	N.	S.	
1871.						
June 6	5432	1	41.5	18.2	15.5	
	5463	22	13.9	18.5	15.2	
	5479	−2	34.4	18.2	15.8	
	5541	12	62.2	17.5	16.8	
	5549	16	49.0	22.0	12.0	
June 7	5252	7	48.2	17.0	15.0	
	5307	35	8.2	18.0	13.8	
	5385	11	72.2	21.8	10.2	
	5400	24	59.5	12.8	19.0	
	5432	13	81.0	15.6	15.0	
	5463	34	47.8	20.0	12.8	
	5479	10	19.2	16.3	16.3	
	5541	18	53.0	20.3	13.0	
	5549	22	35.3	18.0	15.0	
June 8	4568	11	10.0	12.0	10.5	
	4594	29	47.0	12.0	10.5	
	4605	22	55.8	10.7	12.0	
	4640	11	88.8	10.2	12.2	
	4684	29	50.3	13.0	10.2	
	4694	26	51.0	15.5	8.0	
	4701	14	83.6	8.0	16.0	
	4723	23	28.0	12.6	11.8	
	4752	5	48.9	14.0	10.3	Is No. 4742.
	4825	23	27.9	14.8	10.0	
	4841	17	78.8	14.0	10.5	
	4863	28	28.0	14.0	11.0	
	5072	24	9.1	11.8	11.8	
	5113	11	63.6	12.8	11.8	
	5157	32	29.5	15.0	9.5	
	5178	4	65.3	10.0	14.8	
1871.						
June 8	5252	7	91.0	15.0	10.0	
	5307	35	67.0	10.0	15.0	
	5385	8	97.8	13.0	12.5	
	5400	26	90.5	14.8	11.0	Must be 21^t.
	5432	13	76.8	15.8	10.0	
	5463	34	43.5	12.8	13.0	
	5479	10	1.6	15.8	10.0	
	5541	18	16.2	9.5	16.8	
	5549	21	98.9	21.2	5.0	
	5596	25	79.9	12.0	14.0	
	5604	14	51.0	17.5	8.8	
	5752	23	64.8	17.8	9.2	
	5798	23	83.8	17.0	10.2	
June 9	4568	9	86.2	12.0	11.0	
	4594	28	12.0	8.0	15.8	
	4640	10	87.9	13.5	10.3	
	4684	28	79.0	4.0	20.8	
	4694	26	40.2	6.2	18.8	
	4701	14	80.0	17.0	8.0	
	4723	25	68.9	11.2	13.5	Must be 23^t.
	4752	5	93.8	11.2	13.2	
	4804	12	78.2	12.0	13.0	
	4808	16	67.7	13.0	12.2	
	4825	22	94.2	14.0	11.8	
	4841	17	56.7	12.8	13.2	
	4863	27	94.5	16.0	10.5	
	4952	20	42.5	19.2	7.8	
	5000	24	28.5	13.0	15.0	
	5072	23	56.7	14.0	14.0	
	5113	10	87.0	20.8	7.2	

Computations for latitude of Battle Mountain, Nev.

Date.	No. of pair.	Half-sum of declination.	Corrections. Micr. and refr.	Corrections. Level.	Corrections. Merd.	Latitude.
		° ′ ″	′ ″	″		° ′ ″
June 6, 1871	....	40 24 17.66	+13 58.11	+ 4.05	....	40 38 19.82
	....	21 47.85	+16 30.13	+ 3.85	....	21.83
	....	35 35.02	+ 2 36.42	+ 7.26	....	18.70
June 7, 1871	....	40 19 36.46	+18 36.24	+ 4.19	....	16.89
	....	29 34.96	+ 8 40.61	+ 3.64	....	19.21
	....	24 17.95	+13 56.25	+ 5.26	....	19.46
	....	21 48.09	+16 22.16	+ 4.86	....	15.11
	....	35 35.30	+ 2 34.57	+ 6.95	....	16.82
June 8, 1871	....	40 50 41.76	−12 22.92	+ 2.02	....	40 38 20.86
	....	42 56.26	− 4 39.54	+ 0.14	....	16.86
	....	26 24.30	−11 52.38	+ 0.54	....	17.22
	....	46 11.65	− 7 52.12	+ 0.34	....	19.19
	....	50 17.23	−11 59.50	+ 3.04	....	20.77
	....	41 54.87	− 3 42.07	+ 5.60	....	18.40
	....	45 18.28	− 7 4.31	+ 4.32	....	18.29
	....	46 42.34	− 8 23.70	+ 0.67	....	19.31
	....	19 36.73	+18 37.91	+ 0.47	....	15.11
	....	19 36.72	+18 42.71	0.00	....	19.43
	....	29 35.22	+ 8 42.78	+ 2.90	....	20.90
	....	24 18.20	+13 55.82	+ 3.78	....	17.80
	....	21 48.38	+16 27.55	+ 3.78	....	19.71
	....	35 35.57	+ 2 34.77	+ 6.01	....	16.35
	....	30 36.80	+ 7 36.54	+ 4.52	....	17.86
	....	38 15.72	− 0 7.68	+10.39	....	18.43
June 9, 1871	....	40 50 41.91	−12 18.29	− 4.59	....	18.93
	....	26 24.51	+12 4.34	− 9.18	....	19.67
	....	46 11.84	− 7 49.20	− 2.43	....	20.21
	....	50 17.41	−11 57.88	− 2.90	....	16.63
	....	40 58.28	− 2 37.51	− 0.14	....	20.63
	....	41 55.08	− 3 37.37	+ 1.21	....	18.92
	....	45 18.49	− 6 59.70	+ 3.44	....	22.23
	....	40 48.50	− 2 36.10	+ 6.34	....	18.74
	....	46 42.59	− 8 33.49	+ 9.18	....	18.28

Mean latitude of Battle Mountain, Nev., 40° 38′ 18″.74 ±0″.21.

Resulting astronomical co-ordinates.

Adopting the longitude of Detroit as given in the Report of the Chief of Engineers for 1871, to be—

0h 24m 0.14s west of Washington, or

83° 3′ 3″.90 west of Greenwich—

The resulting astronomical co-ordinates of Battle Mountain, Nev., will be—

Longitude: 116° 56′ 13″.50 west of Greenwich.

39° 53′ 11″.70 west of Washington.

Latitude: N. 40° 38′ 18″.74 ±0″.21.

AUSTIN, NEVADA.

Longitude 117° 03′ 41″.70; latitude 39° 29′ 21″.92.

The astronomical station is situated near Austin, Nev., in the cañon through which the road to Belmont passes. A short distance above the Manhattan Mill, to the east of the station, the land rises rapidly to Mount Prometheus; to the north, there is a slope downward to the valley of the Reese River. The mountains to the south and west rise to a height of several hundred feet above the station. The weather seems to have been quite fair when the station was occupied; at least, at night. During the day the clouds accumulated about 3 p. m., clearing again at 11 p. m. No detailed meteorological observations were made by the observer. The observations were taken in the same tent used at Carlin and Battle Mountain; the instrument was placed on three pieces of board buried three feet in the ground. The observer, E. P. Austin, was assisted by two soldiers.

The wires of the Western Union Telegraph Company were used for exchange of signals. For time and latitude observations the same instruments were used as at Carlin and Battle Mountain, a description of which is given in the proper place in the report on Carlin.

Connection was made with Washington and Detroit; Washington could be reached only once. The result derived from the exchanges between Austin, and Detroit and Washington for the longitude of Detroit is again larger than that given in the Report of the Chief of Engineers for 1871. This discrepancy of the results, being all independent of each other, will be investigated at another time.

The observations for time were taken on the 16th, 26th, and 29th of June; those for latitude on June 15, 17, 21, and 23. The corresponding determinations for time at Detroit were taken by Mr. O. B. Wheeler, assistant United States lake-survey, and at Washington by Prof. John R. Eastman, United States Naval Observatory. The reductions of the observations, made at the connected places, were made in the respective offices; those for Austin station by Dr. F. Kampf, who also prepared the report.

The explanation of signs in the report for the Detroit observations will be found in the report for Carlin; the same report contains the observations and computations for time relating to Washington.

For the reductions of observations made at Austin, the same instrumental values as given in the report on Carlin station were used. The signals were sent through by means of automatic repeaters; the number of them and also the places where they are situated are given in the Carlin report.

Computation of clock-correction for Detroit, June 16, 1871.

Ill.	Star.	C △ i	Aberr.	B b	C c	t′	a	(a—t)	v
		s.	s.	s.	s.	h. m. s.	h. m. s.	m. s.	s.
W.	β Bootis	+ .04	− .02	+ .29	+ .08	14 58 32.36	14 57 06.78	−1 25.97	+ .16
	48 Cephei, L. C	....	+ .06	− .47	− .29	15 05 25.12	3 03 58.79	25.63	......
	β Libræ	+ .03	− .01	+ .14	+ .07	11 30.94	15 10 05.49	25.68	− .15
	α Coronæ Borealis	+ .03	− .02	+ .23	+ .07	30 40.68	29 15.14	25.85	+ .01
	α Serpentis	+ .03	− .01	+ .19	+ .07	39 22.07	37 56.38	25.97	+ .12
	ε Serpentis	+ .03	− .01	+ .19	+ .06	45 50.31	44 24.75	25.83	− .03
	ζ Ursæ Minoris	+ .16	− .07	+ .97	+ .31	50 12.81	48 48.52	25.66	− .16
	ε Coronæ Borealis	+ .03	− .02	+ .28	+ .07	53 42.05	52 16.54	25.87	+ .01
W.	δ Ophiuchi	+ .03	− .01	+ .18	+ .06	16 09 02.44	16 07 36.79	25.91	+ .03
E.	ζ Ophiuchi	− .03	− .01	+ .12	− .07	31 30.68	30 05.11	25.58	− .32
	η Herculis	− .04	− .02	+ .24	− .08	39 56.30	38 30.35	26.05	+ .14
	κ Ophiuchi	− .03	− .01	+ .17	− .07	53 01.20	51 35.39	25.87	− .05
	ε Ursæ Minoris	....	− .10	+1.16	− .47	17 00 50.24	59 25.52	25.31	......
E.	a^1 Herculis	− .03	− .02	+ .18	− .07	10 13.51	17 08 47.64	25.93	.00
E.	κ Aquilæ	− .03	− .01	+ 06	− .07	19 31 24.57	19 29 58.59	25.93	− .01
	γ Aquilæ	− .03	− .01	+ .08	− .07	41 35.08	40 09.12	25.93	− .05
	α Aquilæ	− .03	− .01	+ .08	− .07	45 56.92	44 30.85	26.04	+ .07
	β Aquilæ	− .03	− .01	+ .07	− .07	50 26.10	49 00.06	26.00	+ .03
E.	λ Ursæ Minoris	....	− .74	+3.88	−3.39	19 55 44.83	54 13.55	31.03	......
W.	λ Ursæ Minoris	....	+ .74	+3.88	....	29.67	....	....	......
	a^2 Capricorni	+ .03	− .01	+ .06	+ .07	20 12 21.07	20 10 55.20	26.02	+ .08
W.	ε Delphini	+ .03	− .01	+ .09	+ .07	28 30.22	27 04.33	26.07	+ .06

Normal equations.

$$+49.63\,a \qquad\qquad + 9.61\,\rho + 1.74\,\delta\theta + 3.60 = 0$$
$$+ 1480.91\,a' + 90.89\,\rho - 34.62\,\delta\theta - 228.03 = 0$$
$$+ 9.61\,a + 90.89\,a' + 77.44\,\rho \qquad - 16.81 = 0$$
$$+ 1.74\,a - 34.62\,a' \qquad + 21.00\,\delta\theta + 23.13 = 0$$

$a = -\,0^s.01$

$a' = +\,0^s.14$

$c = -\,0^s.06$ lamp east.

$\rho = +\,0^s.051$, per hour.

$\Delta t = -\,1^m\,25^s.93 \pm 0^s.019$ at $17^h\,19^m$

Computation of clock-correction for Detroit, June 26, 1871.

Ill.	Star.	C Δ i	Aberr.	B b	C c	t′ h.	t′ m.	t′ s.	α h.	α m.	α s.	(α−t) m.	(α−t) s	v
		s.	s.	s.	s.	h.	m.	s.	h.	m.	s.	m.	s	s.
E.	β Bootis	−.08	−.02	+ .15	− .10	14	58	35.55	14	57	06.66	−1	28.84	+.16
	48 Cephei, L. C	+.14	+.06	− .27	+ .35	15	05	28.01	15	03	59.68		28.61	......
	μ¹ Bootis	−.08	−.02	+ .18	− .10		21	07.49		19	38.63		28.84	+.17
	α Coronæ Borealis	−.07	−.02	+ .17	− .09		30	43.75		29	15.09		28.65	+.01
	α Scorpii	−.06	−.01	+ .13	− .08		39	24.93		37	56.37		28.54	+.06
	ε Serpentis	−.06	−.01	+ .14	− .08		45	53.16		44	24.74		28.41	−.19
	ε Coronæ Borealis	−.07	−.02	+ .20	− .09		53	45.14		52	16.50		28.66	+.04
	δ Ophiuchi	−.06	−.01	+ .14	− .08	16	09	05.23	16	07	36.81		28.41	−.16
	ζ Ophiuchi	−.06	−.01	+ .13	− .08		31	33.49		30	05.14		28.33	−.21
E.	κ Ophiuchi	−.06	−.01	+ .18	− .08		53	03.93		51	35.42		28.54	.00
W.	δ Ophiuchi	+.06	−.01	+ .15	+ .08	17	30	26.85	17	28	58.56		28.57	+.05
W.	ζ Aquilæ	+.06	−.01	+ .20	+ .08	19	00	58.79	18	59	30.57		28.55	+.11
	ω Aquilæ	+.06	−.01	+ .16	+ .08		13	15.69	19	11	47.40		28.58	+.14
	δ Aquilæ	+.06	−.01	+ .13	+ .08		20	29.48		19	01.35		28.39	−.02
	κ Aquilæ	+.06	−.01	+ .10	+ .08		31	26.91		29	58.78		28.36	−.02
W.	λ Ursæ Minoris	......	−.74	+4.78	+4.12		55	40.46		54	16.37		32.25	.00
E.	ε Delphini	−.06	−.01	+ .11	− .08	20	28	32.83	20	27	04.55		28.24	−.13
	α Cygni	−.08	−.02	+ .18	− .11		38	32.63		37	03.96		28.64	+.22
	μ Aquarii	−.06	−.01	+ .08	− .08		47	11.52		45	43.19		28.26	−.06
	32 Vulpeculæ	−.07	−.02	+ .12	− .09		50	33.70		49	05.35		28.29	−.06
	61¹ Cygni	−.08	−.02	+ .16	− .10	21	02	37.45	21	01	08.83		28.58	+.10
E.	ζ Cygni	−.07	−.02	+ .13	− .09		08	56.69		07	28.32		28.32	−.04

Normal equations.

$$+1502.25\,a + 83.30\,\rho - 25.67\,\delta\theta - 157.33 = 0$$
$$+83.30\,a + 111.16\,\rho - 2.30 = 0$$
$$-25.67\,a + 22.00\,\delta\theta + 14.86 = 0$$

$a = +0^{s}.10$

$c = -0^{s}.08$, lamp east.

$\rho = -0^{s}.053$, per hour.

$\Delta t = -1^{m}\ 28^{s}.54 \pm 0^{s}.019$, at $18^{h}\ 04^{m}$

Computation of clock-correction for Detroit, June 29, 1871.

No wires.	Ill.	Star.	C Δ i	Aberr.	B b	C c	t′ h.	t′ m.	t′ s.	α h.	α m.	α s.	(α—t) m.	(α—t) s.	v
			s.	s.	s.	s.	h.	m.	s.	h.	m.	s.	m.	s.	s.
9	W.	β Ursæ Minoris	+.23	−.05	+ .68	+ .13	14	52	32.24	14	51	09.25	−1	23.98	......
9		β Bootis	+.08	−.02	+ .26	+ .04		58	30.83		57	06.62		24.57	+.08
9		β Libræ	+.06	−.01	+ .11	+ .04	15	11	29.59	15	10	05.45		24.34	+.13
5		μ¹ Bootis	+.04	−.02	+ .23	+ .04		21	02 77		19	38.60		24.46	.00
9		α Serpentis	+.06	−.01	+ .16	+ .04		39	20.55		37	56.36		24.44	+.01
9		ε Serpentis	+.06	−.01	+ .17	+ .04		45	48.84		44	24.73		24.27	−.15
5		ζ Ursæ Minoris	+.16	−.07	+ .88	+ .17		50	10.47		48	47.70		23.91	......
9		ε Coronæ Borealis	+.04	−.02	+ .25	+ .04		53	40.61		52	16.49		24.43	+.02
9		β¹ Scorpii	+.06	−.01	+ .12	+ .04		59	22.05		57	58.00		24.26	−.14
9		δ Ophiuchi	+.06	−.01	+ .17	+ .03	16	08	00.89	16	07	36.81		24.23	−.17
5		τ Herculis	+.05	−.02	+ .37	+ .05		17	17.83		15	53.64		24.64	+.26
9		ζ Ophiuchi	+.06	−.01	+ .15	+ .04		31	29.14		30	05.15		24.23	−.13
9		ζ Herculis	+.07	−.02	+ .29	+ .04		37	51.37		36	27.20		24.55	+.20
9		η Herculis	+.07	−.02	+ .29	+ .04		39	54.39		38	30.31		24.46	+.11
9		κ Ophiuchi	+.06	−.01	+ .22	+ .04		52	59.59		51	35.43		24.47	+.14
7	W.	ε Ursæ Minoris	......	−.10	+1.49	+ .25	17	00	46.86		59	24.69		23.81	......
5	E.	α¹ Herculis	+.03	−.01	+ .13	− .04		10	12.00	17	08	47.70		24.35	+.04
5		α Ophiuchi	+.03	−.01	+ .13	− .04		30	22.82		28	58.58		24.29	+.01
5		μ Herculis	+.04	−.02	+ .16	− .04		42	50.72		41	26.50		24.28	+.02
5		δ Ursæ Minoris	+.54	−.24	+1.79	− .57	18	15	41.00	18	14	16.93		24.51	......
5		κ Aquilæ	+.03	−.01	+ .12	− .04	19	31	22.83	19	29	58.83		24.04	−.07
5		γ Aquilæ	+.03	−.01	+ .13	− .04		41	33.41		40	09.36		24.10	.00
5		α Aquilæ	+.03	−.01	+ .10	− .04		45	55.05		44	31.09		23.98	−.12
3	E.	λ Ursæ Minoris	......	−.74	+1.79	−1.81		55	41.23		54	17.05		23.42	......

Normal equations.

$$1661.89\,a + 125.63\,\rho - 51.00\,\delta\theta + 19.91 = 0$$
$$+ 125.63\,a + 55.18\,\rho + 4.89 = 0$$
$$- 51.00\,a + 24.00\,\delta\theta + 6.02 = 0$$

$a = -0^s.003.$
$c = -0^s.03$, lamp east.
$\rho = -0^s.082$, per hour.
$\Delta t = -1^m\,24^s.33 \pm 0^s.019$, at $16^h\,53^m$.

Austin, Nev., June 16, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
η Bootis	E.	13 48 1.08	+0.22	+0.76	−0.36	13 48 1.70	13 48 33.64	+0 31.94
50 Cassiopeæ, L. C.		51 47.76	−0.25	+6.15	+1.08	51 54.74	52 26.28	31.54
α Draconis		14 0 26.42	+0.53	−2.11	−0.80	14 0 24.04	14 0 55.45	31.41
α Bootis		9 15.28	+0.29	+0.74	−0.36	9 15.95	9 47.80	31.85
ι Cassiopeæ, L. C.	W.	17 50.35	−0.12	+5.04	−0.86	17 54.41	18 26.44	32.03
θ Bootis		20 17.51	+0.28	−0.76	+0.56	20 17.59	20 49.86	32.27
5 Ursæ Minoris		27 24.62	+0.58	−5.20	+1.43	27 21.43	27 53.23	31.80
ε Bootis		38 49.72	+0.13	+0.48	+0.38	38 50.71	39 22.56	+0 31.85
Mean for $14^h\,30^m$ local sidereal time								+0 31.836

Normal equations.

$0 = + 0.08 + 8.00\,\delta t - 2.47\,a' - 3.15\,c \qquad \delta t = -0^s.163$
$0 = + 1.00 + 2.47\,\delta t + 22.68\,a' + 5.92\,c \qquad a' = +0^s.063$
$0 = + 14.82 - 3.15\,\delta t + 5.99\,a' + 46.35\,c \qquad c = -0^s.339$

Adopted azimuth $= + 2^s.00$; the whole azimuth of the instrument, $a = + 2^s.063$.

Austin, Nev., June 16, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
θ Sagittarii	E.	19 9 31.40	−0.03	+4.44	−0.36	19 9 35.45	19 10 6.88	+0 31.43
δ Draconis		12 9.85	−0.15	−6.00	−0.89	12 2.81	12 34.46	31.65
δ Aquilæ		18 27.26	−0.06	+2.93	−0.34	18 29.79	19 1.17	31.38
κ Aquilæ		29 23.80	0.00	+3.56	−0.34	29 27.02	29 58.59	31.57
γ Aquilæ		39 35.78	+0.04	+2.39	−0.35	39 37.86	40 9.12	31.26
α Aquilæ		43 57.38	+0.06	+2.54	−0.35	43 59.63	44 30.85	31.22
ε Draconis		48 15.98	+0.25	−7.22	−0.99	48 8.02	48 39.22	+0 31.20
Mean for $19^h\,30^m$ local sidereal time								+0 31.387

Normal equations.

$0 = - 0.55 + 7.00\,\delta t + 0.54\,a' \qquad \delta t = + 0^s.08$
$0 = + 0.68 + 0.54\,\delta t + 5.93\,a' \qquad a' = - 0^s.122$

Adopted azimuth, $+ 5^s.00$; whole azimuth, $+ 4^s.878$.

Austin, Nev., June 26, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
α Draconis	W.	14 0 9.75	+0.91	+13.11	+1.35	14 0 25.12	14 0 55.45	+0 30.33
κ Virginis		5 42.48	+0.25	− 9.89	+0.58	5 33.42	6 2.09	28.67
α Bootis		9 22.60	+0.30	− 4.60	+0.61	9 18.91	9 47.72	28.81
θ Bootis		20 14.20	+0.58	+ 4.74	+0.93	20 20.45	20 49.67	29.22
5 Ursæ Minoris		26 47.28	+0.95	+ 2.44	+2.41	27 23.08	27 52.54	29.46
ε Bootis		38 55.40	+0.29	−32.98	+0.64	38 53.35	39 22.48	29.13
α² Libræ	E.	43 27.50	+0.11	−10.93	−0.59	43 16.09	43 46.04	29.95
β Ursæ Minoris		50 13.66	+0.68	+28.08	−2 16	50 40.26	51 9.44	29.18
β Bootis		56 36.80	+0.46	+ 0.49	−0.37	56 36.88	57 6.68	29.80
β Libræ		15 9 45.84	+0.06	−10.13	−0.56	15 9 35.21	15 10 5.46	30.25
μ¹ Bootis		19 9.85	+0.11	− 0.48	−0.72	19 8.76	19 38.19	+0 29.43
Mean for $14^h\,40^m$ local sidereal time								+0 29.475

Normal equations.

$0 = -4.68 - 11.00\,\delta t - 3.09\,a - 2.80\,c \qquad \delta t = -0^s.525$

$0 = +42.80 - 3.09\,\delta t + 14.42\,a + 5.64\,c \qquad a = -2^s.858$

$0 = +43.17 - 2.80\,\delta t + 5.64\,a + 49.98\,c \qquad c = -0^s.570$

Adopted azimuth, $-10^s.00$; whole azimuth of the instrument, $-12^s.858$.

Austin, Nev., June 29, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
5 Ursæ Minoris..	E.	14 27 40.83	−0.41	−10.64	−1.11	14 27 28.67	14 27 52.32	+0 23.65
π Bootis................		34 16.22	+0.20	+1.83	−0.28	34 17.57	34 41.00	23.43
ε Bootis................		38 58.40	−0.31	+1.05	−0.30	38 58.84	39 22.04	23.20
α^2 Libræ................		43 19.20	−0.20	+3.90	−0.27	43 22.63	43 46.02	23.39
β Ursæ Minoris..........		50 57.06	−0.16	−10.00	−1.00	50 45.90	51 9.25	23.35
β Bootis................		56 43.98	−0.20	−0.18	−0.40	56 43.20	57 6.62	23.42
48 Cephei, L. C....	W.	15 3 18.96	+0.43	−18.57	−1.19	15 3 36.77	15 3 59.96	23.19
β Libræ................		9 38.22	−0.22	+3.62	+0.27	9 41.89	10 5.45	23.56
γ^2 Ursæ Minoris..........		20 45.32	−0.86	−8.16	+0.87	20 37.17	21 0.04	22.87
α Coronæ................		28 50.50	−0.35	+1.10	−0.29	28 51.54	29 15.07	23.53
α Serpentis................		37 30.08	−0.34	+2.48	+0.27	37 32.49	37 56.36	+0 23.87
Mean for $15^h\ 0^m$ local sidereal time........								+0 23.405

Normal equations.

$0 = -1.48 + 11.00\,\delta t + 0.78\,a + 10.86\,c$

$0 = -13.57 + 0.78\,\delta t + 31.61\,a + 2.91\,c \qquad a = -0^s.415$

$0 = +15.71 + 10.86\,\delta t + 2.91\,a + 72.60\,c \qquad c = -0^s.263$

Adopted azimuth, $+5^s.00$; whole azimuth of the instrument, $+4^s.585$.

The following table shows the corrections and rates for the sidereal chronometer:

Negus 1344.

Date.	Local sidereal time.	Correction of chronometer.	Adopted hourly rate.
	h.	*m. s.*	*s.*
June 16, 1871....................................	17.0	+0 31.612	+0.042
June 26, 1871....................................	14.7	+0 29.475	−0.070
June 29, 1871....................................	15.0	+0 23.405	+0.085

The signals were sent by sound from the mean-time chronometer Hutton No. 288. It was compared with Negus 1344, both before and after exchange. The comparison, June 16, 1871, made before exchange, is:

	h.	*m.*	*s.*	*h.*	*m.*	*s.*
Negus 1344................	14	45	45.0	14	48	50.0
Hutton 288................	8	45	37.0	8	48	41.5

and after exchange—

	h.	*m.*	*s.*	*h.*	*m.*	*s.*
Negus 1344................	18	44	16.0	18	47	20.0
Hutton 288................	12	43	37.0	12	46	40.5

The hourly rate of Hutton 288, derived from these comparisons, would be $7^s.773$; this first comparison has to be rejected, as there is evidently a mistake in it, as shown by the comparison below. Both chronometers were compared again the next morning.

	h.	*m.*	*s.*
Negus 1344................	6	44	37.0
Hutton 288................	0	41	59.5

The rate derived from this comparison and that made after exchange is $9^s.8561$, and is used for the determination of the change of Hutton 288 against sidereal time.

The comparisons of both chronometers on the other dates are as follows:

		h.	m.	s.	h.	m.	s.
June 26, 1871.	Negus 1344	15	38	30.0	15	41	31.0
	Hutton 288	8	58	57.0	9	1	57.5
	After exchange:						
	Negus 1344	13	20	21.0	18	23	24.0
	Hutton 288	11	40	21.0	11	43	23.5
June 29, 1871.	Negus 1344	15	42	12.0	15	45	15.0
	Hutton 288	8	50	44.5	8	53	47.0
	After exchange:						
	Negus 1344	17	30	33.0	17	33	35.0
	Hutton 288	10	38	47.5	10	41	49.0

From these comparisons is derived the data given in the table below.

Hutton 288.

Date.	Hutton's time.	Slow of sidereal time.	Losing per hour.
	h.	h. m. s.	s.
June 16, 1871	12.7524	6 1 10.79	9.8561
June 26, 1871	11.6978	6 40 29.46	9.9620
June 29, 1871	10.6717	6 52 8.94	9.9128

Exchange of signals between Washington, Detroit, and Austin.

JUNE 16, 1871.

Signals sent from Detroit.

Detroit clock.			Austin chronometer.			Detroit clock.			Austin chronometer.			Detroit clock.			Austin chronometer.		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
18	53	30.16	10	35	12.60	18	56	0.05	10	37	42.10	19	0	0.03	10	41	41.30
		40.24			22.70			10.30			52.20						
		50.26			32.70			.....		38	0.00			59.97		42	41.10
	54	0.30			42.60			.....			......		1	10.11			51.20
		10.22			52.60			.....						20.08		43	1.20
		20.21		36	2.60		59	.....		40	0.00			30.10			11.10
		30.08			12.50			10.19			51.60			40.22			21.40
								19.78		41	1.30			50.05			31.10
	55	30.26		37	12.30			30.08			11.70		2	0.07			41.10
		40.08			22.20			40.07			21.60						
		50.15			32.20			50.15			31.60	Mean, 18	57	48.53	10	39	30.26

SECOND SERIES.

Detroit clock.			Austin chronometer.			Detroit clock.			Austin chronometer.			Detroit clock.			Austin chronometer.		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
19	13	0.05	10	54	39.20	19	15	10.17	10	56	49.00	10	17	20.10	10	58	58.50
		10.00			49.10			20.20			59.00			30.10		59	8.60
		20.23			59.40			30.43		57	9.20			40.28			18.70
		30.28		55	9.40			40.17			18.90			50.25			28.60
		40.29			19.50			50.10			28.80			59.57			38.00
		50.21			29.30		16	0.05			38.70						
		59.83			38.90							Mean, 19	15	30.12	10	57	8.90
							17	0.00		58	38.70						
	15	0.00		56	38.90			10.20			48.60						

Signals sent from Austin.

Detroit clock.			Austin chronometer.			Detroit clock.			Austin chronometer.			Detroit clock.			Austin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
19	5	20.33	10	47	0.00	19	7	5.85	10	48	45.00	19	8	51.00	10	50	30.00
		25.26			5.00			10.61			50.00			56.00			35.00
		30.24			10.00			15.70			55.00		9	1.22			40.00
		35.32			15.00			20.70		49	0.00			5.95			45.00
		40.31			20.00			25.77			5.00			10.98			50.00
		45.37			25.00			30.61			10.00			15.92			55.00
		50.38			30.00			35.69			15.00			21.00		51	0.00
		55.58			35.00			40.74			20.00			25.99			5.00
	6	0.77			40.00			45.69			25.00			30.90			10.00
		5.71			45.00			50.80			30.00			35.98			15.00
		10.54			50.00			56.00			35.00			41.21			20.00
		15.46			55.00		8	0.95			40.00			46.24			25.00
		20.44		48	0.00			6.00			45.00			51.23			30.00
		25.47			5.00			10.88			50.00			56.26			35.00
		30.34			10.00			15.72			55.00		10	1.28			40.00
		35.60			15.00			20.86		50	0.00			6.00			45.00
		40.47			20.00			25.87			5.00			11.21			50.00
		45.60			25.00			30.78			10.00			16.10			55.00
		50.63			30.00			35.81			15.00			21.10		52	0.00
		55.68			35.00			41.00			20.00						
	7	0.70			40.00			46.00			25.00	Mean, 19	7	50.78	10	49	30.00

Signals sent from Washington.

Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
20	14	40.00	11	33	36.6	20	15	50.00	11	34	46.2	20	17	10.00	11	36	6.0
		50.00			46.2		16	10.00		35	6.2			20.00			16.0
	15	10.00		34	6.3			20.00			16.1	Mean, 20	16	0.00	11	34	56.16
		20.00			16.3			30.00			26.0						
		30.00			26.4			40.00			36.0						
		40.00			36.0			50.00			46.0						

SECOND SERIES.

Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*		*m.*	*s.*	*h.*	*m.*	*s.*
20	35	25.00	11	54	18.1	20	38	25.00	11	57	17.6	20	40	5.00	11	58	57.0
		35.00			27.9			35.00			27.6			15.00		59	7.0
		45.00			38.0			45.00			37.5			25.00			17.0
		55.00			47.9			55.00			47.4			35.00			27.1
	36	5.00			58.0		39	5.00			57.5			45.00			37.0
		15.00		55	7.9			15.00		58	7.4			55.00			47.0
		25.00			18.0			25.00			17.2						
		35.00			27.7			35.00			27.3	Mean, 20	38	15.40	11	57	7.90
		45.00			37.6			45.00			37.2						
		55.00			47.6			.....			.....						

Signals sent from Austin.

Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
20	21	6.0	11	40	0.00	20	24	36.7	11	43	30.00	20	26	....	11	45	.....
		11.0			5.00			41.7			35.00			41.8			35.00
		15.9			10.00			46.7			40.00			47.0			40.00
		21.0			15.00			51.7			45.00			52.1			45.00
		....			.....			56.4			50.00			56.9			50.00
	22	56.3		41	50.00		25	1.6			55.00		27	1.9			55.00
	23	1.3			55.00			6.4		44	0.00			6.9		46	0.00
		....			.....			11.7			5.00			12.0			5.00
		31.3		42	25.00			16.6			10.00			17.0			10.00
		36.4			30.00			21.7			15.00			21.9			15.00
		...			.....			26.6			20.00			....			.....
		46.6			40.00			31.7			25.00			32.0			25.00
		51.5			45.00			36.7			30.00			37.0			30.00
		56.5			50.00			41.9			35.00			42.0			35.00
		....			.....			....			.....			....			.....
	24	6.3		43	0.00			51.9			45.00			52.0			45.00
		11.2			5.00			56.5			50.00			56.9			50.00
		16.3			10.00		26	1.7			55.00		28	1.8			55.00
		21.4			15.00			6.6		45	0.00			7.0		47	0.00
		26.6			20.00			11.7			5.00						
		31.6			25.00			16.6			10.00	Mean, 20	25	19.37	11	44	12.74

Signals sent from Austin.

Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
20	48	10.3	12	7	0.00	20	48	50.5	12	7	40.00	20	49	30.5	12	8	20.00
		15.3			5.00			55.5			45.00			35.5			25.00
		20.2			10.00		49	0.5			50.00			40.4			30.00
		25.2			15.00			5.5			55.00			45.5			35.00
		30.4			20.00			10.3		8	0.00			50.6			40.00
		35.3			25.00			15.3			5.00						
		40.3			30.00			20.6			10.00	Mean, 20	49	0.41	12	7	50.00
		45.4			35.00			25.5			15.00						

Signals sent from Austin.

Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.			Washington clock.			Austin chronometer.		
h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
20	57	11.9	12	16	0.00	20	58	32.0	12	17	20.00	20	59	52.3	12	18	40.00
		16.9			5.00			....			.....			57.7			45.00
		21.8			10.00			42.1			30.00	21	0	2.4			50.00
		26.8			15.00			47.0			35.00			7.3			55.00
		32.0			20.00			52.1			40.00			12.4		19	0.00
		36.9			25.00			....			.....			....			.....
		41.8			30.00		59	2.4			50.00			22.2			10.00
		46.8			35.00			7.3			55.00			27.2			15.00
		52.0			40.00			12.2		18	0.00			32.4			20.00
		57.0			45.00			17.2			5.00			37.3			25.00
	58	2.1			50.00			22.1			10.00			42.3			30.00
		7.0			55.00			....			.....			47.4			35.00
		12.0		17	0.00			32.2			20.00						
		17.0			5.00			37.2			25.00	Mean, 20	58	57.63	12	17	45.50
		22.0			10.00			42.1			30.00						
		27.0			15.00			47.3			35.00						

JUNE 26, 1871.

Signals sent from Detroit.

Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
19 43 0.19	10 45 9.6	19 43 50.00	10 45 59.3	19 59 0.39	16 1 7.2
.....	....	44 0.00	46 9.2		
19.87	29.2			Mean, 19 48 39.04	10 50 47.57
30.00	39.4	58 40.35	11 0 47.3		
40.00	49.5	50.54	57.4		

SECOND SERIES.

Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
20 9 0.00	11 11 5.2	20 9 59.98	11 12 5.1	20 11 40.10	11 13 44.9
10.00	15.1			50.19	55.0
20.20	25.2	11 0.00	13 5.0	59.73	14 4.8
30.00	35.2	10.27	15.0		
40.51	45.4	20.18	25.0	Mean, 20 10 30.11	11 12 35.09
50.20	55.4	30.13	35.0		

Signals sent from Austin.

Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
20 0 55.49	11 3 0.00	20 2	11 4	20 4 24.74	11 6 30.00
.....		.....	5	29.92	35.00
1 4.60	10.00	49.87	55.00	35.00	40.00
9.58	15.00	54.91	0.00	40.00	45.00
14.79	20.00	59.90	5.00	45.17	50.00
19.77	25.00	3	.....	49.89	55.00
24.69	30.00	.....	.....	55.15	7 0.00
29.78	35.00	.....	.....	.....	.....
34.82	40.00	.....	.....	5 5.00	10.00
39.68	45.00	25.00	30.00	10.18	15.00
44.63	50.00	29.91	35.00	15.20	20.00
49.85	55.00	34.95	40.00	20.10	25.00
54.92	4 0.00	39.89	45.00	25.00	30.00
59.61	5.00	44.93	50.00	30.21	35.00
2 4.79	10.00	49.71	55.00	35.21	40.00
9.90	15.00	54.81	6 0.00	40.39	45.00
14.64	20.00	59.92	5.00	45.47	50.00
19.61	25.00	4 4.91	10.00	50.43	55.00
24.93	30.00	10.00	15.00	55.48	8 0.00
.....	.....	14.80	20.00		
.....	.....	19.87	25.00	Mean, 20 3 30.63	11 5 35.69

JUNE 29, 1871.

Signals sent from Detroit.

Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
18 54 0.00	9 44 34.2	18 56 10.31	9 46 43.9	18 58 20.24	9 48 53.6
10.11	44.0	20.18	53.8	30.19	49 3.5
20.17	54.1	30.21	47 3.6	40.21	13.5
30.20	45 4.2	40.37	13.8	50.20	23.4
40.12	14.0	50.09	23.6	59 0.18	33.4
50.42	24.2	57 0.29	33.7		
55 0.16	34.2			Mean, 18 56 30.19	9 47 3.78
		58 0.15	48 33.5		
56 0.00	46 33.8	10.19	43.4		

SECOND SERIES.

Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
19 10 0.38	10 0 31.6	19 12 10.26	10 2 41.0	19 16 20.21	10 6 50.5
10.32	41.5	20.17	51.1	30.30	7 0.6
20.12	51.6	30.20	3 1.0	40.20	10.5
30.23	1 1.6	40.21	11.0	50.00	20.4
40.16	11.5	50.22	21.1	17 0.32	30.5
50.25	21.6	13 0.18	31.1		
11 0.27	31.5			Mean, 19 13 10.23	10 3 41.06
		16 0.28	6 30.7		
12 0.27	2 31.3	10.20	40.5		

Signals sent from Austin.

Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.	Detroit clock.	Austin chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
19 1 27.99	9 52 0.00	19 3 13.13	9 53 45.00	19 4 58.43	9 55 30.00
32.98	5.00	18.27	50.00	5 3.47	35.00
37.83	10.00	23.32	55.00	8.42	40.00
43.00	15.00	28.46	54 0.00	13.55	45.00
48.18	20.00	33.37	5.00	18.67	50.00
53.00	25.00	38.29	10.00	23.63	55.00
58.10	30.00	43.26	15.00	28.77	56 0.00
2 2.93	35.00	48.27	20.00	33.76	5.00
8.00	40.00	53.25	25.00	38.48	10.00
13.00	45.00	58.42	30.00	43.70	15.00
18.16	50.00	4 3.52	35.00	48.79	20.00
23.10	55.00	8.45	40.00	53.64	25.00
28.00	53 0.00	13.46	45.00	58.72	30.00
33.23	5.00	18.45	50.00	6 3.80	35.00
38.00	10.00	23.35	55.00	8.85	40.00
43.00	15.00	28.65	55 0.00	13.79	45.00
48.00	20.00	33.66	5.00	18.73	50.00
53.10	25.00	38.41	10.00	23.83	55.00
58.22	30.00	43.35	15.00	28.84	57 0.00
3 3.26	35.00	48.45	20.00		
8.24	40.00	53.58	25.00	Mean, 19 3 58.37	9 54 30.00

Deduction of results for longitude of Austin, Nev.

Date.	Signals sent from—	Detroit clock.	Correction of Detroit clock.	Local sidereal time of the mean of signals.	Austin chronometer.	Correction of Austin chronometer.	Local sidereal time of the mean of signals.	Differences of longitude.	Means.	Double-wave time.	Final differences of longitude.
1871.		*h. m. s.*	*m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*	*h. m. s.*
June 16	Detroit to Austin	18 57 48.53	−1 26.01	18 56 22.52	10 39 30.36	+6 0 50.15	16 40 20.41	2 16 2.11			
16	Detroit to Austin	19 15 30.12	26.02	19 14 4.10	10 57 8.90	53.05	16 58 1.95	2.15	2.13		
16	Austin to Detroit	19 7 50.78	26.01	19 6 24.77	10 49 30.00	51.79	16 50 21.79	2.98	2.98	0.85	2 16 2.55
26	Detroit to Austin	19 48 39.04	−1 28.45	19 47 10.59	10 50 47.57	+6 40 20.98	17 31 8.55	2.04			
26	Detroit to Austin	20 10 30.11	28.43	20 9 1.68	11 12 35.09	24.60	17 52 59.69	1.99	2.01		
26	Austin to Detroit	20 3 30.63	28.43	20 2 2.20	11 5 35.69	23.44	17 45 59.13	3.07	3.07	1.06	2.54
29	Detroit to Austin	18 56 30.19	−1 24.17	18 55 6.02	9 47 3.78	+6 52 0.14	16 39 3.92	2.10			
29	Detroit to Austin	19 13 10.23	24.14	19 11 46.09	10 3 41.06	2.89	16 55 43.95	2.14	2.12		
29	Austin to Detroit	19 3 58.37	24.16	19 2 34.21	9 54 30.00	1.37	16 46 31.37	2.84	2.84	0.72	2.48

Austin west of Detroit, $2^h\ 16^m\ 2^s.52 \pm 0^s.015$.

Determination of longitude between Washington, D. C., and Austin, Nev.

June 16, 1871.	Mean of signals sent and received.	Time correction.	Corrected time.	Difference of longitude.	Means.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Washington clock	20 16 0.00	−0 0 2.27	20 15 57.73	....	....
Austin chronometer	11 34 56.16	+6 0 59.26	17 35 55.42	2 40 2.31	....
Washington clock	20 38 15.40	−0 0 2.28	20 38 13.12	....	....
Austin chronometer	11 57 7.90	+6 1 2.90	17 58 10.80	2 40 2.32	2 40 2.32
Austin chronometer	11 44 12.74	+6 1 0.78	17 45 13.52	....	....
Washington clock	20 25 19.37	−0 0 2.28	20 25 17.09	2 40 3.57	....
Austin chronometer	12 7 50.00	+6 1 4.65	18 8 54.65	....	....
Washington clock	20 49 0.41	−0 0 2.28	20 48 58.13	2 40 3.48	....
Austin chronometer	12 17 45.50	+6 1 6.29	18 18 51.79	....	....
Washington clock	20 58 57.63	−0 0 2.28	20 58 55.35	2 40 3.56	2 40 3.54

Austin, Nev., west of Washington, D. C., 2*h.* 40*m.* 2.93*s.*

Mean places of stars for 1871 *used for determination of latitude of Austin, Nev.*

No. of pair.	No. in B. A. C.	Declination.	No. of pair.	No. in B. A. C.	Declination.
		° ′ ″			° ′ ″
	4847	16 58 22.31		5693	31 55 0.47
1	4874	61 48 45.81	11	5706	46 44 55.94
	4905	19 38 14.45	12	5740	65 19 54.64
2	4918	59 49 7.80	13	5745	65 14 7.35
				5753	13 47 26.25
	4980	48 39 1.13		5757	13 45 18.36
3	5001	29 43 14.44			
				5785	54 38 26.40
	5075	30 45 18.71	14	5798	24 23 49.00
4	5113	48 9 26.29			
				5863	32 38 9.99
	5259	36 3 33.20	15	5871	46 22 6.04
5	5271	42 48 48.95			
				5900	20 11 30.49
	5319	33 41 43.38	16	5918	58 45 37.83
6	5388	45 16 26.88			
				5951	55 15 38.97
	5426	19 8 8.60	17	5967	24 23 18.74
7	5459	60 4 6.27			
				6021	27 47 52.65
	5480	34 0 16.80	18	6052	50 48 45.30
8	5497	44 59 9.56			
				6087	30 12 5.28
	5568	46 52 31.27	19	6129	48 27 33.22
9	5604	31 50 17.80			
				6162	43 26 50.67
	5628	64 50 1.62	20	6235	36 0 27.75
10	5647	13 29 20.80			

Observations for latitude.—Station, Austin, Nev.

JUNE 15, 1871.

No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
	t. d.	*d.*	*d.*	
4847	12 9.1	14.0	11.8	
4874	20 61.6	12.2	13.6	
4905	26 80.8	14.0	12.0	
4918	5 12.5	13.2	12.5	
5075	16 41.2	13.3	13.0	
5113	19 25.6	12.5	13.8	
5319	13 80.2	13.8	13.0	
5388	14 21.0	12.0	15.0	
5426	25 88.2	10.5	16.8	
5459	15 76.7	15.0	12.0	
5480	19 95.0	13.3	14.2	
5497	19 36.2	12.2	15.4	
5568	24 99.9	12.5	15.7	
5604	13 19.5	14.0	14.4	
5628	34 57.9	11.8	16.8	
5647	5 50.3	16.0	12.5	
5693	8 75.0	14.5	13.8	
5706	22 49.2	18.8	9.3	

No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
	t. d.	*d.*	*d.*	
5740	12 18.2			
5745	16 48.1	16.8	11.0	
5753	18 48.5			
5757	16 93.4	6.5	21.5	
5785	12 69.7	15.8	12.5	
5798	15 38.0	11.5	16.5	
5863	18 41.1	12.8	15.7	
5871	17 27.4	14.2	14.0	
5900	20 10.6	13.0	15.0	
5918	21 22.4	14.5	14.0	
6021	11 19.6	13.5	15.0	
6052	27 67.7	13.0	15.6	
6087	15 27.5	14.0	14.8	
6129	29 49.6	11.2	17.2	
6162	7 45.0	12.5	16.2	
6235	28 60.0	16.5	12.8	

JUNE 17, 1871.

No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
	t. d.	*d.*	*d.*	
4905	26 3.7	14.0	12.0	
4918	4 77.6	9.0	17.0	
4980	33 38.7	13.8	12.8	
5001	6 60.6	15.3	10.8	
5075	16 98.4	2.0	25.0	Must be $68^d.4$.
5113	19 51.5	22.0	5.2	
5319	13 63.6	13.0	15.8	
5388	14 7.8	12.0	17.2	
5426	26 81.0	15.2	12.8	
5459	16 71.8	11.5	17.8	
5480	20 15.2	13.8	16.0	
5497	19 59.5	13.7	15.6	
5568	24 22.3	15.5	14.2	Must be $2^d.3$.
5604	12 27.9	16.0	14.0	Excl.
5628	34 42.7	8.5	21.2	
5647	5 15.5	20.2	9.3	

No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
	t. d.	*d.*	*d.*	
5740	11 61.0			
5745	15 92.5	13.0	16.9	
5753	18 10.2			
5757	16 56.3	16.5	13.5	
5785	13 36.7	14.0	15.8	
5798	15 94.4	13.7	16.3	
5863	19 39.4	17.0	12.8	
5871	18 30.0	12.3	17.2	
5900	21 13.8	15.8	14.8	
5918	22 31.6	11.8	17.8	
6021	11 41.3	11.2	17.2	
6052	27 84.8	15.8	12.8	
6087	14 61.7	13.0	15.0	
6129	28 87.9	11.2	16.2	
6162	6 89.4	12.2	14.6	
6235	27 92.7	9.8	16.5	

Observations for latitude.—Station, Austin, Nev.—Continued.

JUNE 21, 1871.

No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
	t. d.	*d.*	*d.*			*t. d.*	*d.*	*d.*	
5568	24 75.3	14.8	17.8		5863	18 91.4	16.0	17.2	
5604	17 97.6	17.2	15.5	Must be 12t.	5871	17 81.9	14.9	18.5	
5628	34 59.7	11.7	21.2		5900	22 20.0	16.4	17.0	
5647	5 40.2	21.2	11.5		5918	23 35.9	14.7	18.7	
5693	9 37.0	16.8	16.0		5951	4 81.0	17.0	16.5	
5706	23 29.1	15.0	17.7		5967	34 71.4	16.8	17.0	
5740	12 83.3	14.7	18.0		6021	11 34.5	17.5	16.1	
5745	17 2.9				6052	27 75.1	14.0	19.6	
5753	19 27.4	18.1	15.0						
5757	17 69.7				6087	14 63.7	17.5	16.3	
					6129	28 78.7	15.9	18.0	
5785	13 51.2	15.7	17.2						
5798	16 21.3	16.2	17.0		6162	7 73.0	15.9	18.1	
					6235	28 95.0	19.8	14.0	

JUNE 23, 1871.

No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
	t. d.	*d.*	*d.*			*t. d.*	*d.*	*d.*	
5259	16 5.5	15.5	16.0		5480	20 86.2	20.8	12.5	
5271	20 65.4	15.2	17.0		5497	20 33.4	8.8	24.5	
5319	13 86.7	14.5	18.0		5568	25 29.5	16.5	17.0	
5388	14 31.9	14.2	19.0		5604	13 47.9	12.0	21.0	
5426	26 49.9	12.8	20.5		5628	34 25.0	13.8	19.5	
5459	16 45.5	17.5	15.5		5647	5 4.1	14.5	18.8	

Computations for latitude of Austin, Nev.

Date.	No. of pair.	Half-sum of declination.	Corrections. Micr. and refr.	Corrections. Level.	Corrections. Merid.	Latitude.
		° ′ ″	′ ″	″		° ′ ″
June 15, 1871	1	39 23 40.78	+ 5 44.77	+0.54	....	39 29 26.09
	2	43 47.75	—14 36.93	+1.82	....	22.64
	4	27 28.27	+ 1 55.01	—0.67	....	22.61
	6	29 9.43	+ 0 16.50	—1.48	....	24.45
	7	36 10.96	— 6 49.06	—2.23	....	19.67
	8	29 46.70	— 0 23.78	—2.77	....	20.15
	9	21 27.37	+ 7 57.37	—2.43	....	22.31
	10	9 43.52	+19 35.97	—1.01	....	20.48
	11	20 0.40	+ 9 15.75	+6.88	....	23.03
	12	33 42.18	— 4 14.91	—6.21	....	18.94
	13	29 44.56	— 0 18.31	—6.21	....	20.04
	14	31 9.20	— 1 48.50	—1.15	....	19.55
	15	30 8.97	— 0 45.98	—1.82	....	21.17
	16	28 34.74	+ 0 45.22	—1.01	....	18.95
	18	18 18.66	+11 6.53	—2.77	....	22.42
	19	19 48.31	+ 9 35.12	—4.59	....	18.84
	20	43 37.46	—14 15.35	0.00	....	22.11

Computations for latitude of Austin, Nev.—Continued.

Date.	No. of pair.	Half-sum of declination.	Corrections.			Latitude.
			Micr. and refr.	Level.	Merid.	
		° ′ ″	′ ″	″		° ′ ″
June 17, 1871	2	39 43 48.10	—14 19.87	—4.05	....	39 29 24.18
	3	11 14.51	+18 3.10	+3.71	....	21.32
	4	27 28.70	+ 1 54.48	—2.16	....	21.02
	6	29 9.90	+ 0 17.87	—5.40	....	22.37
	7	36 11.43	— 6 48.13	—2.63	....	20.67
	8	29 47.20	— 0 22.53	—2.77	....	21.90
	10	9 43.99	+19 43.90	—1.21	....	26.68
	12	33 42.60	— 4 22.55	—0.61	....	19.44
	13	29 44.98	— 0 25.79	—0.61	....	18.58
	14	31 9.73	— 1 44.22	—2.97	....	22.54
	15	30 9.53	— 0 44.24	—0.47	....	24.82
	16	28 35.28	+ 0 47.65	—3.38	....	22.55
	18	18 19.22	+11 4.67	—2.02	....	21.87
	19	19 48.90	+ 9 36 78	—4.72	....	20.96
	20	43 38.14	—14 10.62	—6.14	....	21.38
June 21, 1871	9	39 21 28.92	+ 7 56.27	—0.88	....	39 29 24.31
	10	9 44.91	+19 40.78	+0.14	....	25.83
	11	20 2.10	+ 9 22.99	—1.28	....	23.81
	12	33 43.72	— 4 20.49	—0.14	....	23.09
	13	29 46.02	— 0 27.01	—0.13	....	18.88
	14	31 10.80	— 1 49.23	—1.55	....	20.02
	15	30 10.64	— 0 44.28	—3.24	....	26.12
	16	28 36.34	+ 0 46.88	—3.10	....	20.12
	17	49 30.82	—20 9.42	+0.20	....	21.60
	18	18 20.36	+11 3.49	—2.83	....	21.02
	19	19 50.06	+ 9 32.25	—0.61	....	21.70
	20	43 39.50	—14 18.18	+2.43	....	23.77
June 23, 1871	5	39 26 17.51	+ 3 5.99	+1.55	....	39 29 21.95
	6	29 11.32	+ 0 18.27	+5.60	....	23.99
	7	36 12.79	— 6 46.19	+3.85	....	22.75
	8	29 48.69	— 0 21.36	+4.99	....	22.34
	9	21 29.43	+ 7 57.85	+6.41	....	20.87
	10	9 45.38	+19 41.35	+6.75	....	19.98

Mean latitude of Austin, Nev., 39° 29′ 21″.92 ±0″.20

Adopting for the longitude of Detroit 83° 3′ 3″.90 west of Greenwich, the resulting astronomical co-ordinates of Austin, Nev., will be:

Longitude, 117° 3′ 41″.70 west of Greenwich.
40° 0′ 39″.90 west of Washington.

Latitude, N., 39° 29′ 21″.92 ±0″.20.

ST. GEORGE, UTAH.

Longitude, 113° 35′ 0″.30; latitude, 37° 06′ 29″ 38 ± 0″.08.

The astronomical station is situated in St. George, a Mormon town in Southwestern Utah, of about 2,000 inhabitants. The monument, a sandstone pier buried in the ground and 24 inches above the surface, is located 30 feet distant from the southern door of the school-house, 72 feet distant from the street running from east to west, and 150 feet from Main street. The connection with natural objects was made in the year 1872 by Mr. Thompson, topographer of the expedition of that year. The town is situated in the valley or cañon of the Virgin River, near the junction of the Santa Clara with this stream. To the westward, fifteen miles distant, is the Virgin range; to the north, the high Pine Valley range; while, to the south and east the broken, eroded, and faulted plateaus of the Colorado extend. In the immediate neighborhood are several smaller settlements, the most promising of which is Washington. The climate is mild, and the principal industry fruit and wine growing.

No detailed meteorological observations were taken at this place when the station was occupied by the astronomer. As far as can be learned from the diary, the nights were pretty clear, and the condition of the air very favorable for astronomical observations. In 1872 some barometric observations were taken to determine the altitude of the place.

The astronomical observations were taken in a common wall-tent, as at the other stations. Mr. A. R. Marvine, the observer, was assisted by a recorder and two soldiers, and Mr. E. P. Austin had charge of the Salt Lake observatory, the use of which was kindly tendered by President Brigham Young, of the Mormon church. Through him the use of the Deseret Telegraph line, for exchange of signals, was secured. The wires were brought into the tent by a loop.

The astronomical instruments used at St. George were the combined transit, used before by Assistant E. P. Austin, in Nevada, and the sidereal chronometer, Negus No. 1344. The Salt Lake instrument belonged to President Young, and was used by a Coast-Survey party, and by the expeditions of 1872 and 1873. All the data relating to this instrument will be found in the general report for 1873 by J. H. Clark.

Hutton mean-time chronometer No. 288 was used for the determination of time. All the observations were taken by eye and ear, and the exchange of signals made by sound.

Connection was made, as stated, with Salt Lake observatory. Exchanges of signals were effected on the nights of September 13, 14, and 15, 1871.

The observations at both stations were compared in 1873 by Dr. F. Kampf, and rereduced in 1874, when this report was made up by him.

The instrumental values for the St. George instruments will be found in the Carlin report, and those for the Salt Lake transit in J. H. Clark's general report for 1873. The telegraphic line is three hundred miles long, and the signals were transferred direct, without repeaters. The discrepancy between the results for longitude on the first and second days is very remarkable, but too large on the second day to take into the final result. It may be that this change is an example of rapid variation in personal equation.

Salt Lake City, September 13, 1871.

Name of star.	Clamp.	T	bB	aA	cC	T′	AR.	ΔT
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
ι Lyræ	W.	6 54 12.09	−0.33	0.00	+0.02	6 54 11.78	18 32 35.48	+11 38 23.70
β Lyræ	....	7 6 56.94	−0.26	+0.02	+0.02	7 6 56.72	45 20.37	23.65
50 Draconis..	....	12 9.50	−0.65	−0.28	+0.06	12 8.63	50 32.36	23.73
ζ Aquilæ ...	....	21 6.88	−0.22	+0.06	+0.02	21 6.74	59 30.33	23.59
δ Draconis..	....	34 9.65	−0.40	−0.15	+0.04	34 9.14	19 12 32.64	23.50
δ Aquilæ ...	E.	40 37.59	−0.17	+0.08	−0.02	40 37.48	19 1.31	23.83
κ Aquilæ ...	....	51 35.09	−0.15	+0.09	−0.02	51 35.01	29 58.86	23.85
Aquilæ ...	....	8 1 45.70	−0.20	+0.07	−0.02	8 1 45.55	40 9.35	23.80
ε Draconis..	....	10 14.64	−0.34	−0.18	−0.05	10 14.07	48 37.84	+11 38 23.77
Mean for $7^h.5369$ Hutton's time								+11 38 23.713

Normal equations.

$$0 = +0.12 + 9.00\,\delta t - 1.25\,a - 4.10\,c \qquad \delta t = +0^s.013$$
$$0 = -1.35 - 1.25\,\delta t + 9.79\,a + 8.84\,c \qquad a = +0^s.125$$
$$0 = -1.66 - 4.10\,\delta t + 8.84\,a + 38.01\,c \qquad c = -0^s.016$$

Salt Lake City, September 13, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
ε Pegasi........	W.	9 59 2.53	− 0.06	+ 0.13	+ 0.02	9 59 2.62	21 37 53.24	+11 38 50.62
μ Capricorni....	....	10 7 27.46	− 0.02	+ 0.21	+ 0.02	10 7 27.67	46 18.06	50.39
79 Draconis......	....	12 29.62	0.00	− 0.44	+ 0.06	12 29.24	51 19.74	50.50
α Aquarii.......	....	20 20.91	− 0.06	+ 0.16	+ 0.02	20 21.03	59 11.74	+11 38 50.71
Mean for $10^h.1616$ Hutton's time								+11 38 50.555

Normal equations.

$0 = +0.52 + 4.00\,\delta t + 0.24\,a$ $\qquad \delta t = -0^s.145$

$0 = -1.23 + 0.24\,\delta t + 4.89a$ $\qquad a = +0^s.238$

Adopted $c = -0^s.016$. It is not possible to solve normal equations if factors for *c* are introduced.

Salt Lake City, September 14, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
δ Draconis......	W.	7 30 7.07	0.00	− 0.32	+ 0.05	7 30 6.80	19 12 32.59	+11 42 25.79
δ Aquilæ.......	....	36 35.50	− 0.04	+ 0.17	+ 0.02	36 35.65	19 1.29	25.64
κ Aquilæ.......	....	47 32.92	0.00	+ 0.21	+ 0.02	47 33.15	29 58.84	25.69
γ Aquilæ.......	E.	57 43.50	+ 0.06	+ 0.14	− 0.02	57 43.68	40 9.33	25.65
α Aquilæ.......	....	8 2 5.16	+ 0.06	+ 0.15	− 0.02	8 2 5.35	44 31.12	25.77
ε Draconis......	....	6 12.38	+ 0.20	− 0.39	− 0.06	6 12.13	48 37.78	25.65
τ Aquilæ.......	....	15 26.03	+ 0.07	+ 0.16	− 0.02	15 26.24	57 52.12	+11 42 25.88
Mean for $7^h.8796$ Hutton's time 288								+11 42 25.724

Normal equations.

$0 = +0.41 + 7.00\,\delta t + 0.41\,a$ $\qquad \delta t = -0^s.076$

$0 = -1.41 + 0.41\,\delta t + 5.18\,a$ $\qquad a = +0^s.278$

Error of collimation found by preliminary reduction = $-0^s.02$.

Salt Lake City, September 14, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
ξ Aquarii..............	E.	9 48 06.08	−0.14	+0.16	−0.02	9 48 06.08	21 30 55.26	+11 42 49.18
11 Cephei............	....	57 16.36	−0.10	−0.31	−0.06	57 15.89	40 05.01	49.12
μ Capricorni...........	....	10 03 28.76	−0.02	+0.18	−0.02	10 03 28.90	46 18.05	49.15
79 Draconis............	W.	08 30.76	0.00	−0.38	+0.07	08 30.45	51 19.71	49.26
α Aquarii...............	....	16 22.57	−0.04	+0.14	+0.02	16 22.69	59 11.74	49.05
θ Aquarii...............	....	27 14.42	−0.10	+0.16	+0.02	27 14.50	22 10 03.89	+11 42 49.39
Mean for $10^h.1279$ Hutton 288								+11 42 49.192

Normal equations.

$0 = +0.07 + 6.00\,\delta t - 0.27\,a$ $\qquad \delta t = -0^s.108$

$0 = -1.69 - 0.27\,\delta t + 8.06\,a$ $\qquad a = +0^s.206$

Adopted $c = -0^s.02$

Salt Lake City, September 15, 1871.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
1 Aquilæ	W.	6 41 51. 86	+0. 03	+0. 23	+0. 02	6 41 52. 14	18 28 12. 71	+11 46 20. 57
α Lyræ		46 15. 03	0. 00	+0. 01	+0. 03	46 15. 07	32 35. 43	20. 36
β Lyræ		58 59. 85	−0. 06	+0. 05	+0. 02	58 59. 86	45 20. 32	20. 46
50 Draconis		7 04 12. 47	−0. 10	−0. 69	+0. 08	7 04 11. 76	50 32. 17	20. 41
ζ Aquilæ		13 09. 94	−0. 05	+0. 15	+0. 02	13 10. 06	59 30. 29	20. 23
δ Draconis	E.	26 12. 37	+0. 12	−0. 36	−0. 05	26 12. 08	19 12 32. 52	20. 44
δ Aquilæ		32 40. 70	+0. 04	+0. 19	−0. 02	32 40. 91	19 01. 27	20. 36
κ Aquilæ		43 38. 21	+0. 02	+0. 23	−0. 02	43 38. 44	29 58. 83	20. 39
γ Aquilæ		53 48. 70	+0. 03	+0. 16	−0. 02	53 48. 87	40 09. 32	20. 45
α Aquilæ		58 10. 48	+0. 03	+0. 17	−0. 02	58 10. 66	44 31. 11	+11 46 20. 45
Mean for 7h 3337 Hutton 288								+11 46 20. 412

Normal equations.

$0 = +1.74 + 10.00\,\delta t + 0.47\,a$ $\qquad \delta t = -0^s.188$

$0 = -2.59 + 0.47\,\delta t + 8.67\,a$ $\qquad a = +0^s.309$

Adopted $c = -0^s.02$

Salt Lake City, September 15, 1871.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
ξ Aquarii	E.	9 44 5. 42	+ 0. 03	+ 0. 27	− 0. 02	9 44 5. 70	21 30 55. 25	+11 46 49. 55
11 Cephei		53 15. 48	+ 0. 42	− 0. 53	− 0. 06	53 15. 31	40 04. 97	49. 66
μ Capricornii		59 27. 96	+ 0. 03	+ 0. 31	− 0. 02	59 28. 28	46 18. 04	49. 76
α Aquarii	W.	10 12 21. 94	− 0. 04	+ 0. 23	+ 0. 02	10 12 22. 15	59 11. 74	49. 59
θ Aquarii		23 13. 93	+ 0. 03	+ 0. 27	+ 0. 02	23 14. 25	22 10 03. 88	49. 63
π Aquarii		31 53. 79	+ 0. 03	+ 0. 22	+ 0. 02	31 54. 06	18 43. 63	49. 57
226 Cephei		43 15. 74	+ 0. 45	− 0. 92	+ 0. 09	43 15. 36	30 04. 97	+11 46 49. 61
Mean for 10h.2278 Hutton's time								+11 46 49. 624

Normal equations.

$0 = -0.72 + 7.00\,\delta t - 0.43\,a$ $\qquad \delta t = +0^s.124$

$0 = -4.15 - 0.43\,\delta t + 12.05\,a$ $\qquad a = +0^s.349$

Adopted $c = -0^s.02$

St. George, Utah, September 13, 1871.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
α Sagitarii	W.	19 06 04. 44	− 0. 11	− 0. 13	+ 0. 42	19 06 04. 62	19 10 07. 05	+ 4 02. 43
τ Draconis		14 00. 18	− 1. 39	+ 0. 29	+ 1. 28	14 00. 36	18 02. 76	02. 40
κ Aquilæ		25 56. 62	− 0. 43	− 0. 10	+ 0. 40	25 56. 49	29 58. 86	02. 37
β Aquilæ	E.	44 58. 83	− 0. 34	− 0. 03	− 0. 40	44 58. 06	49 00. 40	02. 34
τ Aquilæ		53 50. 47	− 0. 18	− 0. 03	− 0. 41	53 49. 85	57 52. 14	02. 29
κ Cephei		20 09 15. 02	− 1. 53	+ 0. 18	− 1. 82	20 09 11. 85	20 13 14. 25	02. 40
π Capricorni		15 56. 56	− 0. 32	− 0. 05	− 0. 42	15 55. 77	19 58. 30	02. 53
ε Delphini		23 03 52	− 0. 52	− 0. 03	− 0. 41	23 02. 56	27 04. 92	+ 4 02. 36
Mean for 19h 40m local sidereal time								+ 4 02. 39

The azimuth of the instrument is changed after reversing. The error of collimation is derived by preliminary computation, $= -0^s.40$; and the azimuth determined for both positions separately.

Normal equations.

For clamp west: $0 = -0.06 + 3.00\,\delta t - 0.44\,a$ $\qquad \delta t = 0^s.000$

$0 = +0.78 - 0.44\,\delta t + 5.39\,a$ $\qquad a = -0^s.145$

For clamp east: $0 = +0.04 + 5.00\,\delta t - 0.59\,a$ $\qquad \delta t = -0^s.01$

$0 = +0.61 - 0.59\,\delta t + 10.13\,a$ $\qquad a = -0^s.060$

St. George, Utah, September 13, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T.
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
ε Pegasi..........	E.	21 33 50.76	— 0.57	— 0.07	— 0.75	21 33 49.37	21 37 53.23	+ 4 03.86
π Aquarii..........	....	22 14 41.04	— 0.51	— 0.09	— 0.74	22 14 39.70	22 18 43.64	03.94
ζ Pegasi..........	....	31 01.65	— 0.66	— 0.07	— 0.75	31 00.17	35 03.99	03.82
ι Cephei..........	....	41 08.34	— 1.66	+ 0.36	— 1.79	41 05.25	45 09.12	03.87
θ Piscium	W.	23 17 24.31	— 0.94	— 0.08	+ 0.74	23 17 24.03	23 21 27.82	03.79
ι Piscium	....	29 17.88	— 1.02	— 0.08	+ 0.75	29 17.53	33 21.38	+ 4 03.85
Mean for $22^h\ 30^m$ local sidereal time								+ 4 03.855

Normal equations.

$0 = -0.30 \quad + 6.00\,\delta t \quad + 0.28\,a \qquad \delta t = +0^s.055$

$0 = +1.03 \quad + 0.28\,\delta t \quad + 6.57\,a \qquad a = -0^s.158$

Error of collimation found by preliminary reduction $= -0^s.74$.

St. George, Utah, September 14, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
ξ Aquarii........	W.	21 26 42.34	— 0.03	+ 0.64	— 1.46	21 26 41.49	21 30 55.26	+ 4 13.77
ε Pegasi..........	....	33 40.54	+ 0.09	+ 0.42	— 1.46	33 39.59	37 53.23	13.64
μ Capricorni......	....	42 05.11	— 0.06	+ 0.71	— 1.46	42 04.30	46 18.05	13.75
α Aquarii........	....	54 58.92	0.00	+ 0.55	— 1.44	54 58.03	59 11.74	13.71
π Aquarii........	....	22 14 30.82	— 0.10	+ 0.52	— 1.44	22 14 29.80	22 18 43.64	13.84
226 Cephei........	....	26 00.90	— 1.28	— 2.23	— 5.79	25 51.60	30 05.00	13.40
ζ Pegasi..........	E.	30 49.11	— 0.24	+ 0.41	+ 1.46	30 50.74	35 03.98	13.24
ι Cephei..........	....	40 54.56	— 0.79	— 2.03	+ 3.48	40 55.22	45 09.11	13.89
α Pegasi..........	....	54 07.67	— 0.29	+ 0.35	+ 1.49	54 09.22	58 22.53	13.31
θ Piscium	....	23 17 12.90	— 0.50	+ 0.46	+ 1.45	23 17 14.31	23 21 27.82	+ 4 13.51
Mean for $22^h\ 25^m$ local sidereal time								+ 4 13.606

Normal equations.

$0 = +\ 4.31 \quad + 10.00\,\delta t \quad - 0.23\,a \quad - 3.57\,c$

$0 = -16.67 \quad - 0.23\,\delta t \quad + 14.34\,a \quad + 2.78\,c \qquad a = +0^s.884$

$0 = -45.50 \quad - 3.57\,\delta t \quad + 2.78\,a \quad + 30.07\,c \qquad c = +1^s.444$

St. George, Utah, September 15, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
δ Ursæ Minoris..	E.	18 10 06.18	+4.18	—33.93	—5.46	18 09 30.97	18 13 53.94	+ 4 22.97
α Lyræ..........	....	28 12.63	+0.38	— 0.08	—0.42	28 12.51	32 35.43	22.92
ζ Aquilæ	....	55 06.36	+0.26	+ 1.08	—0.33	55 07.37	59 30.29	22.92
τ Draconis	W.	19 13 43.67	+0.26	— 5.37	+1.12	19 13 39.68	19 18 02.62	22.94
κ Aquilæ	....	25 33.83	+0.10	+ 1.32	+0.33	25 35.58	29 58.83	23.25
γ Aquilæ	....	35 44.76	+0.14	+ 1.22	+0.33	35 46.45	40 09.32	22.87
α Aquilæ	....	40 06.46	+0.17	+ 1.24	+0.33	40 08.20	44 31.11	+ 4 22.91
Mean for $19^h\ 0^m$ local sidereal time........								+ 4 22.97

Normal equations.

$0 = +\ 38.84 + \ 7.00\,\delta t - \ 13.04\,a + \ 12.69\,c \qquad \delta t = -0^s.030$

$0 = -516.71 - 13.04\,\delta t + 169.32\,a - 210.22\,c \qquad a = +2^s.647$

$0 = +654.68 + 12.69\,\delta t - 210.22\,a + 301.96\,c \qquad c = -0^s.324$

St. George, Utah, September 15, 1871.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	ΔT
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*m. s.*
β Aquarii	W.	21 20 21.48	−0.20	+1.53	+0.38	21 20 23.19	21 24 48.25	+ 4 25.06
ξ Aquarii		26 28.60	−0.06	+2.15	+0.38	26 31.07	30 55.25	24.18
α Aquarii		54 45.11	−0.13	+1.85	+0.38	54 47.21	59 11.74	24.53
π Aquarii		22 14 17.20	−0.24	+1.76	+0.38	22 14 19.10	22 18 43.63	24.53
α Pegasi		53 56.92	−0.38	+1.19	+0.39	53 58.12	58 22.52	24.40
θ Piscium		23 17 01.49	−0.31	+1.56	+0.38	23 17 03.12	23 21 27.82	24.70
γ Cephei		29 53.33	−1.50	−7.86	+1.66	29 45.63	34 10.25	24.62
Groom. 4163	E.	44 23.63	−1.32	−6.34	−1.34	44 14.63	48 40.14	25.51
α Andromedæ		57 21.36	−0.43	+0.54	−0.42	57 21.05	0 01 45.88	24.83
γ Pegasi		70 02 13.10	−0.37	+1.23	−0.39	0 02 13.57	06 38.08	24.51
α Cassiopeæ		28 53.74	−0.80	−1.70	−0.67	28 50.57	33 15.31	24.74
21 Cassiopeæ		33 02.86	−2.67	−6.67	−1.38	32 52.14	37 15.71	+ 4 23.57
Mean for $23^h\ 5^m$ local sidereal time								+ 4 24.60

Normal equations.

$$0 = +33.83 + 12.00\,\delta t - 3.60\,a + 0.72\,c \qquad \delta t = -1^s.900$$
$$0 = -66.22 - 3.60\,\delta t + 18.84\,a - 7.91\,c \qquad a = +2^s.992$$
$$0 = +46.58 + 0.72\,\delta t - 7.91\,a + 57.38\,c \qquad c = -0^s.375$$

The following table contains correction and rate of Hutton 288:

Date.	Hutton's time.	Correction of Hutton.	Rate per hour.
	h.	*h. m. s.*	*s.*
September 13, 1871	8.8492	+11 38 37.134	−10.2265
September 14, 1871	9.0038	42 37.458	−10.4379
September 15, 1871	8.7807	46 35.018	−10.0937

The corresponding observations at Saint George give for Negus 1344:

Date.	Local sidereal time.	Correction of Negus 1344.	Rate per hour adopted.
	h.	*h. m. s.*	*s.*
September 13, 1871	21.1	+0 4 3.122	−0.410
September 14, 1871	22.4	13.606	−0.432
September 15, 1871	21.0	23.785	−0.450

Exchange of signals between Salt Lake City and Saint George.

SEPTEMBER 13, 1871.

Signals sent from Salt Lake City.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 11 0.0	20 38 52.7	9 13 10.0	20 41 3.0	9 15 20.0	20 43 13.2
10.0	39 2.8	20.0	13.1	30.0	23.2
20.0	12.6	30.0	23.2	40.0	33.2
30.0	22.6	40.0	33.0	50.0	43.1
40.0	32.6	50.0	43.0	16 0.0	53.2
50.0	42.7	14 0.0	53.2		
12 0.0	52.8			Mean, 9 13 30.00	20 41 23.00
		15 0.0	42 53.4		
13 0.0	40 52.9	10.0	43 3.4		

SEPTEMBER 13, 1871.

Signals sent from Salt Lake City—Continued.

SECOND SERIES.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 26 4.2	20 53 59.9	9 28 14.0	20 56 9.6	9 30 26.0	20 58 21.3
13.8	54 8.8	25.3	20.6	35.7	31.5
25.1	20.1	35.2	30.5	45.6	41.3
35.2	30.1	45.7	40.9	55.4	51.0
45.1	40.2	....	....	31 5.6	59 1.1
55.1	50.1	29 5.1	57 0.7		
27 4.7	59.9			Mean, 9 28 29.35	20 56 24.70
		30	58		
28 5.2	56 0.6	15.6	11.2		

Signals sent from Saint George.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 19 6.3	20 47 0.0	9 21 15.8	20 49 10.0	9 23 25.4	20 51 20.0
16.1	10.0	25.8	20.0	35.4	30.0
26.2	20.0	35.7	30.0	45.4	40.0
36.0	30.0	45.6	40.0	55.3	50.0
46.1	40.0	55.5	50.0	24 5.2	52 0.0
56.0	50.0	22 5.5	50 0.0		
20 6.0	48 0.0			Mean, 9 21 35.72	20 49 30.00
		23 5.4	51 0.0		
21 5.9	49 0.0	15.5	10.0		

SECOND SERIES.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 36 44.1	21 4 40.2	9 38 54.1	21 6 51.0	9 41 4.0	21 9 1.3
53.7	50.3	39 3.6	7 0.6	14.8	12.0
37 3.6	5 0.2	14.6	11.1	24.6	21.9
14.2	10.7	24.2	21.0	34.5	31.9
24.1	20.7	34.0	31.0	44.2	41.7
34.0	30.4	44.0	41.1		
43.9	40.5			Mean, 9 39 14.12	21 7 11.02
		40 44.2	8 41.4		
38 43.8	6 40.9	54.4	51.5		

SEPTEMBER 14, 1871.

Signals sent from Salt Lake City.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 6 0.00	20 37 41.1	9 8 10.0	20 39 51.5	9 10 20.0	20 42 1.8
10.0	51.1	20.0	40 1.5	30.0	11.8
20.0	38 1.2	30.0	11.5	40.0	21.8
30.0	11.2	40.0	21.6	50.0	31.9
40.0	21.3	50.0	31.5	11 0.0	42.0
50.0	31.1	9 0.0	41.7		
7 0.0	41.3			Mean, 9 8 30.00	20 40 11.53
		10 0.0	41 41.8		
8 0.0	39 41.4	10.0	52.0		

SEPTEMBER 14, 1871.

Signals sent from Salt Lake City—Continued.

SECOND SERIES.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 18 46.8	20 50 29.8	9 20 57.1	20 52 40.5	9 23 7.1	20 54 51.0
57.0	40.0	21 16.9	50.4	17.3	55 1.1
19 6.7	49.9	17.0	53 0.5	26.4	10.4
16.6	51 0.0	26.1	9.6	37.6	21.4
26.0	9.1	37.0	20.5	47.7	31.4
37.6	20.5	47.5	30.7		
47.2	30.4			Mean, 9 21 17.33	20 53 0.46
		22 47.4	54 30.9		
20 47.2	52 30.4	57.5	41.1		

Signals sent from Saint George.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 12 18.2	20 44 0.3	9 14 27.5	20 46 10.0	9 16 37.1	20 48 20.0
27.9	10.0	37.6	20.0	47.1	30.0
37.8	20.0	47.5	30.0	57.1	40.0
47.7	30.0	57.6	40.0	17 7.0	50.0
57.7	40.0	15 7.5	50.0	17.1	49 0.0
13 7.6	50.0	17.5	47 0.0		
17.6	45 0.0			Mean, 9 14 47.48	20 46 30.00
		16 17.2	48 0.0		
14 17.6	46 0.0	27.2	10.0		

SECOND SERIES.

Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.	Salt Lake chronometer.	Saint George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 25 36.6	20 57 20.5	9 27 46.0	20 59 30.6	9 29 56.5	21 1 41.4
45.7	30.0	55.9	40.5	30 7.7	52.3
55.7	40.1	28 7.1	51.6	16.7	2 1.7
26 7.1	51.3	16.8	21 0 1.6	27.6	12.6
16.2	58 0.6	27.1	11.7	37.2	22.2
27.6	11.7	37.1	21.7		
37.0	21.4			Mean, 9 28 6.79	20 59 51.38
		29 37.2	1 22.0		
27 37.2	59 21.7	46.6	31.8		

SEPTEMBER 15, 1871.

Signals sent from Salt Lake City.

Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
8 53 0.0	20 28 27.5	8 55 10.0	20 30 37.6	8 57 20.0	20 32 48.1
10.0	37.4	20.0	47.7	30.0	58.1
20.0	47.3	30.0	57.6	40.0	33 8.0
30.0	57.4	40.0	31 7.7	50.0	18.0
40.0	29 7.5	50.0	17.7	58 0.0	28.0
50.0	17.5	56 0.0	27.8		
54 0.0	27.5			Mean, 8 55 30.00	20 30 57.76
		57 0.0	32 28.0		
55 0.0	30 27.5	10.0	38.1		

SEPTEMBER 15, 1871.

Signals sent from Salt Lake City—Continued.

Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 8	22 44	9 10 47.6	22 46 17.7	9 12 57.2	22 48 27.6
47.5	17.1	57.4	27.5	13 6.7	37.4
57.5	27.2	11 6.6	36.9	17 9	48.4
9 6.6	36.8	18.3	48.3	27.6	58.4
18.0	48.0	27.4	57.6	38.0	49 8.5
28.1	58.1	37.6	47 8.0		
37.7	45 7.8			Mean, 9 11 15.00	22 46 45.23
		12 37.5	48 8.2		
10 37.6	46 7.8	47.1	17.3		

SEPTEMBER 15, 1871.

Signals sent from St. George.

Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 2 31.2	20 38 0.0	9 4 40.7	20 40 10.0	9 6 50.4	20 42 20.0
41.1	10.0	50.8	20.0	7 0.4	30.0
51.2	20.0	5 0.6	30.0	10.5	40.0
3 1.2	30.0	10.6	40.0	20.4	50.0
11.0	40.0	20.6	50.0	30.4	43 0.0
21.1	50.0	30.6	41 0.0		
31.0	39 0.0			Mean, 9 5 0.75	20 40 30.00
		6 30.5	42 0.0		
4 30.9	20 40 0.0	40.6	10.0		

Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.	Salt Lake chronometer.	St. George chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 14	20 50	9 16 41.6	20 52 12.9	9 18 52.4	20 54 23.6
41.4	12.0	51.6	22.4	19 3.1	34.2
51.3	22.0	17 2.1	33.1	12.6	44.1
15 1.8	32.6	12.0	43.2	22.8	54.2
11.6	42.5	22.1	53.3	32.7	55 4.2
21.7	52.6	32.4	53 3.6		
32.4	51 3.2			Mean, 9 17 9.62	20 52 40.71
		18 32.7	54 4.0		
16 32.3	52 3.3	41.9	13.3		

Signals sent from—	Recorded at—	Mean of signals sent and received.	Time corrections.	Corrected time.	Difference of longitude.	Means.
September 13, 1871.						
		h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
Salt Lake	St. George........	9 13 30.00 20 41 23.00	+11 38 40.98 + 0 4 2.95	20 52 10.98 20 45 25.95	0 6 45.03	
		9 28 29.35 20 56 24.70	+11 38 43.53 + 0 4 3.05	21 7 12.88 21 0 27.75	45.13	
St. George	Salt Lake	9 21 35.72 20 49 30.00	+11 38 42.36 + 0 4 3.01	21 0 18.08 20 53 33.01	45.07	
		9 39 14.12 21 7 11.02	+11 38 45.36 + 0 4 3.13	21 17 59.48 21 11 14.15	45.33	0 6 45.14

Signals sent from—	Recorded at—	Mean of signals sent and received.	Time corrections.	Corrected time.	Difference of longitude.	Means.
September 14, 1871.						
		h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s
Salt Lake............	St. George........	9 8 30.00	+11 42 38.90	20 51 8.90		
		20 40 11.53	+ 0 4 12.88	20 44 24.41	44.49	
		9 21 17.33	+11 42 41.12	21 3 58.45		
		20 53 0.46	+ 0 4 12.98	20 57 13.44	45.01	
St. George	Salt Lake.........	9 14 47.48	+11 42 39.99	20 57 27.47		
		20 46 30.00	+ 0 4 12.93	20 50 42.93	44.54	
		9 28 6.79	+11 42 42.31	21 10 49.10		
		20 59 51.38	+ 0 4 13.03	21 4 4.41	44.69	44.68
September 15, 1871.						
Salt Lake............	St. George........	8 55 30.00	+11 46 36.48	20 42 6.48		
		20 30 57.76	+ 0 4 23.60	20 35 21.36	45.12	
		9 11 15.00	+11 46 39.12	20 57 54.12		
		22 46 45.23	+ 0 4 23.72	20 51 8.95	45.17	
St. George	Salt Lake.........	9 5 0.75	+11 46 38.07	20 51 38.82		
		20 40 30.00	+ 0 4 23.67	20 44 53.67	45.15	
		9 17 9.62	+11 46 40.12	21 3 49.74		
		20 52 40.71	+ 0 4 23.76	20 57 4.47	45.27	45.18

h. m. s.
Final difference of longitude, St. George, west of Salt Lake..0 6 45.00
Adopted longitude, (by excluding September 14, 1871)..0 6 45.16

Mean places of stars for 1871.0, *used for determination of latitude of St. George, Utah.*

No. in B. A. C.	Declination.	No. in B. A. C.	Declination.	No. in B. A. C.	Declination.	No. in B. A. C.	Declination.
	° ′ ″		° ′ ″		° ′ ″		° ′ ″
6404	41 18 15.82	6731	44 24 40.50	7029	31 46 30.12	7474	23 4 28.25
6426	32 39 56.12	6740	29 51 26.07	7041	42 11 1.46	7512	51 7 27.42
6473	41 26 19.86	6784	33 25 42.66	7121	14 8 52.88	7548	49 5 53.46
6491	32 30 50.60	6817	40 16 22.12	7160	14 7 31.14	7571	25 3 10.72
				7176	60 2 22.18		
6542	24 3 8.51	6839	16 17 41.03	7193	60 8 14.29	7598	48 42 47.58
6566	50 9 24.24	6863	57 54 36.98			7627	25 19 8.54
				7218	52 31 33.82		
6589	21 9 50.63	6882	24 26 37.77	7275	21 49 41.53	7736	58 39 42.20
6623	53 7 52.68	6895	49 44 47.56			7742	15 24 20.81
				7317	44 16 58.50	7755	58 46 41.68
6659	50 1 11.62	6912	23 14 38.59	7368	29 41 56.66		
6674	24 24 19.93	6959	51 4 35.00			7807	20 11 49.54
				7410	23 18 50.27	7846	53 35 9.44
6712	58 19 28.10	6986	39 58 0.90	7448	51 6 11.60		
6724	16 10 29.08	6998	34 34 51.16				

Observations for latitude.—Station, Saint George, Utah.

Date.	No. of star.	Micrometer-readings.		Level. N.	Level. S.	Remarks.
1871.						
19	6404	25	72.9	8.9	8.4	
	6426	15	20.0	9.0	8.5	
	6473	19	78.5	8.0	9.5	
	6491	8	46.8	9.5	8.3	
	6542	17	81.9	8.4	9.7	
	6566	17	70.9	10.1	8.0	
	6589	22	45.8	9.0	9.1	
	6623	18	49.9	9.1	9.0	
	6839	20	60.0	7.7	10.9	
	6863	20	72.3	11.0	7.5	
	6882	20	34.4	8.0	11.0	
	6895	21	4.5	10.0	8.5	
20	6404	25	69.9	8.9	8.0	
	6426	15	20.1	9.0	8.0	
	6473	19	70.5	9.4	7.8	
	6491	8	46.8	9.0	8.5	
	6542	17	24.6	9.0	8.5	
	6566	17	4.9	10.0	7.4	
	6659	16	10.0	11.0	6.8	
	6674	25	90.6	8.3	9.1	
	6712	10	40.3	8.9	8.4	
	6784	23	49.1	10.3	7.0	
	6731	18	13.7	6.0	11.4	
	6740	20	90.8	13.1	4.4	
	6784	12	41.2	8.6	9.3	
	6817	34	78.9	9.9	8.0	Must be 87.9
	6839	21	4.0	7.7	10.0	
	6863	21	4.0	13.7	4.0	
	6882	19	45.1	10.0	7.8	
	6895	20	9.5	10.0	7.3	
	6912	21	75.7	9.0	8.5	
	6959	16	63.3	11.2	6.5	
	6986	11	1.0	9.6	8.4	
	6998	26	30.7	10.0	8.7	
	7029	13	13.1	8.8	9.9	
	7041	24	5.0	12.0	6.8	
21	6404	26	14.0	8.3	7.1	
	6426	15	59.7	7.5	8.1	
	6473	20	14.5	9.0	6.8	
	6491	8	86.0	7.4	8.7	
	6542	17	48.0	8.5	8.0	
	6566	17	35.1	8.8	8.0	
	6589	22	41.6	7.0	10.2	
	6623	18	43.2	10.5	6.6	
	6659	15	97.8	11.1	6.3	
	6674	25	74.0	6.5	11.2	
	6712	10	1.3	8.0	9.7	
	6724	23	3.0	10.0	8.0	
	6731	18	13.5	9.7	8.4	
	6740	20	93.0	9.5	8.8	
1871. Sept. 21	6839	21	6.7	9.6	9.4	
	6863	21	14.1	9.8	9.0	
	6882	19	16.0	8.6	10.4	
	6895	19	77.1	12.0	6.8	
	6912	22	49.4	5.0	13.9	
	6959	17	34.7	15.3	3.4	
	6986	11	14.0	12.1	6.3	
	6998	26	39.7	7.2	11.3	
	7029	12	52.8	7.7	11.0	
	7041	23	49.7	10.0	7.7	
22	6404	25	33.5	8.8	7.9	
	6426	15	41.3	7.3	9.3	
	6473	20	10.4	5.5	11.5	
	6491	8	68.5	8.5	8.9	
	6542	17	56.1	7.9	9.8	
	6566	17	43.0	10.0	7.3	
	6589	23	5.9	9.0	8.7	
	6623	19	9.6	9.1	8.4	
	6659	16	6.4	11.0	6.9	
	6674	26	1.3	12.0	6.0	
	6712	10	26.7	9.0	9.0	
	6724	23	33.3	9.0	9.0	
	6784	12	35.3	8.7	10.4	
	6817	34	90.9	6.1	12.0	
	6839	21	10.0	11.9	8.8	
	6863	21	16.4	7.6	11.9	
	6882	19	30.0	9.4	10.4	
	6895	20	7.8	7.9	12.0	
	6912	22	50.7	9.9	10.3	
	6959	17	42.1	10.5	10.0	
	6986	11	27.4	10.8	9.9	
	6998	26	48.0	9.2	11.2	
	7029	12	85.6	5.5	15.0	
	7041	23	83.2	15.0	5.5	
	7121	22	24.8	10.6	10.5	
	7160	21	24.3	10.8	10.6	
	7176	23	8.0	10.3	10.5	
	7193	18	73.9	10.2	10.5	
	7218	16	16.8	11.0	10.0	
	7275	22	78.4	10.0	101	
	7410	29	10.8	11.0	10.0	
	7448	19	73.0	9.9	11.1	
	7474	18	46.3	11.3	10.0	
	7512	18	81.4	10.0	11.3	
	7548	19	76.5	11.7	9.4	
	7571	17	34.3	9.4	11.9	
	7598	22	86.2	11.4	10.0	
	7627	15	14.6	9.5	12.2	
	7736	25	0.1	12.1	10.0	
	7742	18	77.9	9.4	13.1	
	7755	19	76.3	12.3	9.0	

Observations for latitude.—Station, Saint George, Utah—Continued.

Date.	No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
1871. Sept. 22	7807	9 40.7	12.0	11.0	
	7846	28 25.7	11.8	11.8	
23	6404	26 16.1	9.6	8.5	
	6426	15 70.2	10.3	7.7	
	6473	20 16.9	9.7	8.5	
	6491	8 92.5	10.0	8.2	
	6542	17 82.9	9.8	8.9	
	6566	17 65.4	10.3	8.3	
	6589	22 52.3	8.6	10.5	
	6623	18 47.1	13.1	5.8	
	6659	16 39.9	10.9	8.5	
	6674	26 20.8	10.0	9.5	
	6712	10 57.9	8.0	11.4	
	6724	23 65.6	12.9	6.9	
	6839	21 8.6	9.0	10.3	
	6863	21 8.2	13.3	6.4	
	6882	19 59.0	9.4	10.1	
	6895	20 22.5	12.1	7.4	
	6912	22 73.9	14.0	5.6	
	6959	17 59.3	8.1	12.0	
	6986	11 34.9	9.8	10.5	
	6998	26 60.3	13.3	7.0	
	7029	12 94.1	11.5	9.1	
	7041	23 68.0	16.4	4.1	
	7121	22 31.0	11.0	10.6	
	7160	21 28.9	11.0	10.7	
	7176	23 4.0	13.5	7.5	
	7193	18 70.1	13.4	7.5	
	7218	16 14.4	11.1	11.1	
	7275	22 76.3	11.4	11.6	
	7317	26 95.0	11.0	11.5	
	7368	16 96.4	10.6	11.9	
	7410	29 50.2	10.7	11.9	
	7448	20 14.0	11.1	11.0	
	7474	18 87.5	11.1	11.0	
	7512	19 13.7	13.8	8.5	
	7548	20 52.2	12.0	10.3	
	7571	18 15.6	12.9	9.5	
	7598	22 34.1	[illegible]	11.4	
	7627	14 70.4	[illegible]	8.1	
	7807	9 28.8		10.0	
	7846	8 4.7		10.6	
24	6659	16 46.2		13.4	
	6674	26 9.3		8.9	
	6731	17 70.0		8.5	
	6740	20 45.4		10.4	
	6784	8 62.0	[illegible]	10.0	
	6817	31 3.4	[illegible]	9.5	
	6882	19 50.5	[illegible]	11.0	
	6895	20 18.2		7.9	

Date.	No. of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.
1871. Sept. 24	7029	13 2.6	10.7	9.9	
	7041	23 98.3	10.4	10.2	
	2121	22 24.3	10.1	11.0	
	7160	21 27.5	11.1	10.1	
	7176	23 10.8	10.0	11.2	
	7193	18 74.9	10.0	11.1	
	7218	15 85.7	10.9	10.6	
	7275	22 49.9	11.2	10.6	
	7317	27 2.0	3.6	13.5	Very faint.
	7368	16 97.0	9.7	12.3	
	7410	29 13.4	11.9	10.3	
	7448	19 72.4	11.1	11.1	
	7474	23 52.5	12.4	9.9	
	7512	23 78.9	12.0	10.2	
	7548	19 74.3	15.1	6.6	
	7571	17 31.4	7.0	14.5	
	7598	22 66.3	9.0	12.5	
	7627	14 80.6	8.3	13.2	
	7736	25 8.9	7.8	14.1	
	7742	18 99.0	16.8	5.1	
	7755	19 77.4	11.0	10.9	
	7807	9 11.1	10.9	10.5	
	7846	28 1.3	9.0	12.4	
25	6404	26 22.0	7.7	9.3	
	6426	15 69.8	9.0	8.0	
	6473	20 28.4	8.6	9.0	
	6491	8 96.7	9.0	8.6	
	6731	17 13.5	13.7	5.0	
	6740	20 4.4	9.5	9.3	
	6784	8 65.9	8.0	10.5	
	6817	31 8.5	11.1	7.6	
	6882	19 53.7	10.0	9.6	
	6895	20 24.0	9.0	10.5	
	7029	13 25.6	11.6	8.8	
	7041	24 23.1	7.5	13.0	
	7121	21 88.9	8.8	10.0	
	7160	20 88.6	9.0	9.9	
	7176	22 71.1	10.6	8.1	
	7193	18 36.4	10.4	8.4	
	7218	16 13.1	9.3	11.8	
	7275	22 64.5	9.5	12.0	
	7410	28 69.4	10.5	11.6	
	7448	19 27.7	12.0	9.8	
	7474	18 1.7	10.0	12.1	
	7512	18 33.6	12.4	9.7	
	7598	22 65.0	11.9	10.5	
	7627	14 83.1	7.5	14.9	
	7736	25 3.9	13.0	9.9	
	7742	18 86.7	9.8	13.2	
	7755	19 80.8	14.0	9.0	
	7807	9 20.0	12.3	11.0	
	7846	27 98.0	11.8	11.6	

Computations for latitude of St. George, Utah.

Mean latitude of St. George, Utah: 37° 6′ 29″.38 ± 0″.08.

Date.	No. of pair.	Half-sum of declination.	Corrections.			Latitude.
			Micr. and refr.	Level.	Merid.	
		° ′ ″	′ ″	″		° ′ ″
September 19, 1871	1	36 59 23.58	+ 7 5.81	+ 0.67		37 6 30.06
	2	58 52.98	+ 7 37.68	− 0.14		30.52
	3	37 6 33.93	− 0 4.45	+ 0.54		30.02
	4	9 9.16	− 2 40.11	0.00		29.05
	6	15 15.90	− 8 47.94	− 0.07		27.89
	9	6 26.50	+ 0 4.97	+ 0.20		31.67
	10	6 0 87	+ 0 28.34	− 1.01		28.20
September 20, 1871	1	36 59 23.61	+ 7 4.55	+ 1.27		29.43
	2	58 53.04	+ 7 34.44	+ 1.41		28.89
	3	37 6 34.00	− 0 7.96	+ 2.09		28.13
	5	13 3.77	− 6 36.57	+ 2.29		29.49
	6	15 15.99	− 8 49.31	+ 2.57		29.25
	7	8 21.69	− 1 52.07	+ 2.56		32.18
	8	36 51 20.96	+15 8.61	+ 0.80		30.37
	9	37 6 26.62	+ 0 0.00	+ 5.00		31.62
	10	6 1.00	+ 0 26.04	+ 3.31		30.35
	11	9 55.07	− 3 27.23	+ 3.51		31.35
	12	16 44.84	−10 18.63	+ 1.69		27.90
	13	36 59 4.51	+ 7 21.59	+ 2.77		28.87
September 21, 1871	1	36 59 23.65	+ 7 6.37	+ 0.40		30.42
	3	37 6 34.07	− 0 51.22	+ 0.88		29.73
	4	9 9.31	− 2 41.12	+ 0.47		28.66
	5	13 3.84	− 6 34.79	+ 0.07		29.12
	6	15 16.08	− 8 46.44	+ 0.20		29.84
	7	8 21.78	− 1 53.04	+ 1.35		30.09
	9	6 26.73	+ 0 2.99	+ 0.67		30.39
	10	6 1.12	+ 0 24.70	+ 2.30		28.12
	11	9 55.20	− 3 28.16	+ 2.02		29.06
	12	16 44.97	−10 17.01	+ 1.15		29.11
	13	36 59 4.65	+ 7 23.61	0.00		28.26
September 22, 1871	1	36 59 23.69	+ 7 5.52	− 0.74		28.47
	2	58 53.15	+ 7 41.80	+ 4.32		30.63
	3	37 6 34.13	− 0 5.30	+ 0.54		29.37
	4	9 9.38	− 2 41.08	+ 0.68		28.98
	5	13 3.92	− 6 42.35	+ 6.82		28.39
	6	15 16.16	− 8 48.42	0.00		27.74
	8	36 51 21.17	+15 12.21	− 5.13		28.25
	9	37 6 26.84	+ 0 2.59	− 0.81		28.62
	10	6 1.23	+ 0 31.45	− 3.44		29.24
	11	9 55.32	− 3 25.70	+ 0.07		29.69
	12	16 45.10	−10 14.95	− 0.74		29.41
	13	36 59 4.78	+ 7 23.89	0.00		28.67
	14	37 5 55.35	+ 0 33.65	− 0.07		28.93
	15	8 10.55	− 1 41.27	− 0.07		29.21
	16	10 56.26	− 4 27.57	+ 0.61		29.30
	18	12 49.32	− 6 19.26	− 0.14		29.92
	19	6 16.09	+ 0 14.19	0.00		30.28
	20	4 50.35	+ 1 17.95	− 0.13		28.17
	21	1 16.23	+ 5 12.06	− 0.88		27.41
	22	2 18.68	+ 4 11.64	− 1.08		29.24
	23	5 48.36	+ 0 39.79	− 0.94		27.21
	24	36 53 46.64	+12 42.34	+ 0.67		29.74
September 23, 1871	1	36 59 23.72	+ 7 2.98	+ 2.50		29.20
	2	58 53.20	+ 7 34.72	+ 2.02		29.94
	3	37 6 34.18	− 0 7.08	+ 1.96		29.06
	4	9 9.45	− 2 43.87	+ 3.78		29.36
	5	13 4.00	− 6 36.69	+ 1.96		29.27
	6	15 16.25	− 8 48.86	+ 1.76		29.15
	9	6 26.94	+ 0 0.08	+ 3.78		30.80
	10	6 1.35	+ 0 25.67	+ 2.70		29.72
	11	9 55.45	− 3 28.12	+ 3.04		30.37
	12	16 45.23	−10 16.89	+ 3.78		32.12
	13	36 59 4.92	+ 7 14.31	+ 9.92		29.15
	14	37 5 55.49	+ 0 29.52	+ 4.32		29.33
	15	8 10.69	− 1 44.66	+ 4.18		30.21
	16	10 56.41	− 4 27.70	− 0.14		28.57
	17	36 59 46.58	+ 6 43.84	− 1.22		29.20
	18	37 12 49.50	− 6 18.62	− 0.74		30.14
	19	6 16.27	+ 0 10.59	+ 3.64		30.50
	20	4 50.54	+ 1 35.69	+ 3.44		29.57
	21	1 16.42	+ 5 8.86	+ 4.05		29.33
	24	36 53 46.82	+12 38.66	+ 2.70		28.18

Computations for latitude of St. George, Utah—Continued.

Date.	No. of pair.	Half-sum of declination.	Corrections.			Latitude.
			Micr. and refr.	Level.	Merid.	
		° ′ ″	′ ″	″		° ′ ″
September 24, 1871	5	37 13 4.08	− 6 29.49	− 4.93	....	37 6 29.66
	7	8 22.05	− 1 51.38	0.00	....	30.67
	8	36 51 21.36	+15 6.47	− 0.40	....	27.43
	10	37 6 1.45	+ 0 27.30	+ 0.68	....	29.43
	13	36 59 5.05	+ 7 23.12	+ 0.67	....	28.84
	14	37 5 55.63	+ 0 34.98	− 1.42	....	29.19
	15	8 10.83	− 1 42.16	− 0.07	....	28.60
	16	10 56.56	− 4 28.63	+ 0.61	....	28.54
	17	36 59 46.73	+ 6 46.43	− 5.06	....	28.10
	18	37 12 49.67	− 6 20.56	+ 1.08	....	30.19
	19	6 16.45	+ 0 10.67	+ 2.90	....	30.02
	20	4 50.73	+ 1 38.23	+ 0.67	....	29.63
	21	1 16.61	+ 5 17.76	− 5.67	....	28.70
	22	2 19.07	+ 4 6.66	+ 3.64	....	29.37
	23	5 48.75	+ 0 31.71	+ 7.96	....	28.42
	24	36 53 47.00	+12 21.44	− 2.02	....	31.42
September 25, 1871	1	36 59 23.79	+ 7 5.52	− 0.40	....	28.91
	2	58 53.29	+ 7 37.68	0.00	....	30.97
	7	37 8 22.14	+ 1 57.65	+ 6.01	....	30.50
	8	36 51 21.45	+15 6.95	+ 0.68	....	29.08
	10	37 6 1.55	+ 0 28.43	− 0.75	....	29.23
	13	36 59 5.18	+ 7 23.85	− 1.82	....	27.21
	14	37 5 55.76	+ 0 33.24	+ 0 88	....	29.88
	15	8 10.97	− 1 41.99	+ 0.74	....	29.72
	16	10 56.72	− 4 23.45	− 3.37	....	29.90
	18	12 49.85	− 6 20.84	+ 0.74	....	29.75
	19	6 16.63	+ 0 12.90	+ 0.40	....	29.93
	21	1 16.81	+ 5 16.22	− 4.05	....	28.98
	22	2 19.28	4 9.61	− 0.20	....	28.69
	23	5 48.95	+ 0 38.05	+ 1.08	....	28.08
	24	36 53 47.17	+12 39.75	+ 1.01	....	27.93

Adopting the longitude of Salt Lake, 111° 53′ 42″.90 west of Greenwich, the astronomical co-ordinates of St. George will be:

Longitude, 113° 35′ 0″.30 west of Greenwich.

Longitude, 36° 31′ 58″.50 west of Washington.

Latitude: N. 37° 6′ 29″.38 ± 0″.08.

The results obtained for the longitude by lunar culminations of Camp Independence, California, and Fort Whipple, Arizona Territory, and for the latitude of Camp Independence, California, will be incorporated in the astronomical volume.

In the same publication will appear a list of the geographical positions established by the survey.

Observations and computations for latitude.—Station, Fort Whipple, Arizona Ter.

OCTOBER 27, 1871.

Number of star.	Micrometer-readings.	Level.		Remarks.	Half-sum of declination.	Corrections.			Latitude.
		N.	S.			Micrometer and reference.	Level.	Merid.	
	t. d.				° ′ ″	′ ″	″		° ′ ″
6990	12 40.4	12.5	13.8						
7029	26 52.2	15.7	11.0	....	34 42 35.1	− 9 30.5	+2.3	....	34 33 6.9
7061	16 86.3	11.9	18.2						
7131	19 6.5	19.0	12.0	....	34 34.6	− 1 29.0	+0.5	....	6.1
7275	13 76.4	16.3	16.0						
7301	24 67.0	15.0	17.1	....	25 46.7	+ 7 20.7	−1.2	....	6.2
7372	17 49.9	17.0	16.0						
7387	19 32.5	16.0	17.2	....	31 53.5	+ 1 13.8	−0.1	....	7.2

Observations and computations for latitude of Fort Whipple, Arizona—Continued.

OCTOBER 27, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.				° ′ ″	′ ″	″		° ′ ″
7455	14 82.7	20.1	13.6						
7474	21 3.9	12.9	20.8	....	34 37 18.0	−4 11.0	−0.9	....	34 33 6.1
7520	24 70.4	16.4	17.6						
7560	13 58.7	17.7	16.7	....	40 35.8	−7 29.2	−0.1	....	6.5
7606	14 81.4	5.5	5.6						
7676	21 26.5	2.9	7.3	....	28 48.9	+4 20.7	−3.0	....	6.6
7749	19 32.3	4.9	4.9						
7796	20 65.3	4.0	5.8	....	34 2.0	−0 53.7	−1.2	....	7.1
7807	19 8.6	2.8	4.0						
7820	22 24.8	4.0	3.0	....	30 58.4	+2 7.6	−0.1	....	5.9
7915	19 70.0	7.5	6.4						
7923	20 4.2	4.9	9.0	....	33 22.2	−0 13.8	−2.0	....	6.4
8023	22 60.7	7.1	7.0						
8032	19 24.2	5.3	8.9	....	30 52.7	+2 16.0	−2.4	....	6.3
8076	20 60.7	6.7	8.0						
8079	16 59.0	6.5	8.0	....	30 27.1	+2 42.3	−1.9	....	7.5
8097	15 74.2	8.5	7.4	?					
8128	23 73.4	6.5	8.3	....	27 53.9	+5 10.8	−0.5	....	4.2
8158	26 10.1	6.1	8.3						
8182	16 50.8	6.8	7.9	....	26 40.6	+6 27.6	−2.2	....	6.0
8195	19 80.5	7.9	7.0						
8206	22 0.8	5.3	9.1	....	34 36.1	−1 29.0	−2.0	....	5.1
8250	15 42.4	8.0	6.7						
8280	25 1.5	5.1	9.9	....	26 38.9	+6 27.6	−2.4	....	4.1
8299	20 90.1	7.3	7.9						
8307	15 74.8	6.0	9.1	....	36 36.8	−3 28.2	−2.5	....	6.1
8335	16 59.0	7.1	8.0						
7	21 0.9	8.0	7.1	....	30 5.3	+2 58.6	0.0	....	3.9
166	16 83.9	8.6	6.0						
173	25 23.6	3.2	10.0	....	28 28.6	+5 39.3	−2.8	....	5.1
201	14 0.9	6.4	7.6						
211	22 60.1	5.7	8.2	....	38 55.2	−5 47.2	−2.5	....	5.5
232	15 93.0	5.8	8.5						
235	13 11.1	5.9	8.4	....	39 7.9	−6 8.0	+7.3	....	7.2
247	25 3.7	14.0	0.4	....	41 3.4	−8 1.9	+4.1	....	5.6

OCTOBER 28, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.								
7275	13 63.2	5.1	8.5						
7301	24 47.1	9.9	4.0	....	25 46.6	+7 18.0	+1.7	....	34 33 6.3
7345	19 48.3	9.6	4.0	....	29 9.4	+3 56.4	+1.5	....	7.3
				Cloudy.					
8299	20 29.2	8.3	8.7						
8307	15 2.0	9.6	6.3	....	36 37.0	−3 33.0	+2.0	....	6.0
48	18 98.8	7.0	9.0						
92	17 45.0	10.9	5.3	....	34 7.6	−1 2.2	+2.4	....	7.8
166	16 55.9	18.4	19.6						
173	25 6.0	15.0	22.9	....	28 28.8	+5 43.5	−6.1	....	6.2
201	14 77.4	7.8	9.5						
211	23 45.5	11.0	6.4	....	38 55.3	−5 51.6	+2.0	....	5.7
232	15 53.3	4.6	12.7						
247	24 48.5	13.0	4.0	....	39 8.1	−6 1.8	+0.8	....	7.1

Observations and computations for latitude of Fort Whipple, Arizona—Continued.

OCTOBER 29, 1871.

Number of star.	Micrometer-readings.	Level.		Remarks.	Half sum of declination.	Corrections.			Latitude.
		N.	S.			Micrometer and reference.	Level.	Meridian.	
	t. d.				° ′ ″	″	″		° ′ ″
7275	13 12.4	7.7	3.2						
7301	23 99.2	3.3	7.5	....	34 25 46.6	+7 19.2	+0.2	....	34 33 6.0
7345	18 99.6	3.9	7.7	....	29 9.4	+3 57.3	+0.4	....	7.1
7372	16 55.9	6.8	5.0						
7387	18 33.0	5.6	6.3	....	31 53.5	+1 11.6	+0.7	....	5.8
7455	14 50.2	5.3	6.8						
7474	20 79.1	8.4	4.0	....	37 18.0	4 14.1	+1.9	....	5.8
7520	24 27.4	7.0	5.4						
7560	13 10.0	7.2	5.2	....	40 35.8	−7 31.5	+2.4	....	6.7
7641	16 6.1	6.3	7.0						
7683	27 3.6	9.0	4.6	....	25 40.4	+7 23.5	+2.5	....	6.4
7749	18 72.7	9.1	4.5						
7796	20 13.5	5.5	8.5	....	34 2.1	−0 56.9	+1.1	....	6.3
7807	20 73.0	3.6	10.7						
7820	22 78.0	14.7	− 0.8	....	30 58.5	+2 3.2	+5.7	....	7.4
7915	19 7.0	8.0	7.2						
7923	19 52.4	7.8	6.9	....	33 22.4	−0 18.4	+1.1	....	5.1
7943	25 57.0	6.5	7.8						
7953	15 62.6	7.2	7.2	....	39 48.5	−6 41.8	−0.9	....	5.8
8023	22 67.0	8.5	6.6						
8032	19 40.7	7.3	7.8	....	30 52.9	+2 11.9	+0.9	....	5.7
8076	20 25.8	8.2	7.0						
8079	16 35.4	7.2	8.0	....	30 27.3	+2 37.7	+0.3	....	5.3
8158	25 85.0	5.6	9.5						
8182	16 33.8	10.0	5.2	....	26 40.8	+6 24.4	+0.6	....	5.8
8195	16 51.0	8.1	7.2						
8206	18 82.2	8.5	7.0	....	34 36.3	−1 33.4	+1.6	....	4.5
8250	15 31.3	7.4	8.1						
8280	24 94.0	8.1	7.3	....	26 39.1	+6 29.0	0.0	....	8.1
48	19 14.5	7.6	8.0						
92	17 62.1	7.9	8.2	....	34 7.7	− 1 1.6	−0.5	....	5.6
122	12 48.5	8.5	7.5						
146	26 97.8	7.5	8.7	....	23 19.7	+ 9 45.6	−0.1	....	5.2
201	13 76.2	8.7	7.8						
211	22 40.7	7.8	8.8	....	38 55.4	− 5 49.3	−0.1	....	6.0
232	15 42.3	8.4	8.0						
235	12 58.0	8.2	8.0	....	39 8.2	− 6 0.7	+0.1	....	7.6
247	24 34.9	8.0	8.3	....	41 3.6	− 7 55.6	−0.1	....	7.9

OCTOBER 30, 1871.

Number of star.	Micrometer-readings.	Level N.	Level S.	Remarks.	Half sum of declination.	Micrometer and reference.	Level.	Meridian.	Latitude.
7275	12 90.6	7.3	7.0						
7301	23 83.4	5.8	7.4	....	34 25 46.6	+ 7 21.6	−0.9	....	34 33 7.3
7345	18 78.4	6.2	8.4	....	29 9.3	+ 3 57.5	−1.3	....	5.5
7372	16 71.3	6.8	8.0						
7377	23 35.7	7.8	7.0	....	28 36.4	+ 4 28.5	−0.3	....	4.6
7455	14 47.3	9.5	5.8						
7474	20 70.6	6.0	9.6	....	37 18.0	− 4 11.9	+0.1	....	6.2
7520	24 44.9	8.0	7.4						
7560	13 39.2	7.3	8.5	....	40 35.8	− 7 26.8	−0.4	....	8.6
7641	15 80.1	7.3	8.5						
7683	26 84.0	8.6	7.9	....	25 40.4	+ 7 26.1	−0.3	....	6.2

Observations and computations for latitude of Fort Whipple, Arizona—Continued.

OCTOBER 30, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.				° ′ ″	′ ″	″		° ′ ″
7749	18 57.6	6.0	10.3						
7796	19 88.4	7.5	8.9	....	34 34 2.2	− 0 52.9	−3.8	....	34 33 5.5
7807	18 95.8	6.7	9.8						
7820	22 0.5	12.5	3.7	....	30 58.6	+ 2 3.1	+3.9	....	5.6
7915	18 95.1	8.6	7.7						
7923	19 35.3	7.7	8.6	....	33 22.5	− 0 16.2	0.0	....	6.3
7943	25 64.5	8.6	7.5						
7953	15 70.2	7.4	9.0	....	39 48.6	− 6 41.8	−0.3	....	6.5
8158	24 41.0	7.8	8.5						
8182	14 82.2	8.0	8.1	....	26 41.0	+ 6 27.5	−0.5	....	8.0
8250	15 94.3	8.0	7.8		2				
8280	25 42.6	10.2	6.4	....	26 39.2	+ 6 23.2	+2.7	....	5.1
8299	26 22.0	7.9	9.0						
8307	15 11.7	5.6	11.0	....	36 37.2	− 3 26.2	−4.4	....	6.6
8335	16 31.0	7.7	9.2						
7	20 74.7	8.6	8.8	....	30 5.7	+ 2 59.3	−1.1	....	3.9
48	19 33.9	9.0	8.6						
92	17 83.4	8.7	9.1	....	34 8.0	− 1 0.08	0.0	....	7.2
116	13 1.2	8.9	9.1						
122	12 34.3	9.1	9.0	....	23 47.2	+ 9 17.3	+0.1	....	4.6
146	26 80.3	9.1	8.8	....	23 19.8	+ 9 44.3	+0.3	....	4.4

OCTOBER 31, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
166	16 53.7	9.5	8.5						
173	24 91.4	8.0	10.0	....	34 27 29.0	+ 5 38.5	−0.7	....	34 33 6.8
201	13 86.5	9.0	9.0						
211	22 49.3	7.9	10.0	....	38 55.6	− 5 48.7	−1.4	....	5.5
232	15 12.1	7.2	10.7						
235	12 29.2	6.6	11.4	....	39 8.4	− 6 2.9	+3.1	....	8.6
247	24 10.0	13.1	5.0	....	41 3.8	− 7 57.2	+2.2	....	8.8
7204	28 23.0	8.7	4.5						
7213	9 77.6	4.6	8.6	....	45 32.1	−12 25.7	+0.1	....	6.5
7275	13 16.7	11.4	10.4						
7301	23 98.4	12.0	9.8	....	25 46.7	+ 7 17.1	+2.2	....	6.0
7345	19 9.7	9.0	13.0	....	29 9.4	+ 3 59.6	−2.0	....	7.0
7372	16 33.5	10.3	12.0						
7387	18 6.4	13.2	9.0	Very faint	31 53.6	+ 1 9.9	+1.7	....	5.2
7455	14 37.0	11.0	12.0						
7474	20 69.2	14.6	8.5	....	37 18.1	− 4 15.5	+3.4	....	6.0
7520	23 98.9	11.0	12.1						
7560	12 82.0	13.0	9.4	....	40 35.9	− 7 31.3	+1.7	....	6.3
7606	13 84.1	12.0	11.5						
7676	20 14.7	13.1	11.0	....	28 49.2	+ 4 14.8	+1.8	....	5.8
7749	18 16.7	12.0	12.2						
7796	19 49.3	10.0	14.7	....	34 2.2	− 0 53.6	−3.3	....	5.3
7807	18 55.2	16.2	8.3						
7820	21 68.0	7.8	12.0	....	30 58.7	+ 2 6.4	+2.5	....	7.6
7915	18 89.5	7.7	7.7						
7923	19 28.0	6.8	8.5	....	33 22.6	− 0 15.6	−1.1	....	5.9
7943	25 84.9	8.4	6.8						
7953	15 89.0	8.0	7.4	....	39 48.7	− 6 42.5	+1.5	....	7.7
8023	22 80.1	9.0	6.7						
8032	19 52.6	6.8	9.0	....	30 53.2	+ 2 12.3	−0.0	....	5.5

Observations and computations for latitude of Fort Whipple, Arizona—Continued.

OCTOBER 31, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.				° ′ ″	′ ″	″		° ′ ″
8097	18 95.0	8.8	7.4	Very faint					
8128	26 65.6	7.6	8.9	....	34 27 54.3	+ 5 11.4	+ 0.1	....	34 33 5.8
8158	25 30.6	7.0	9.1						
8182	15 63.3	5.7	10.5	....	26 41.2	+ 6 30.9	−4.7	....	7.4
8195	16 77.6	9.9	6.4	d.					
8206	19 1.6	2.3	8.8	(?) Is 7.3.	34 36.6	− 1 30.5	+1.3	....	7.4
8250	15 23.6	7.5	8.8						
8280	24 60.5	13.1	3.2	....	26 39.4	+ 6 18.6	+ 5.8	....	3.8
8299	20 47.1	9.0	7.4						
8307	15 25.9	7.4	9.0	....	36 37.3	− 3 30.6	0.0	....	6.7
8317	12 23.1	12.1	4.3						
8370	24 74.4	6.5	10.2	....	41 31.6	− 8 25.6	+ 2.8	....	8.8
48	18 65.5	8.1	9.0						
92	17 12.2	8.9	8.3	....	34 8.0	−1 2.0	−0.2	....	5.8
116	13 34.4	10.1	7.0						
122	12 70.9	10.1	7.0	....	23 47.4	+ 9 17.2	+0.5	....	5.1
146	27 13.2	7.5	9.8	....	23 20.0	+ 9 42.9	+ 0.5	....	3.4
166	16 15.2	5.1	12.2						
173	24 68.0	7.1	10.2	....	27 29.2	+ 5 44.6	−6.9	....	6.9
201	13 60.2	7.2	10.0						
211	22 20.8	8.8	8.4	....	38 55.7	− 5 47.8	−1.6	....	6.3
232	14 84.4	11.5	6.0						
235	11 95.0	11.9	5.6	....	39 8.6	− 5 58.3	−1.9	....	8.4
247	23 71.1	4.6	12.9	....	41 4.0	− 7 55.3	−1.3	....	7.4

NOVEMBER 1, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
7275	12 41.5	8.5	7.0						
7301	23 26.0	7.9	7.9	....	34 25 46.6	+ 7 18.3	+1.0	....	34 33 5.9
7345	18 26.2	8.4	7.8	....	29 9.4	+ 3 56.3	+1.4	....	7.1
7372	16 48.8	8.1	8.0						
7387	18 31.4	7.2	9.1	....	31 53.6	+ 1 13.8	−1.2	....	6.2
7520	24 34.6	8.3	8.7						
7560	13 19.6	9.7	8.1	....	40 36.0	− 7 30.6	+0.8	....	6.2
7749	18 51.3	6.1	12.1						
7796	19 82.7	10.1	8.2	....	34 2.2	− 0 53.1	−2.8	....	6.3
7807	18 14 0	10.3	8.4						
7820	21 29.7	7.8	12.1	....	30 58.8	+ 2 7.6	−1.6	....	4.8
7915	18 86.8	9.0	10.0						
7923	19 26.0	9.6	9.6	....	33 22.7	− 0 15.8	−0.7	....	6.2
7943	17 40.3	6.1	12.8						
7953	7 44.5	13.0	5.9	....	39 48.8	− 6 42.4	+0.3	....	6.7
8023	22 93.0	9.5	9.8						
8032	19 60.4	8.6	10.9	....	30 53.3	+ 2 10.8	+1.4	....	5.5
8076	20 43.1	10.6	8.9						
8079	16 51.0	8.3	11.1	....	30 27.6	+ 2 38.5	−0.7	....	5.4
8097	18 85.0	9.0	10.8						
8128	26 55.5	9.8	10.1	....	27 54.3	+ 5 11.4	−1.4	....	4.5
8195	16 6.4	10.5	9.2						
8206	18 31.1	9.2	10.6	....	34 36.7	− 1 30.8	−0.1	....	5.8
8299	20 12.4	8.0	12.1						
8307	14 24.0	13.7	6.7	....	36 37.6	− 3 33.5	+2.0	....	6.1

Observations and computations for latitude of Fort Whipple, Arizona—Continued.

NOVEMBER 1, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.				° ′ ″	′ ″	″		° ′ ″
8317	12 2. 6	10. 2	9. 7						
8370	24 52. 1	10. 1	10. 0	....	34 41 31. 7	− 8 24. 9	+0. 4	....	34 33 7. 2
4	11 66. 2	10. 0	10. 3						
28	29 3. 5	8. 8	11. 7	....	21 24. 6	+11 42. 1	−2. 2	....	4. 5
48	18 46. 4	11. 8	8. 7						
92	16 96. 2	8. 0	12. 7	....	34 8. 2	− 1 0. 7	−1. 1	....	6. 4
116	13 42. 1	9. 0	12. 0						
122	12 76. 1	9. 0	12. 0	....	23 47. 5	+ 9 19. 4	−1. 7	....	5. 2
146	27 26. 5	10. 5	10. 0	....	23 20. 2	+ 9 46. 1	−1. 7	....	4. 6
166	16 27. 3	8. 4	12. 9						
173	24 66. 3	11. 2	10. 0	....	27 29. 4	+ 5 39. 0	−2. 2	....	6. 2
201	12 93. 5	9. 5	11. 8						
211	21 52. 0	10. 8	10. 8	....	38 56. 0	− 5 46. 9	−1. 6	....	7. 5
232	15 9. 0	10. 6	10. 6						
235	12 20. 2	10. 6	10. 6	....	39 8. 7	− 5 59. 6	−2. 3	....	6. 8
247	23 99. 0	9. 0	12. 4	....	41 4. 1	− 7 56. 3	−2. 3	....	5. 5

NOVEMBER 2, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8250	15 30. 3	9. 2	12. 4						
8280	24 96. 0	8. 3	13. 5	....	34 26 39. 6	+ 6 30. 2	−5. 7	....	34 33 4. 1
4	11 88. 0	10. 4	12. 0						
28	29 27. 8	10. 5	12. 0	....	21 24. 7	+11 43. 1	−2. 1	....	5. 7
116	13 23. 0	10. 4	12. 0						
146	27 5. 6	10. 5	12. 0	....	23 47. 6	+ 9 18. 6	−2. 1	....	4. 1
166	16 83. 1	10. 7	12. 4						
173	25 18. 5	12. 0	10. 5	....	27 29. 5	+ 5 37. 6	− 0. 1	....	7. 0
201	13 60. 5	9. 8	13. 0						
211	22 27. 2	13. 6	9. 0	....	38 56. 0	− 5 50. 2	+0. 9	....	6. 7
214	19 52. 0	19. 5	3. 0						
219	17 52. 9	− 0. 5	22. 7	Very faint	34 26. 9	− 1 20. 5	− 0. 8	....	5. 6
232	15 78. 7	11. 6	10. 9						
235	12 91. 8	12. 0	10. 7	....	39 8. 9	− 6 12. 0	+9. 0	....	5. 9
247	24 99. 3	17. 6	5. 0	....	41 4. 2	− 8 8. 0	+9. 4	....	5. 6

NOVEMBER 5, 1871.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8097	19 39. 7	9. 8	8. 1	Very faint					
8128	27 1. 4	10. 2	7. 5	....	34 27 55. 0	+ 5 7. 8	+3. 0	....	34 33 5. 8
8136	17 87. 9	12. 9	4. 8						
8159	20 82. 6	7. 0	10. 7	....	35 2. 3	− 1 59. 1	+3. 0	....	6. 2
8250	15 54. 8	10. 3	7. 6						
8280	25 4. 0	8. 6	9. 8	....	26 40. 0	+ 6 23. 6	+1. 0	....	4. 6
8299	20 68. 0	9. 0	9. 1	Very faint					
8307	15 41. 8	11. 3	7. 2	....	36 37. 8	− 3 32. 6	+2. 7	....	7. 8
8317	13 11. 2	7. 5	11. 0						
8370	25 66. 7	12. 6	6. 1	....	41 32. 2	− 8 27. 4	+2. 0	....	6. 8
4	12 8. 5	11. 5	7. 3						
28	29 32. 0	9. 9	8. 9	....	21 25. 1	+11 36. 5	+3. 5	....	5. 1
214	19 18. 2	11. 0	8. 1						
219	17 7. 0	10. 4	9. 0	....	34 27. 3	− 1 25. 3	+2. 9	....	4. 9

Mean latitude of Fort Whipple, Arizona, 34° 33′ 6″. 124 ±0. 065.

FORT FRED STEELE, WYOMING, (1872.)

Longitude, 106° 56′ 48″.80; latitude, 41° 46′ 40″.24 ±0″.05.

The point selected for the station at Fort Fred Steele was just in the rear of the sutler's store, on the west side of the railroad-track. Being across a ravine which lay between it and the railroad, it was entirely free from the jar of passing trains; and being at the same time to the windward, there was no interference from smoke. Fort Fred Steele is a military post pure and simple, is situated on the left bank of the North Platte, where the Union Pacific Railroad crosses it, and has no citizen-population whatever, if the few railroad employés and the proprietors of one or two insignificant ranches in the immediate vicinity be excepted. The location is on a bluff of the river, which presents here limited and rather barreñ valleys, while the surrounding country has been much disturbed by volcanic action, and, subsequently, further cut up by erosion. The general view is very limited; the top of Elk Mountain can be seen at the southeast and directly north on the east side of the river, and but two or three miles distant a rocky ridge, around which the river works its way to the west. Southward the view is up the valley of the river, the barrenness of which is somewhat relieved by a few straggling cotton-wood trees. Taken altogether, its surroundings are not inviting, and, if we except the country about Green River, no region which the Union Pacific Railroad traverses is more destitute of animal and vegetable life.

Meteorological.—The most unfavorable condition possible as to weather prevailed during the occupation of this station, which was in the month of November. In this time there was scarcely a week altogether that could be made available for astronomical work in connection with Salt Lake. It was entirely too cold to make anything like satisfactory observations, the thermometer showing frequently a range of temperature from 30° to 40° below freezing, and once it actually touched 60°, when it was no longer possible to remain in the tent or keep the ink and battery from freezing, despite the use of a stove—a very objectionable feature to an observatory under any circumstances. It was not only cold, but an almost uninterrupted series of drifting snow and dust storms succeeded each other.

Observatory and instruments.—The observatory and instruments were the same as those used at Cheyenne, Wyo., and the transit was mounted in the same way. The assistants, (J. H. Clark being the principal.) were also the same. The telegraphic work was done over the Atlantic and Pacific line, and the operators were Messrs. Brown, McCoy, Murphy, and three others. These were not all present at the same time, but came as reliefs during the occupancy of this station.

Connections.—Connection was made with Salt Lake observatory. On the 1st, 4th, 5th, 7th, 19th, 20th, 21st, 22d, 25th, and 26th of November, observations were made with the view of interchanging signals for longitude, and chronometer-signals were sent and received on six nights. For eleven nights, work was prosecuted on the latitude. On many of them only a pair or two of stars here and there between the passing storm-clouds could be observed.

Instrumental values.—The instrumental values are given in the report on Cheyenne station already published.

Circumstances of telegraphic connection.—The length of the circuit is about four hundred miles. The observatory was connected by a loop with the railroad telegraph-office, and all the signals were received and sent by the instrumentality of the chronograph. No information is available as to the batteries and repeaters on the circuit employed,

The computations were made by civilian assistants, J. H. Clark and Dr. F. Kampf. The arrangement into publication form was made by the latter.

Uniform tables of time-reductions at Fort Fred Steele, Wyo., November 5, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
ε Pegasi	W.	23 38 16.20	−0.28	+ 2.37	−0.04	23 38 18.25	21 37 55.64	−2 00 22.61
11 Cephei	....	40 32.96	−0.87	− 6.45	−0.12	40 25.52	40 02.79	22.73
μ Capricorni	....	46 40.04	−0.19	+ 3.73	−0.04	46 43.54	46 20.92	22.62
79 Draconis	....	51 48.27	−0.41	− 7.86	−0.13	51 39.87	51 16.95	22.92
α Aquarii	....	59 34.12	+0.04	+ 2.99	−0.04	59 37.11	59 14.42	22.69
32 Urs. Maj., L. C	E.	0 08 58.09	+0.04	+10.18	−0.10	0 09 08.21	22 08 44.65	23.56
π Aquarii	....	19 06.25	−0.04	+ 2.90	+0.04	19 09.15	18 46.36	22.79
9 Draconis, L. C	....	24 17.43	+0.20	+16.42	−0.17	24 33.88	24 11.01	22.87
η Draconis	....	29 08.83	−0.10	+ 2.99	+0.04	29 11.76	28 48.74	23.02
ζ Pegasi	....	35 27.42	−0.17	+ 2.33	+0.04	35 29.62	35 06.65	−2 00 22.97
Mean for 22^h 0^m local sidereal time								−2 00 22.88

Normal equations.

$$10\ \delta t - 6.74\ a - 13.16\ c = + 30.82$$
$$- 6.74\ \delta t + 27.38\ a + 11.12\ c = - 121.02 \qquad a = - 4^s.390$$
$$- 13.16\ \delta t + 11.12\ a + 51.01\ c = - 49.81 \qquad c = + 0^s.035$$

Fort Fred Steele, Wyo., November 5, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
ι Piscium	E	1 33 43.92	+0.07	+ 2.68	0.00	1 33 46.67	23 33 24.44	− 2 00 22.23
Groomb. 4163	....	49 12.05	+0.21	− 8.45	−0.01	49 03.80	48 41.34	22.46
ω Piscium	....	53 06.65	+0.04	+ 2.64	0.00	53 09.33	52 46.80	22.53
α Adrom	....	2 02 10.38	+0.05	+ 1.16	0.00	2 02 11.59	0 01 48.95	22.64
4 Drac., L. C	....	06 12.13	−0.12	+19.09	+0.02	06 31.12	06 08.90	22.22
α Cassiopeiæ	W.	33 43.22	−0.04	− 1.92	0.00	33 41.26	33 18.58	22.68
β Ceti	....	37 31.54	+0.05	+ 4.11	0.00	37 35.70	37 12.51	23.19
32 Camel., L. C	....	47 51.86	−0.57	+35.27	− 0.03	47 26.53	48 04.97	22.56
ε Piscium	....	56 40.98	+0.08	+ 2.55	0.00	56 43.61	56 20.77	22.84
Mean for 0^h 0^m local sidereal time								− 2 00 22.59

Normal equations.

$$9\ \delta t - 12.78\ a + 7.66\ c = + 60.50$$
$$- 12.78\ \delta t + 86.18\ a - 49.74\ c = - 389.94 \qquad a = - 4^s.470$$
$$+ 7.66\ \delta t - 49.74\ a + 140.57\ c = + 224.57 \qquad c = - 0^s.003$$

Fort Fred Steele, November 19, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
ζ Pegasi	W.	0 34 32.85	− 0.44	+ 0.93	− 0.50	0 34 32.84	22 35 06.47	−1 59 26.37
ι Cephei	....	44 39.27	− 1.16	− 1.71	− 1.19	44 35.21	45 08.90	26.31
α Piscis Australis	....	50 02.05	0.19	1.94	− 0.57	50 03.23	50 36.74	26.49
α Ursæ Majoris, L. C	....	55 12.13	0.33	3.70	+ 1.07	55 17.23	55 50.44	26.79
o Cephei	....	1 12 56.31	1.69	1.99	− 1.29	1 12 51.34	23 13 24.57	26.77
θ Piscium	....	20 57.12	0.57	1.04	− 0.50	20 57.09	21 30.63	26.46
γ Cephei	W.	33 45.03	2.56	4.47	− 2.19	33 35.81	33 69.15	26.66
α Cassiopeiæ	E.	2 32 46.48	1.78	0.76	+ 0.88	2 32 44.82	0 33 18.38	26.44
β Ceti	....	36 37.46	0.54	1.62	+ 0.52	36 39.06	37 12.43	26.63
ε Piscium	....	55 46.54	0.86	+ 1.00	+ 0.50	55 47.18	56 20.74	−1 59 26.44
Mean for 23^h 0^m local sidereal time								−1 59 26.44

Normal equations.

$$10\ \delta t - 0.74\,a - 6.61\,c = -7.33$$
$$-0.74\ \delta t + 16.27\,a - 19.42\,c = -37.82 \qquad a = -1^s.758$$
$$-6.61\ \delta t - 19.42\,a + 45.50\,c = +60.16 \qquad c = +0^s.495$$

Fort Fred Steele, November 20, 1872.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
θ Piscium	E.	1 20 50.90	− 0.28	+ 2.63	+ 0.41	1 20 53.66	23 21 30.62	−1 59 23.04
γ Cephei	....	33 42.87	− 1.23	−11.30	+ 1.78	33 32 12	33 69.08	23.04
α Cassiopeiæ	W.	2 32 44.71	− 0.69	− 1.91	− 0.72	2 32 41.39	0 33 18.35	23.04
Mean for $0^h\ 0^m$ local sidereal time								−1 59 23.04

Normal equations.

$$+3\ \delta t + 2.38\,a + 3.65\,c = -9.23$$
$$+2.38\ \delta t + 6.98\,a + 9.86\,c = -27.20 \qquad a = -4^s.452$$
$$+3.65\ \delta t + 9.86\,a + 23.73\,c = -34.48 \qquad c = ..\ 0^s.403$$

Fort Fred Steele, November 21, 1872.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
α Aquarii	W.	23 58 30.00	−0.12	+ 2.64	−0.38	23 58 32.14	21 59 14.22	−1 59 17.92
32 Ursæ Majoris, L. C	....	0 07 53.67	+0.15	+ 9.00	+0.91	0 08 03.73	22 08 45.72	18.01
π Aquarii	....	18 02.05	−0.18	+ 2.56	−0.38	18 04.05	18 46.16	17.89
9 Draconis (H.)	....	23 14.17	+0.60	+14.51	+1.59	23 30.87	24 12.70	18.17
γ Aquarii	....	28 04.42	−0.19	+ 2.64	−0.38	28 06.49	28 48.55	17.94
226 Cephei	....	29 30.59	−0.73	− 8.65	−1.51	29 19.70	29 61.29	18.41
ζ Pegasi	....	34 22.83	−0.16	+ 2.06	−0.38	34 24.35	35 06.45	17.90
π Aquarii	E.	45 13.18	−0.34	+ 3.03	+0.38	45 16.27	45 58.10	18.17
α Piscis Australis	....	49 50.12	−0.19	+ 4.27	+0.44	49 54.64	50 36.71	17.93
α Ursæ Majoris, L. C	....	55 01.30	−0.28	+ 8.15	−0.81	55 08 36	55 50.56	17.80
α Pegasi	....	57 41.12	−0.50	+ 1.82	+0.39	57 42.83	58 25.07	17.76
ι Piscium	....	1 32 39.65	−0.44	+ 2.33	+0.38	1 32 41.92	23 33 24.29	17.63
γ Cephei	....	33 36.89	−2.02	− 9.86	+1.66	33 26.67	33 69.01	−1 59 17.66
Mean for $22^h\ 30^m$ local sidereal time								−1 59 17.94

Normal equations.

$$13\ \delta t - 8.89\,a + 5.09\,c = +37.50$$
$$-8.89\ \delta t + 39.24\,a - 15.28\,c = -158.95 \qquad a = -3^s.880$$
$$5.09\ \delta t - 15.28\,a + 72.72\,c = +90.21 \qquad c = +0^s.375$$

Fort Fred Steele, November 22, 1872.

Name of star.	Clamp.	T	*b* B	*a* A	*c* C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
9 Draconis, L. C	W.	0 23 18.72	+0.12	+8.75	0.00	0 23 27.59	22 24 12.81	−1 59 14.78
226 Cephei	....	29 20.84	−0.20	−5.22	0.00	29 15.42	29 61.20	14.22
ι Cephei	....	44 25.84	−0.30	−2.27	0.00	44 23.27	45 08 78	14.49
α Ursæ Majoris, L. C	....	54 59.83	+0.05	+4.91	0.00	55 04.79	55 50.62	14.17
ο Cephei	....	1 12 41.38	−0.20	−2.65	0.00	1 12 38.53	23 13 24.41	14.12
λ Draconis, L. C	....	22 55.62	+0.08	+6.37	0.00	23 02.07	23 48.22	13.85
γ Cephei	....	33 29.63	−0.25	−5.94	0.00	33 23.44	33 68.88	−1 59 14.56
Mean for $23^h\ 0^m$ local sidereal time								−1 59 14.31

Normal equations.

$$7\ \delta t - 1.69\,a - 4.12\,c = +1.76$$
$$-1.69\ \delta t + 39.44\,a - 53.84\,c = -91.94 \qquad a = -2^s.345$$
$$-4.12\ \delta t - 53.84\,a + 79.50\,c = +127.58 \qquad c = 0^s.000$$

Fort Fred Steele, November 22, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
κ Draconis	W.	2 27 07.19	+0.11	+ 6.48	+0.67	2 27 14.45	0 28 00.46	—1 59 13.99
α Cassiopeiæ ...	....	32 33.67	—0.17	— 1.01	—0.40	32 32.09	33 18.30	13.79
21 Cassiopeiæ ...	....	36 38.17	—0.32	— 4.66	—0.83	36 32.36	37 18.18	14.18
32 Camelop'rdalis	E.	47 04.43	+0.57	+18.46	—2.19	47 21.27	48 07.25	14.02
ε Piscium	....	55 33.60	—0.08	+ 1.33	+0.23	55 35.08	56 20.71	14.37
38 Cassiopeiæ ...	....	3 21 05.61	—0.25	— 3.14	+0.65	3 21 02.87	1 21 48.97	—1 59 13.90
Mean for $0^h\ 30^m$ local sidereal time								—1 59 14.04

Normal equations.

$$6\ \delta t - 7.47\, a - 8.34\, c = 15.34$$
$$-7.47\ \delta t + 76.18\, a + 63.73\, c = -163.74$$
$$-8.34\ \delta t + 63.73\, a + 129.86\, c = -119.46$$

$a = -2^s.340$
$c = +0^s.225$

Fort Fred Steele, November 25, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
ι Cephei	....	0 44 13.50	—1.12	—2.03	+0.45	0 44 10.80	22 45 08.60	—1 59 02.20
α Piscis Aust...	....	49 36.43	—0.18	+2.30	+0.21	49 38.76	50 36.64	02.12
α Urs.Maj.(L.C.)	....	54 48.09	+0.27	+4.39	—0.40	54 52.31	55 50.79	01.52
ο Cephei	....	1 12 29.60	—1.17	—2.36	+0.48	1 12 26.55	23 13 24.28	02.27
θ Piscium	....	20 31.54	—0.40	+1.23	+0.19	20 32.56	21 30.56	02.00
ι Piscium	....	32 25.09	—0.35	+1.25	+0.19	32 26.18	33 24.25	01.93
Groom. 4163 ...	....	47 46.42	—1.38	—3.95	+0.66	47 41.75	48 40.24	01.51
μ Piscium	....	51 47.50	—0.37	+1.23	+0.19	51 48.55	52 46.63	01.92
α Andromedæ ..	....	2 00 50.32	—0.45	+0.54	+0.21	2 00 50.62	0 01 48.74	01.88
4 Draconis(L.C.)	....	04 03.82	+1.02	+8.92	—0.91	04 12.85	06 10.73	02.12
θ Ceti	....	3 16 41.14	—0.12	+1.63	—0.19	16 42.46	17 40.24	02.22
38 Cassiopieæ ...	....	20 54.96	—0.76	—2.80	—0.53	20 50.87	21 48.91	01.96
γ Piscium	....	23 42.39	—0.31	+0.98	—0.19	23 42.87	24 40.90	01.97
ο Piscium	....	37 42.31	—0.31	+1.17	—0.19	37 42.98	38 41.05	01.93
β Arietis	....	46 38.92	—0.44	+0.82	—0.20	46 39.10	47 37.27	—1 59 01.83
Mean for $0^h\ 0^m$ local sidereal time								—1 59 01.96

Normal equations.

$$+15.00\ \delta t - 6.38\, a - 0.21\, c = +13.83$$
$$-6.38\ \delta t + 33.86\, a + 32.67\, c = -64.88$$
$$-0.21\ \delta t + 32.67\, a + 72.51\, c = -54.83$$

$a = -2^s.090$
$e = +0^s.185$

Salt Lake, November 5, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
ο Cephi	W.	23 16 01.13	-0.46	+ 5.09	+0.08	23 16 05.84	23 13 25.09	-0 02 40.75
θ Piscium	....	24 14.06	0.07	- 2.52	0.03	24 11.50	21 30.82	40.68
ω Piscium	....	36 07.59	0.10	- 2.57	+0.03	36 04.95	33 24.40	40.55
γ Cephei	....	36 40.31	0.62	+11.31	+0.13	36 51.13	34 10.29	40.84
Groom. 4163	E.	51 14.14	0.44	+ 8.44	-0.11	51 22.03	48 41.35	40.68
ω Piscium	....	55 30.21	0.09	— 2.48	-0.03	55 27.61	52 46.80	40.81
α Andromedæ	....	0 04 30.97	0.10	— 1.04	0.03	0 04 29.80	0 01 48.96	40.84
γ Pegasi	....	09 24.11	0.06	— 2.00	0.03	09 22.02	06 41.26	40.76
ι Ceti	....	15 41.21	0.02	- 3.39	-0.03	15 37.81	12 56.96	-0 02 40.85
Mean for $23^h\ 30^m$ local sidereal time								0 02 40.75

Normal equations.

$$+9.00\ \delta t - 2.49\, a + 1.27\, c = +13.12$$
$$-2.49\ \delta t + 13.78\, a - 8.53\, c = -60.68$$
$$+1.27\ \delta t - 8.53\, a + 45.30\, c = +38.70$$

$a = -4^s.346.$
$c = +0^s.029$

Salt Lake, November 19, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
θ Aquarii	W.	22 12 19.55	−0.15	−0.35	+0.04	22 12 19.09	22 10 06.54	−0 02 12.55
π Aquarii	....	20 59.27	−0.12	−0.29	+0.04	20 58.90	18 46.19	12.71
9 Draconis, L. C	....	26 27.29	+0.13	−1.71	−0.17	26 25.54	24 12.22	13.32
226 Cephei	....	32 13.80	−0.30	+1.05	+0.16	32 14.71	30 01.39	13.32
ζ Pegasi	....	37 19.55	−0.12	−0.24	+0.04	37 19.23	35 06.53	12.70
ι Cephei	E.	43 21.71	−0.21	+0.46	−0.09	43 21.87	45 08.89	12.98
λ Aquarii	....	48 11.40	−0.07	−0.35	−0.04	48 10.94	45 58.17	12.77
α Pegasi	....	23 00 38.24	−0.18	−0.21	−0.04	23 00 37.81	58 25.10	12.71
φ Aquarii	....	9 56.96	−0.14	−0.34	−0.04	09 56.44	23 07 43.74	12.70
o Cephei	....	15 37.22	−0.46	+0.53	−0.10	15 37.19	13 24.50	−0 02 12.69
Mean, excluding 9 Draconis and 226 Cephei								−0 02 12.84
Mean for 22h. 30m. local sidereal time								−0 02 12.74

Normal equations.

$$10.00\,\delta t + 3.19\,a - 5.25\,c = -0.17$$
$$+3.19\,\delta t + 24.29\,a - 19.60\,c = -11.45$$
$$-5.25\,\delta t - 19.60\,a + 52.59\,c = +10.57$$

$a = -0^s.457$
$c = +0^s.042$

Salt Lake, November 19, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
α Andromedæ	E.	0 04 01.72	−0.32	−0.06	−0.10	0 04 01.24	0 01 48.83	−0 02 12.41
γ Pegasi	....	08 53.98	−0.28	−0.11	−0.09	08 53.50	06 41.16	12.34
12 Ceti	....	25 46.17	−0.21	−0.18	−0.09	25 45.69	23 32.92	12.77
α Cassiopeiæ	W.	35 30.98	−0.73	+0.11	+0.16	35 30.52	33 18.27	12.25
β Ceti	....	39 25.21	−0.10	−0.22	+0.09	39 24.98	37 12.46	12.52
32 Camelopardalis, L. C	....	50 20.52	+0.92	−1.97	−0.88	50 18.59	48 06.17	12.42
ε Piscium	....	58 33.47	−0.13	−0.14	+0.09	58 33.29	56 20.73	−0 02 12.56
Mean for 0h 30m local sidereal time								−0 02 12.47

Normal equations.

$$+7.00\,\delta t + 10.43\,a - 9.07\,c = +0.34$$
$$+10.43\,\delta t + 66.14\,a - 78.83\,c = -17.81$$
$$-9.07\,\delta t - 78.83\,a + 103.96\,c = +23.82$$

$a = -0^s.246$
$c = +0^s.091$

Salt Lake, November 20, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
π Aqnarii	W.	22 20 56.45	−0.17	−0.27	+0.03	22 20 56.04	22 18 46.18	−0 02 09.86
9 Draconis, L. C	....	26 23.86	+0.40	−1.60	−0.11	26 22.55	24. 12.32	10.23
226 Cephei	....	32 11.20	−0.66	+0.98	+0.11	32 11.63	30 01.31	10.32
ξ Pegasi	....	37 16.75	−0.16	−0.22	+0.03	37 16.40	35 06.52	09.88
λ Aquarii	....	48 08.30	−0.17	−0.33	+0.03	48 07.83	45 58.16	09.67
o Cephei	E.	23 15 34.54	−0.62	+0.50	−0.07	23 15 34.35	23 13 24.45	09.90
θ Piscium	....	23 41.23	−0.22	−0.24	−0.03	23 40.74	21 30.67	10.07
γ Cephei	....	36 19.15	−0.97	+1.11	−0.12	36 19.17	34 09.22	09.95
ι Piscium	....	35 34.79	−0.22	−0.25	−0.03	35 34.29	33 24.26	−0 02 10.03
Mean for 23h 0m local sidereal time								−0 02 09.99

Normal equations.

$$+9.00\,\delta t + 0.77\,a - 6.19\,c = -0.39$$
$$+0.77\,\delta t + 29.42\,a - 9.54\,c = -12.82$$
$$-6.19\,\delta t - 9.54\,a + 65.34\,c = +5.77$$

$a = -0^s.427$
$c = +0^s.027$

Salt Lake, November 20, 1872.

Name of star.	Clamp.	T	bB	aA	cC	T′	AR	ΔT
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
α Andromedæ	E.	0 03 59.26	− 0.28	− 0.08	− 0.10	0 03 58.80	0 01 48.82	−00 02 9.98
γ Pegasi	....	08 51.73	− 0.22	− 0.16	− 0.09	08 51.26	06 41.16	10.10
ι Ceti	....	15 07.28	− 0.14	− 0.27	− 0.09	15 06.78	12 56.84	09.94
12 Ceti	W.	25 43.15	− 0.12	− 0.25	+ 0.09	25 42.87	23 32.91	09.96
α Cassiopeiæ	....	35 28.16	− 0.22	+ 0.16	+ 0.15	35 28.25	33 18.25	10.00
β Ceti	....	39 22.79	− 0.06	− 0.32	+ 0.09	39 22.50	37 12.45	−0 02 10.05
Mean for 0h 0m local sidereal time								−0 02 10.00

Normal equations.

$$+6.00\,\delta t + 2.64\,a + 0.66\,c = -0.91$$
$$+2.64\,\delta t + 2.43\,a - 0.68\,c = -0.91 \qquad a = -0^s.351$$
$$+0.66\,\delta t - 0.68\,a + 8.72\,c = +0.99 \qquad c = +0^s.086$$

Salt Lake, November 21, 1872.

Name of star.	Clamp.	T	bB	aA	cC	T′	AR	T
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m s.
ζ Pegasi	W.	22 37 14.76	0.22	0.35	+ 0.14	22 37 14.33	22 35 06.51	−0 02 07.82
ι Cephei	....	47 16.32	− 0.59	+ 0.68	+ 0.33	47 16.74	45 08.80	07.94
α Pegasi	....	23 00 33 24	− 0.25	− 0.30	+ 0.14	23 00 32.83	58 25.08	07.75
φ Aquarii	....	09 52.01	0.16	− 0.50	+ 0.14	09 51.49	23 07 43.72	07.77
ο Cephei	E.	15 32.32	0.46	0.78	0.35	15 32.29	13 24.41	07.88
Piscium	....	23 38.99	0.16	− 0.38	0.14	23 38.31	21 30.66	07.65
ι Piscium	....	35 32.38	0.16	− 0.39	0.14	35 31.69	33 24.25	07.44
γ Cephei	....	36 16.64	− 0.72	+ 1.73	0.61	36 17.04	34 09.14	−0 02 07.90
Mean for 23h 0m local sidereal time								−0 02 07.77

Normal equations.

$$+8.00\,\delta t + 1.92\,a + 3.54\,c = +2.63$$
$$+1.92\,\delta t + 10.92\,a + 12.78\,c = 5.07 \qquad a = 0^s.664$$
$$+3.54\,\delta t + 12.78\,a + 37.43 \quad 4.19 \qquad c = +0^s.137$$

Salt Lake, November 21, 1872.

Name of star.	Clamp.	T	bB	aA	cC	T′	AR.	ΔT
		h. m. s.	s.	s.	s.	h. m. s.	h. m. s.	h. m. s.
α Andromedæ	E.	0 03 56.88	− 0.34	− 0.13	− 0.02	0 03 56.39	0 01 48.81	−0 02 07.58
γ Pegasi	....	08 49.33	− 0.28	− 0.24	− 0.02	08 48.79	06 41.14	07.65
ι Ceti	....	15 05.16	− 0.18	− 0.42	− 0.02	15 04.54	12 56.76	07.78
α Cassiopeiæ	W.	35 25.70	− 0.38	+ 0.25	+ 0.03	35 25.60	33 18.23	07.37
β Ceti	....	39 20.53	− 0.09	− 0.49	+ 0.02	39 19.97	37 12.44	07.53
32 Camelop., L.C.	....	50 17.64	+ 0.90	− 4.33	− 0.18	50 14.03	48 06.53	07.50
ε Piscium	....	58 28.78	− 0.14	− 0.30	+ 0.02	58 28.36	56 20.72	−0 02 07.64
Mean for 0h 0m local sidereal time								−0 02 07.58

Normal equations.

$$+7.00\,\delta t + 10.47\,a - 9.08\,c = -2.88$$
$$+10.47\,\delta t + 66.21\,a - 78.92\,c = -32.53 \qquad a = -0^s.541$$
$$-9.08\,\delta t - 78.92\,a + 104.02\,c = +40.66 \qquad c = +0^s.018$$

Salt Lake, November 22, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	ΔT
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
π Aquarii	W.	22 20 52. 18	— 0. 22	— 0. 30	+ 0. 03	22 20 51. 69	22 18 46. 17	—0 02 05. 52
226 Cephei	....	32 06. 86	— 1. 02	+ 1. 08	+ 0. 12	32 07. 04	30 01. 13	05. 91
ζ Pegasi	....	37 12. 47	— 0. 27	— 0. 25	+ 0. 03	37 11. 98	35 06. 50	05. 48
ι Cephei	....	47 13. 93	— 0. 59	+ 0. 48	+ 0. 07	47 13. 89	45 08. 75	05. 14
λ Aquarii	....	48 04. 16	— 0. 15	— 0. 36	+ 0. 03	48 03. 68	45 58. 14	05. 54
α Pegasi	E.	23 00 30. 98	— 0. 07	— 0. 21	— 0. 03	23 00 30. 67	58 25. 07	05. 60
φ Aquarii	....	09 49. 85	— 0. 01	— 0. 35	— 0. 03	09 49. 46	23 07 43. 72	05. 74
ο Cephei	....	15 29. 60	+ 0. 07	+ 0. 55	— 0. 08	15 30. 14	13 24. 36	05. 78
θ Piscium	....	23 36. 69	+ 0. 04	— 0. 27	— 0. 03	23 36. 43	21 30. 64	05. 79
γ Cephei	....	36 13. 19	+ 0. 18	+ 1. 23	— 0. 13	36 14. 47	34 09. 05	—0 02 05. 42
Mean for 23^h 0^m local sidereal time								—0 02 05. 59

Normal equations.

$$+ 10.00\,\delta t - 3.39\,a - 0.63\,c = - 4.34$$
$$- 3.39\,\delta t + 16.81\,a + 3.15\,c = - 5.87 \qquad a = - 0^s.473$$
$$- 0.63\,\delta t + 3.15\,a + 54.55\,c = + 0.64 \qquad c = + 0^s.032$$

Salt Lake, November 25, 1872.

Name of star.	Clamp.	T	b B	a A	c C	T′	AR.	Δ T
		h. m. s.	*s.*	*s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
226 Cephei	W.	22 31 58. 88	+0. 06	+0. 68	+0. 21	22 31 59. 83	22 30 00. 88	—0 01 58. 95
ζ Pegasi	....	37 05. 63	+0. 01	—0. 15	+0. 05	37 05. 54	35 06. 46	59. 08
ι Cephei	....	47 06. 96	+0. 06	+0. 30	+0. 12	47 07. 44	45 08. 61	58. 83
λ Aquarii	....	47 57. 30	+0. 04	—0. 23	+0. 05	47 57. 16	45 58. 11	59. 05
α Pegasi	....	23 00 24. 06	+0. 02	—0. 13	+0. 05	23 00 24. 00	58 25. 03	58. 97
φ Aquarii	E.	09 42. 89	+0. 05	—0. 22	—0. 05	09 42. 67	23 07 43. 70	58. 97
ο Cephei	....	15 22. 82	+0. 14	+0. 35	—0. 13	15 23. 18	13 24. 22	58. 96
θ Piscium	....	23 29. 51	+0. 04	—0. 17	—0. 05	23 29. 33	21 30. 61	58. 72
ι Piscium	....	35 23. 34	+0. 04	—0. 18	—0. 05	35 23. 15	33 24. 21	58. 94
γ Cephei	....	36 07. 12	+0. 14	+0. 78	—0. 23	36 07. 81	34 08. 82	—0 01 58. 99
Mean for 23^h 0^m local sidereal time								—0 01 58. 95

Normal equations.

$$+10.00\,\delta t - 3.44\,a - 0.55\,c = +1.53$$
$$- 3.44\,\delta t + 16.75\,a + 2.85\,c = -5.03 \qquad a = -0^s.298$$
$$- 0.55\,\delta t + 2.85\,a + 54.55\,c = +1.96 \qquad c = +0^s.052$$

Salt Lake chronometer.

NEGUS 1511.

1872.	Local sidereal time.	Correction of chronometer.	Adopted hourly rates.
	h.	*m. s.*	*s.*
November 5	23. 5	—2 40. 75	0. 017
November 7	22. 5	39. 96	0. 026
November 19	23. 5	12. 61	0. 101
November 20	23. 5	10. 00	0. 103
November 21	23. 5	07. 68	0. 092
November 22	23. 0	—2 05. 59	0. 090
November 25	23. 0	—1 58. 95	0. 112
November 26	23. 0	55. 78	0. 132

Fort Fred Steele chronometer.

NEGUS 1499.

1872.	Local sidereal time.	Correction of chronometer.	Adopted hourly rates.
	h.	*h. m. s.*	*s.*
November 5	23.0	—2 00 22.70	0.129
November 7	22.5	16.52	0.140
November 19	23.0	—1 59 26.54	0.150
November 20	24.0	23.04	0.180
November 21	22.5	17.93	0.181
November 22	23.5	14.16	0.161
November 25	0.0	59 01.96	0.201
November 26	22.5	—1 58 56.40	0.232

NOVEMBER 5, 1872.

Signals sent from Salt Lake.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
1 03 40.4	22 46 10.7	1 05 30.7	22 48 01.1	1 07 20.9	22 49 51.1
50.4	20.8	40.7	11.1	31.2	50 01.4
04 00.2	30.6	50.6	20.9	41.2	11.4
10.2	40.6	6 01.0	31.1	51.1	21.2
20.3	50.7	10.6	40.9	08 00.7	31.1
30.7	47 01.1	20.7	51.0	11.0	41.1
40.6	10.9	30.9	49 01.1	21.0	51.3
50.4	20.8	40.9	11.1	31.4	51 01.7
05 00.5	30.8	50.7	21.1	41.0	11.3
10.4	40.7	07 00.7	31.0		
20.4	50.8	10.7	41.1	Mean, 1 6 10.71	22 48 41.02

Signals sent from Fort Fred Steele.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
1 10 06.1	22 52 36.3	1 12 06.7	22 54 37.1	1 14 07.5	22 56 37.9
17.1	47.3	17.3	47.7	16.8	47.1
27.6	58.0	27.0	57.4	27.7	58.1
35.8	53 06.3	36.1	55 06.4	36.6	57 07.0
46.0	16.3	47.9	18.2	47.2	17.8
56.1	26.3	56.6	27.0	57.2	27.8
11 06.5	36.8	13 07.3	37.8	15 07.5	38.0
17.0	47.3	17.1	47.4	17.2	47.6
26.4	56.9	27.0	57.4	27.4	57.9
36.1	54 06.3	36.8	56 07.2		
46.7	16.1	47.2	17.7	Mean, 1 12 46.88	22 55 17.23
56.6	27.0	57.0	27.3		

NOVEMBER 19, 1872.

Signals sent from Salt Lake.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
2 00 28.3	23 43 27.0	2 02 18.0	23 45 16.7	2 04 08.3	23 47 07.1
38.1	36.9	28.2	26.9	18.3	17.1
48.2	46.9	38.2	36.9	28.6	27.1
58.0	56.8	48.3	47.1	38.7	37.2
01 08.2	44 06.9	58.2	56.9	48.7	47.2
17.9	16.6	03 08.1	46 06.9	58.7	57.2
27.8	26.3	18.3	17.0	05 08.6	48 07.2
38.2	36.9	28.3	26.9	18.7	17.3
48.3	47.0	38.3	37.1	28.6	27.2
58.1	56.8	48.7	47.2		
02 07.9	45 06.7	58.3	57.1	Mean, 2 02 58.30	23 45 56.97

Signals sent from Fort Fred Steele.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h, m. s.*	*h. m. s.*
2 07 33. 8	23 50 32. 6	2 09 24. 6	23 52 23. 3	2 11 14. 6	23 54 12. 3
43. 5	42. 2	34. 2	33. 0	24. 9	23 8
53. 6	52. 3	43. 7	42. 5	34. 8	33. 7
08 03. 2	51 02. 0	54. 1	52. 9	43. 8	42. 6
14. 0	12. 9	10 03. 2	53 01. 8	53. 3	53. 1
24. 7	23. 3	14. 5	13. 2	12 03. 5	55 02. 1
34. 4	33. 1	24. 6	23. 3	14. 8	13. 5
43. 7	42. 3	34 5	33. 2	25. 0	23. 8
53. 7	52. 3	44. 0	42. 8	34. 9	33. 8
09 03. 4	52 02. 1	54. 5	53. 1		
14. 6	12. 2	11 03. 3	54 02. 0	Mean, 2 10 03. 11	23 53 01. 84

NOVEMBER 20, 1872.

Signals sent from Salt Lake.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
2 55 17. 7	23 38 16. 9	1 57 07. 5	23 40 06. 8	1 58 57. 8	23 41 57. 0
27. 3	26. 5	17. 5	16. 8	59 07. 8	42 07. 0
37. 6	36. 9	27. 8	27. 0	17. 8	17. 0
47. 6	46. 9	37. 8	37. 1	28. 0	27. 2
57. 1	56. 2	47. 8	47. 1	38. 1	37. 3
56 07. 1	39 06. 3	57. 8	56. 9	48. 2	47. 4
17. 3	16. 5	58 07. 6	41 06. 9	58. 0	57. 2
27. 6	26. 9	17. 5	16. 8	2 00 08. 0	43 07. 1
37. 8	37. 0	28. 0	27. 1	17. 8	17. 0
47. 8	47. 0	38. 1	37. 2		
57. 5	56. 8	47. 7	47. 1	Mean, 1 57 47. 71	23 40 46. 93

Signals sent from Fort Fred Steele.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
2 01 19. 5	23 44 18. 8	2 03 10. 5	23 46 09. 9	2 05 01. 1	23 48 00. 3
30. 5	30. 0	20. 3	19. 7	11. 2	10. 2
40. 7	40. 0	30. 7	30. 0	20. 8	20. 1
50. 7	50. 0	41. 0	40. 2	30. 8	30. 1
02 00. 3	59. 7	50. 8	50. 1	40. 9	40. 1
10. 4	45 09. 7	59. 9	59. 2	51. 2	50. 4
19. 7	19. 0	04 10. 3	47 09. 6	06 01. 2	49 00. 5
30. 5	29. 9	20. 2	19. 5	11. 0	10. 2
41. 0	40. 2	30. 3	29. 6	21. 0	20. 2
50. 8	50. 1	41. 1	40. 2		
03 00. 4	59. 8	51. 3	50. 6	Mean, 2 03 50. 65	23 46 49. 93

NOVEMBER 21, 1872.

Signals sent from Salt Lake.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
2 00 34. 5	23 43 36. 9	2 02 24. 8	23 45 27. 1	2 04 14. 9	23 47 17. 3
44. 2	46. 8	34. 6	37. 0	25. 1	27. 7
54. 1	56. 7	44. 4	46. 9	34. 9	37. 3
01 04. 2	44 06. 8	54. 5	56. 9	44. 7	47. 1
14. 5	17. 0	03 04. 5	46 07. 0	54. 7	57. 1
24. 6	27. 1	14. 8	17. 1	05 04. 9	48 07. 4
34. 4	36. 9	25. 1	27. 6	15. 1	17. 6
44. 3	46. 8	34. 6	37. 1	25. 3	27. 8
54. 3	56. 8	44. 6	47. 1	35. 1	37. 8
02 04. 3	45 06. 8	54. 6	57. 0		
14. 6	17. 0	04 04. 8	47 07. 1	Mean, 2 03 04. 65	23 46 07. 12

Signals sent from Fort Fred Steele.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
2 06 45.2	23 49 47.8	2 08 55.5	23 51 58.1	2 11 05.9	23 54 08.5
56.6	59.2	09 05.8	52 08.3	15.1	17.5
07 05.1	50 07.6	....	....	25.6	28.1
14.9	17.5	....	....	35.0	37.5
25.2	27.5	34.9	37.5	45.7	48.2
34.5	37.0	....	....	56.1	58.5
45.4	48.0	....	....	12 06.2	55 08.5
55.5	58.1	10	53	15.6	18.1
08 05.6	51 08.1	....	....	25.5	28.1
....	....	....	....	35.0	37.6
....	....	34.8	37.3	45.7	48.2
34.4	37.0	45.5	48.0		
45.2	47.5	55.9	58.3	Mean, 2 09 49.69	23 52 52.20

NOVEMBER 22, 1872.

Signals sent from Salt Lake.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1 57 23.1	23 40 27.1	1 59 13.1	23 42 17.1	2 01 03.3	23 44 07.2
33.0	37.0	23.1	27.1	13.5	17.3
42.9	46.9	33.0	36.9	23.4	27.2
53.1	57.1	43.0	46.9	33.3	37.1
58 02.6	41 06.6	53.0	56.9	43.3	47.2
12.9	16.9	2 00 03.1	43 07.1	53.1	57.1
22.9	26.9	13.1	17.1	02 03.4	45 07.2
32.8	36.8	23.1	27.1	13.7	17.7
42.9	46.9	33.0	37.0	23.6	27.4
52.8	56.8	43.1	47.0		
59 03.0	42 06.9	53.1	57.0	Mean, 1 59 53.11	23 42 57.05

Signals sent from Fort Fred Steele.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
2 12 00.1	23 55 04.1	2 13 50.6	23 56 54.7	2 15 40.4	23 58 44.3
10.8	14.9	14 00.3	57 04.3	50.9	54.9
20.8	24.9	10.8	14.9	16 00.6	59 04.5
31.0	35.0	20.7	24.8	10.9	14.8
40.3	44.2	30.7	34.7	20.8	24.9
50.6	54.7	40.4	44.3	30.9	34.9
13 00.0	56 04.0	50.9	54.9	40.5	44.6
10.3	14.2	15 00.9	58 04.9	51.0	55.0
20.6	24.7	10.5	14.3	17 01.0	24 00 05.0
31.0	35.0	20.6	24.8		
40.4	44.3	30.9	34.9	Mean, 2 14 30.65	23 57 34.66

NOVEMBER 25, 1872.

Signals sent from Salt Lake.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
2 36 24.0	0 19 33.1	2 38 14.4	0 21 23.5	2 40 04.7	0 23 13.9
34.3	43.3	24.2	33.3	14.7	23.9
44.8	54.0	34.5	43.8	24.6	33.9
54.5	20 03.8	45.0	54.2	34.9	44.0
37 04.3	13.4	54.8	22 04.0	45.1	54.1
14.2	23.3	39 04.6	13.9	55.0	24 04.2
24.1	33.3	14.7	23.9	41 04.8	14.1
34.3	43.5	24.3	33.3	14.8	24.0
44.8	54.0	34.7	44.0	24.8	34.0
54.7	21 04.0	44.8	54.1		
38 04.4	13.6	54.8	23 04.1	Mean, 2 38 54.60	0 32 03.79

Signals sent from Fort Fred Steele.

Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.	Ft. Fred Steele chronometer.	Salt Lake chronometer.
h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
2 48 54.8	0 32 04.1	2 50 25.5	0 33 34.9	2 51 54.9	0 35 04.2
49 05.2	14.2	34.8	44.1	52 05.6	15.0
15.7	25.1	45.3	54.6	15.9	25.2
25.7	35.1	54.9	34 04.2	25.7	35.1
35.2	44.5	51 05.5	14.8	34.7	44.1
45.3	54.7	15.7	25.1	45.6	55.0
54.7	33 04.0	25.7	35.1	55.3	36 04.7
50 05.1	14.4	35.2	44.6		
15.7	25.1	45.4	54.9	Mean, 2 50 55.32	0 34 04.67

Signals sent from—	Recorded at—	Mean of signals sent and received.	Time corrections.	Corrected time.	Difference of longitude.	time.	Means.
Nov. 5, 1872.							
		h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*
Salt Lake	Ft. Fred Steele.	1 06 10.71	—2 00 22.69	23 05 48.02			
	Salt Lake......	22 48 41.02	—0 02 40.76	22 46 00.26	0 19 47.76		
Fort Fred Steele	Ft. Fred Steele.	1 12 46.88	—2 00 22.67	23 12 24.21			
	Salt Lake......	22 55 17.23	—0 02 40.76	22 52 36.47	47.74	0.02	47.750
Nov. 19, 1872.							
Salt Lake	Ft. Fred Steele.	2 02 58.30	—1 59 26.39	0 03 31.91			
	Salt Lake......	23 45 56.97	—0 02 12.59	23 43 44.38	47.53		
Fort Fred Steele	Ft. Fred Steele.	2 10 03.11	—1 59 26.37	0 10 36.74			
	Salt Lake......	23 53 01.84	—0 02 12.58	23 50 49.26	47.48	0.05	47.505
Nov. 20, 1872.							
Salt Lake	Ft. Fred Steele.	1 57 47.71	—1 59 23.03	23 58 24.68			
	Salt Lake......	23 40 46.93	—0 02 09.98	23 38 36.95	47.73		
Fort Fred Steele	Ft. Fred Steele.	2 03 50.65	—1 59 23.01	0 04 27.64			
	Salt Lake......	23 46 49.93	—0 02 09.97	23 44 39.96	47.68	0.05	47.705
Nov. 21, 1872.							
Salt Lake	Ft. Fred Steele.	2 03 04.65	—1 59 17.64	0 03 47.01			
	Salt Lake......	23 46 07.12	—0 02 07.66	23 43 59.46	47.55		
Fort Fred Steele	Ft. Fred Steele.	2 09 49.69	—1 59 17.62	0 10 32.07			
	Salt Lake......	23 52 52.20	—0 02 07.65	23 50 44.55	47.52	0.03	47.535
Nov. 22, 1872.							
Salt Lake	Ft. Fred Steele.	1 59 53.11	—1 59 14.08	0 00 39.03			
	Salt Lake	23 42 57.05	—0 02 05.53	23 40 51.52	47.51		
Fort Fred Steele	Ft. Fred Steele.	2 14 30.65	—1 59 14.04	0 15 16.61			
	Salt Lake......	23 57 34.66	—0 02 05.51	23 55 29.15	47.46	0.05	47.485
Nov. 25, 1872.							
Salt Lake	Ft. Fred Steele.	2 38 54.60	—1 59 01.83	0 39 52.77			
	Salt Lake......	0 22 03.79	—0 01 58.80	0 20 04.99	47.78		
Fort Fred Steele	Ft. Fred Steele.	2 50 55.32	—1 59 01.79	0 51 53.53			
	Salt Lake......	0 34 04.67	—0 01 58.78	0 32 05.89	47.64	0.14	47.710

longitude: Fort Fred Steele, east of Salt Lake, $0^h\ 19^m\ 47^s.612 \pm 0^s.034$.

Observations and computations for latitude of Fort Fred Steele, Wyo.

NOVEMBER 3, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
8212	4 1.5	9.5	32.5						
8237	26 32.2	36.0	6.0	....	41 35 6.2	+11 33.3	+ 1.8	....	41 46 41.3
8256	35 67.0	20.0	21.0						
8322	29 63.5	23.0	17.5	....	49 47.4	− 3 7.6	+ 1.2	....	41.0
8284	5 43.0	20.0	21.0						
8322	29 63.5	23.0	17.5	....	34 6.3	+12 32.3	+ 2.9	....	41.5
8330	26 82.0	23.0	17.5						
4	20 7.0	23.0	18.0	....	43 11.3	+ 3 29.8	+ 2.9	....	44.0
51	25 46.5	24.5	19.0						
58	12 23.5	28.5	14.0	....	39 44.2	+ 6 51.2	+ 5.5	....	40.9
101	2 43.3	19.5	20.0						
114	34 17.0	14.0	26.0	....	30 15.0	+16 26.4	− 3.4	....	38.0
gr.96	9 2.2				50 6.1	− 3 29.9	+ 2.0	....	38.2
146	11 5.0	7.0	32.0	....	49 3.7	− 2 26.8	+ 2.0	....	38.9
153	26 75.6				40 56.5	+ 5 41.3	+ 2.0	....	39.8
166	15 77.5	35.5	3.5						
215	36 99.5	25.5	13.5						
239	11 5.0	15.5	25.5	....	60 5.8	−13 26.4	+ 0.6	....	40.0
250	0 19.0	25.5	13.5						
253	34 10.0	15.0	27.5	....	29 6.0	+17 33.9	− 0.1	....	39.8
282	13 10.0	......	......	....	39 59.5	+ 6 41.2	− 0.1	....	40.6
299	10 83.2	24.5	19.0						
314	26 98.0	15.5	28.0	....	38 21.1	+ 8 21.9	− 1.8	....	41.2
330	12 58.0	20.5	22.0						
343	15 96.0	25.0	18.0	....	48 23.5	− 1 45.1	+ 1.5	....	39.9

NOVEMBER 4, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8024	6 48.0	28.0	23.0						
8032	21 53.0	8.0	44.0	....	41 54 37.0	− 7 47.7	− 8.6	....	41 46 40.7
8083	3 99.0	26.0	26.0						
8097	30 91.5	8.5	43.5	....	60 46.7	−13 56.8	−11.4	....	38.5
8212	4 96.0	24.0	27.0						
8223	22 13.0	9.0	43.0	....	37 59.0	+ 8 53.6	−10.1	....	42.5
8237	27 65.0	10.0	42.0	....	35 6.3	+11 45.2	− 9.7	....	41.8
8256	35 37.0	6.0	45.0						
8322	29 58.5	30.0	20.5	....	49 47.5	− 2 59.8	− 8.1	....	39.6
8330	26 82.4	30.0	20.5						
4	19 78.5	6.0	42.0	....	43 11.4	+ 3 38.8	− 7.3	....	42.9
153	25 68.0	19.0	33.0						
166	14 28.5	10.0	42.5	....	40 56.7	+ 5 54.2	−12.7	....	38.2
215	37 6.0	18.0	35.0						
239	11 37.5	18.0	35.0	....	60 6.0	−13 18.3	− 9.3	....	38.4
250	0 27.0	15.0	39.5						
282	13 50.2	17.0	40.0	....	39 59.6	+ 6 51.3	−13.1	....	37.8
299	9 71.0	28.0	28.0						
314	26 4.5	8.0	48.0	....	38 21.3	+ 8 27.7	−11.0	....	38.0
330	12 70.0	48.0	8.0						
343	15 68.0	....	....	(*)	48 23.7	− 1 32.6	−11.0	....	40.1

* Level could not be read on reversal.

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 4, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
409	15 86.0	....	....						
441	24 98.0	....	....	....	41 42 6.5	— 4 43.5	—11.0	....	41 46 39.0
480	12 15.5	14.0	40.0						
501	20 7.0	19.0	35.0	....	42 45.4	+ 4 6.0	—11.5	....	39.9
558	24 68.0	14.0	42.0						
569	38 78.5	....	....		44 18.4	+ 2 32.0	—11.0	....	39.7
610	22 54.0	....	....		39 10.3	+ 7 43.7	—10.5	....	43.5
620	10 70.2	11.0	44.0	....	54 8.1	— 7 14.1	—10.4	....	43.6
686	7 62.0	25.0	30.0						
707	24 67.0								
731	11 99.0	38.0	18.0						
786	12 2.0	0.0	56.0	....	46 50.9	— 0 0.9	— 9.9	....	40.1

NOVEMBER 6, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
7623	17 46.7	30.0	32.0						
7636	2 70.5	11.0	51.0	....	41 54 32.0	— 7 38.8	—11.5	....	41 46 41.7
7699	17 50.2	16.0	47.0						
7712	19 58.0	48.0	15.5	....	47 43.3	— 1 4.6	+ 0.4	....	39.1
7754	12 67.2	30.5	31.5	....	57 6.0	—10 26.9	+ 1.2	....	40.3
7778	0 94.5	....	....	....	63 10.5	—16 31.5	+ 1.2	....	40.2
7798	22 84.0	33.5	28.0	Must be 32t					
7815	18 74.2	....	....	(†)					
7843	16 74.8	....	....	....	45 36.0	+ 1 2.0	+ 1.2	....	39.2
7880	16 61.2	21.0	40.0						
7894	19 64.0	35.0	26.0	....	45 8.4	+ 1 34.1	— 2.7	....	39.8
7962	28 31.8	29.0	34.0	(‡)	57 40.5	—10 50.4	—10.4	....	39.7
7972	7 39.0	15.0	48.0	....	47 1.5	— 0 21.1	— 2.0	....	38.4
7994	8 7.0	45.0	19.0						
8024	6 75.8	35.5	28.0	....	54 10.8	— 7 27.5	— 3.4	....	39.9
8083	4 22.0	34.5	29.0	....	60 46.9	—14 5.1	— 4.0	....	37.8
8091	21 15.5								
8097	31 41.0	22.0	42.0						
8212	4 89.7	33.0	29.0						
8237	27 45.0	17.0	45.0	....	35 6.5	+11 41.0	— 6.6	....	40.9
				Releveled.					
8256	36 35.2	31.5	31.5	....	51 15.9	— 4 29.7	— 6.6	....	39.6
8284	6 13.5	23.0	39.0	....	34 6.7	+12 36.0	— 4.4	....	38.3
8322	30 46.0	....	....	....	49 47.7	+ 6 59.0	— 4.4	....	42.3
8330	27 67.5	23.0	40.0						
4	20 95.7	42.0	20.0	....	43 11.6	+ 3 28.8	+ 1.3	....	41.7
51	25 54.2	32.0	31.0						
58	12 57.2	51.0	12.0	....	39 44.5	+ 6 43.1	+12.6	....	40.2
101	2 41.0	28.0	35.5						
114	33 80.0	57.5	6.0	....	30 15.5	+16 15.6	+12.1	....	43.2
146	9 83.8	....	....	....	49 4.1	— 2 24.0	— 0.2	....	39.9
153	25 50.3	31.0	31.0	....	40 57.0	+ 5 42.9	— 0.3	....	39.6
166	14 47.0	31.0	32.0						
215	36 61.0	35.0	27.5						
239	10 62.0	27.5	36.0	....	60 6.3	—13 27.8	— 0.3	....	38.2
253	33 65.2	30.0	33.5	....	48 10.6	— 1 31.9	+ 1.1	....	39.8
282	12 58.8	35.0	27.5	....	59 3.8	—12 26.6	+ 4.1	....	41.3

† No level taken.

‡ Level doubtful.

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 6, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
299	10 43.0	29.0	35.0						
314	26 30.0	48.0	16.0	....	41 38 21.6	+ 8 13.2	+ 7.1	....	41 46 41.9
330	12 32.5	36.0	27.5						
343	15 87.0	37.0	27.0	....	48 24.0	− 1 50.2	+ 5.1	....	38.9
409	16 9.8	38.0	25.0						
441	24 66.2	38.5	24.5	....	42 6.8	+ 4 26.2	+ 7.4	....	40.4
480	13 65.0	25.0	36.5						
501	20 98.5	50.5	11.0	....	42 45.8	+ 3 48.0	+ 7.7	....	41.5
558	24 39.0	46.0	17.5						
569	19 93.0	23.5	40.0	Cloudy....	44 19.1	+ 2 18.6	+ 3.3	....	41.0

NOVEMBER 8, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8212	3 65.0	23.5	23.0		41 37 59.4	+ 8 33.5	+ 9.4	....	41 46 42.3
8223	20 17.3	40.0	6.0						
8237	25 74.7	....	....	....	35 6.7	+11 26.8	+ 9.4	....	42.9
8256	35 85.5	26.0	19.5		49 47.8	− 3 12.0	+ 5.4	....	41.2
8284	5 58.0	....	....		34 6.9	+12 28.9	+ 5.4	....	41.2
8322	29 67.7	29.0	16.0						
8330	26 88.0	29.0	16.0						
4	20 40.0	32.0	14.0	....	43 11.8	+ 3 21.4	+ 8.6	....	41.8
51	24 86.0	24.0	22.0						
58	11 87.0	41.0	4.0	....	39 45.0	+ 6 43.7	+10.7	....	39.4
101	1 77.0	19.0	27.0						
114	33 37.0	32.0	13.0	....	30 15.8	+16 22.1	+ 3.0	....	40.9
Gr.96	8 57.8	29.0	16.5		50 6.9	− 3 33.3	+ 5.7	....	39.3
146	10 59.0	....	....		49 4.4	− 2 30.7	+ 5.7	....	39.4
153	26 26.0	....	....		40 57.4	+ 5 36.2	+ 5.7	....	39.3
166	15 44.0	27.0	18.5						
215	37 46.0	16.0	30.0						
239	11 30.0	39.0	7.0	....	60 6.6	−13 33.0	+ 4.9	....	38.5
250	0 63.6	17.0	28.5						
253	34 29.0	40.0	6.0		29 6.9	+17 26.2	+ 6.2	....	39.3
282	13 35.6	....	....		40 0.4	+ 6 35.5	+ 6.2	....	42.1
299	7 94.5	21.0	25.0						
314	24 11.5	18.0	28.0	(*)	38 21.9	+ 8 22.6	− 3.8	....	40.7
330	12 27.0	30.0	15.0						
343	15 93.5	34.0	12.0	....	48 24.5	− 1 53.9	+10.1	....	40.7
409	16 5.0	29.0	18.0						
441	24 48.0	42.0	5.0	....	42 7.2	+ 4 22.0	+13.2	....	42.4
480	12 3.0	13.5	33.5						
501	19 42.5	44.5	2.5	....	42 46.1	+ 3 49.8	+ 6.0	....	41.9
558	23 81.0	25.0	22.0						
569	19 51.0	32.5	14.0	....	44 19.5	+ 2 13.6	+ 5.9	....	39.0
588	38 76.5	....	....		27 5.7	+19 26.4	+ 7.7	....	39.8
610	22 32.3	27.0	19.0	....	39 11.0	+ 7 22.5	+ 7.7	....	41.2
665	1 23.7								
686	8 8.5	34.0	14.0						
915	41 49.0	38.0	9.0						
962	27 18.2	22.0	25.0	....	53 58.1	− 7 24.7	+ 6.2	....	39.6

* Level doubtful.

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 8, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
1007	14 97.2	27.0	19.0		41 45 20.1	+ 1 10.2	+ 8.5	....	41 46 38.8
1011	22 25.7	....	....		41 33.3	+ 4 56.6	+ 8.5	....	38.4
1017	12 71.5	35.0	11.5						
1052	24 51.0	19.0	28.0						
1058	11 88.8	46.0	0.0	....	53 2.7	− 6 32.3	+10.1	....	40.5
1111	23 84.8	25.0	22.0		39 51.2	+ 6 38.1	+11.0	....	40.3
1133	15 80.8	....	....		44 0.9	+ 2 28.2	+11.0	....	40.1
1143	11 4.0	42.0	5.0						
1252	4 77.0	28.0	18.5						
1268	29 0.5	31.0	16.0	....	59 6.9	−12 33.2	+ 6.7	....	40.4
1320	14 88.5	40.0	7.5						
1339	10 53.0	18.0	28.0	....	48 50.5	− 2 15.4	+ 6.2	....	41.3
1397	12 41.0	....	....		52 52.5	− 6 20.1	+ 8.8	....	41.2
1398	10 62.5	20.0	27.0		53 45.2	− 7 15.6	+ 8.8	....	38.4
1414	24 64.0	43.0	4.0						

NOVEMBER 10, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8212	3 76.0	8.0	40.0						
8223	20 47.0	42.0	6.0		41 37 59.5	+ 8 39.3	+ 1.1	....	41 46 40.0
8237	26 2.0	....	....	....	35 7.0	+11 31.8	+ 1.1	....	39.9
8330	26 44.0	16.0	42.0						
8374	15 75.5	....	....		41 8.6	+ 5 32.1	0.0	....	40.7
4	19 71.0	42.0	16.0	....	43 12.0	+ 3 29.2	0.0	....	41.2
146	9 53.7	33.0	23.0						
166	14 42.0	42.0	14.0	....	49 4.7	− 2 31.8	+10.4	....	43.3
299	8 23.7	18.0	40.0						
314	24 54.0	22.0	35.0	....	38 22.3	+ 8 26.7	− 9.9	....	39.1
480	12 44 0	28.0	29.0	....					
501	20 33.5	15.0	42.0	Cloudy...	42 46.6	+ 4 2.3	− 7.7	....	41.2

NOVEMBER 12, 1873.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
7778	2 35.0	25.0	26.0						
7798	34 47.7	42.0	10.0	....	41 63 10.3	−16 38.5	+ 8.6	....	41 46 40.4
7815	18 82.2	31.0	20.0						
7843	17 6.0	38.0	12.0	....	45 36.2	+ 0 54.8	+10.1	....	41.1
7880	16 86.2	23.0	24.5						
7894	19 80.0	29.0	18.5	....	45 8.5	+ 1 31.3	+ 2.4	....	42.2
7962	28 50.5	31.0	28.0	....	57 41.0	−11 9.3	+ 6.1	....	37.8
7972	6 97.0	40.0	21.0						
7994	8 5.0	39.0	24.0	....	47 1.9	− 0 33.5	+ 8.3	....	36.7
8024	6 71.5	32.0	30.0						
8032	22 33.5	45.0	20.0	....	54 37.7	− 8 5.5	+ 7.4	....	39.6
8212	4 87.0	33.0	30.0						
8223	21 66.0	....	....	....	37 59.8	+ 8 41.8	− 1.8	....	39.8
8237	27 24.5	27.0	36.5	....	35 7.2	+11 35.4	− 1.7	....	40.9
8256	36 46.5	....	....	....	49 48.2	− 3 23.1	+16.0	....	41.1
8284	6 18.0	....	....	....	34 7.2	+12 18.1	+16.0	....	41.3
8322	29 93.0	34.0	29.0						
8330	27 10.0	....	....						
8374	16 86.0	58.0	5.0	....	41 8.7	+ 5 18.3	+ 16.0	....	43.0

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 12, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
51	25 82.3	34.5	30.0						
58	12 81.0	44.0	21.0	....	41 39 45.4	+ 6 44.4	+ 7.7	....	41 46 37.5
101	3 95.0	38.0	27.0						
114	35 29.0	49.0	16.5	....	30 16.4	+16 14.0	+ 12.0	....	42.4
146	10 64.3	....	....	....	49 5.0	− 2 39.2	+14.3	....	40.1
153	26 30.3	35.0	27.0	....	40 57.4	+ 5 27.5	+14.3	....	39.2
166	15 76.5	53.0	9.0						
215	36 80.7	25.5	30.0						
239	10 80.0	42.0	14.0	....	60 7.3	−13 34.5	+6.4	....	39.2
250	0 2.0	24.5	33.0	50s. late.					
282	12 66.5	42.0	16.0	....	40 1.0	+ 6 33.0	+ 4.8	+ 0.2	39.0
299	9 97.0	20.0	27.0						
314	25 93.0	38.0	19.0	....	38 22.6	+ 8 16.0	+ 3.3	....	41.9
330	13 42.0	31.0	25.5						
343	16 90.5	32.0	25.0	....	48 25.1	−1 48.3	+ 3.4	....	40.2
409	17 17.5	35.5	20.0						
441	25 70.0	37.5	20.0	....	42 7.9	+4 25.0	+ 8.2	....	41.1
480	12 68.0	28.0	31.0						
501	20 17.0	33.5	25.0	....	42 46.9	+ 3 52.8	+ 1.5	....	41.2
558	24 7.0	33.5	26.5						
569	20 4.0	50.0	10.0	....	44 20.2	+ 2 5.3	+13.2	....	38.7
610	23 8.0	39.0	20.0	....	39 11.8	+ 7 25.2	+ 4.6	....	41.6
620	11 14.2	29.0	31.0	....	54 9.4	− 7 35.4	+ 3.7	....	37.8
686	8 75.5	39.5	20.5						
707	25 79.3	27.0	33.5	....					
885	14 64.8	36.0	23.5						
904	21 32.0	43.0	17.0	....	49 58.3	− 3 27.4	+10.5	....	41.4
1007	15 77.0	....	....	....	45 20.7	+ 0 59.4	+18.1	....	38.2
1011	23 6.5	39.0	20.0	....	41 33.9	+ 4 46.1	+18.1	....	38.1
1017	13 86.0	53.0	6.0	Releveled.					
1052	23 73.2	25.0	33.0						
1058	11 74.0	10.0	*48.0	....	53 3.4	− 6 12.7	−12.6	....	38.1

NOVEMBER 18, 1872.

8330	25 96.2	36.0	8.0						
4	19 59.5	31.0	†16.0	....	41 43 13.0	+ 3 17.9	+11.9		41 46 42.8

NOVEMBER 21, 1872.

857	21 44.8	....	....	....	41 37 10.8	+ 9 37.1	− 7.1	....	41 46 40.8
858	18 48.5	33.0	25.0	....	38 42.1	+ 8 5.0	− 7.1	....	40.0
872	2 88.0	12.0	46.0						
885	14 35.5	29.0	27.5						
904	20 60.0	18.0	40.0	Cloudy . .	49 59.9	− 3 14.1	− 5.6	....	40.2

* Observer became sick. † Clouds prevented further observations.

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 24, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.				° ′ ″	′ ″	″		° ′ ″
7623	17 73.5	16.0	37.0						
7631	26 62.0	32.5	20.0	....	41 42 7.2	+ 4 36.1	− 2.3	....	41 46 41.0
7699	17 11.8	26.5	24.0						
7712	19 20.5	24.0	26.0	....	47 43.3	− 1 4.9	+ 0.1	....	38.5
7754	12 28.0	....	....	....	57 6.2	−10 33.6	+ 8.8	....	41.4
7778	0 52.0	22.0	28.0	....	63 10.4	−16 39.1	+ 8.8	....	40.1
7798	32 66.7	45.0	7.0						
7962	27 89.5	28.0	18.0						
7972	6 91.0	3.0	43.5	....	57 41.4	−10 52.2	− 8.8	....	40.4
8024	5 98.0	29.5	17.0	....	54 12.1	− 7 45.1	+13.1	....	40.1
8083	3 71.0	16.0	33.5	....	60 48.2	−14 11.9	+ 4.8	....	41.1
8091	20 94.5	42.0	7.0						
8097	31 12.0	....	....						
8284	5 87.0	5.0	35.5						
8322	30 18.0	28.0	16.0	....	34 8.7	+12 35.6	− 5.1	....	39.2
8330	27 37.3	28.0	16.0						
8374	16 87.5	23.0	21.0	....	41 10.2	+ 5 26.3	+ 3.6	....	40.1
4	20 82.2	....	....	....	43 13.7	+ 3 23.6	+ 3.6	....	40.9
146	10 4.0	28.5	11.5	....	49 6.6	− 2 34.5	+ 9.5	....	41.6
153	25 75.0	....	....	....	40 59.0	+ 5 33.7	+ 9.5	....	42.2
166	15 1.2	29.0	11.5						
299	10 55.0	18.5	27.0						
314	26 23.0	48.0	− 3.0	....	38 24.3	+ 8 7.3	+10.1	....	41.7
330	13 49.0	33.0	12.5						
343	17 18.5	27.0	18.0	....	48 26.9	− 1 54.8	+ 8.1	....	40.2
409	17 40.5	30.0	16.0	....	48 32.7	− 1 1.7	+ 9.4	....	40.4
558	24 23.0	25.0	21.5						
569	20 13.0	42.5	4.0	....	44 22.1	+ 2 7.4	+11.5	....	41.0
610	23 10.0	24.0	33.0						
686	8 71.2	23.0	25.5	30 s. late ..	39 13.6	+ 7 27.2	− 3.2	+ 0.1	37.7
757	16 40.8	....	....	....	49 58.1	− 3 9.5	− 7.0	....	41.6
759	31 38.0	30.5	18.0	....	57 42.4	−10 54.9	− 7.0	....	40.5
816	10 31.0	5.0	43.0						
831	27 83.0	13.5	32.5						
857	21 14.0	42.0	3.0	....	50 4.6	− 3 27.9	+ 5.5	....	42.2
858	18 23.0	42.0	3.0						
872	2 91.0	7.0	36.5	....	38 42.6	+ 7 56.1	+ 2.6	....	41.3
915	25 51.5	16.0	25.0						
962	11 22.2	37.0	5.0	....	54 1.0	− 7 24.2	+ 6.3	....	43.1
1007	20 3.6	25.0	17.0	....	45 22.9	+ 1 2.3	+13.7	....	38.9
1011	27 35.0	....	....	....	41 36.1	+ 4 49.7	+13.7	....	39.5
1017	18 3.0	47.0	− 5.0						
1052	24 2.5	30.0	27.0	....					
1058	11 83.5	17.0	40.0	....	53 5.5	− 6 18.9	− 5.5	....	41.1
1111	24 82.0	31.0	26.0						
1143	11 72.0	30.5	26.0	....	39 53.7	+ 6 47.1	+ 2.6	....	43.4
1305	28 7.5	26.0	33.0						
1320	15 24.0	52.0	7.0	....	39 48.9	+ 6 38.9	+10.4	....	38.2
1397	16 41.0	....	....	....	52 54.4	− 6 13.6	− 1.5	....	39.3
1398	14 70.0	30.5	32.0	....	53 47.6	− 7 6.7	− 1.5	....	39.4
1414	28 43.0	29.0	33.0						
1527	30 88.0	30.0	31.0						
1536	5 24.5	15.0	46.0	Cloudy ...	60 3.6	−13 16.7	− 8.8	....	38.1

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 26, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
					° ′ ″	′ ″	″		° ′ ″
480	12 76.5	27.0	33.0						
501	20 47.2	21.0	39.0	....	41 42 50.5	+ 3 59.5	− 6.6	....	41 46 43.4
558	23 58.5	34.0	25.0						
569	19 70.3	52.0	7.0	....	44 22.4	+ 2 0.7	+14.9	....	38.0
831	28 56.2	19.0	34.0						
858	19 26.8	22.5	31.0	....	51 36.3	− 4 48.9	− 6.4	....	41.0
915	26 40.0	15.0	39.0						
962	12 24.0	37.0	18.0	....	54 1.3	− 7 20.1	− 1.3	....	39.9
1007	19 39.0	28.0	25.0						
1017	17 38.0	48.0	5.0	....	45 23.2	+ 1 2.5	+12.6	....	38.3
1052	24 50.8	24.0	30.0						
1058	12.23.0	18.0	36.0	....	53 5.8	− 6 21.6	− 6.6	....	37.6
1111	24 85.8	28.0	26.0	....	39 54.0	+ 6 32.5	+12.9	....	39.4
1133	16 82.5	....	....	....	44 3.7	+ 2 22.8	+13.2	....	39.7
1143	12 23.0	50.0	5.0						
1252	5 80.0	29.0	26.0						
1268	30 39.6	53.0	2.0	....	59 9.8	−12 44.4	+14.8	....	40.2
1305	28 31.0	30.0	26.0	....	39 49.3	+ 6 37.5	+11.0	....	37.8
1320	15 52.0	46.0	10.0						
1339	11 17.0	12.0	43.0	....	48 53.3	− 2 15.2	+ 1.3	....	39.4
1397	16 37.2	....	....	....	52 54.7	− 6 13.5	− 2.9	....	38.3
1398	14 64.0	29.5	25.0	....	53 47.9	− 7 7.3	− 2.9	....	37.7
1414	28 39.0	20.0	35.0						

NOVEMBER 27, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
7623	16 62.5	31.0	20.0						
7631	25 56.3	15.0	35.0	....	41 42 7.1	+ 4 37.8	− 2.4	....	41 46 42.5
7699	16 54.0	19.5	26.5						
7712	18 72.0	35.0	10.0	....	47 43.5	− 1 7.8	+ 4.9	....	40.6
7754	11 56.3	22.0	23.0						
7798	31 42.0	3.0	40.0	....	57 6.2	−10 17.1	−10.4	....	38.7
7962	26 85.5	2.0	26.0						
7972	5 65.0	16.5	30 0	....	57 41.4	−10 59.0	− 3.7	....	38.7
8024	4 67.5	19.0	29.0	....	54 12.3	− 7 41.9	+ 9.9	....	40.3
8083	2 49.5	2.0	46.0	....	60 48.5	−14 10 1	+ 0.6	....	39.0
8091	19 53.5	47.0	1.0						
8097	29 84.7								
8212	3 90.3	20.0	24.5						
8223	20 73.8	19.0	27.0	....	38 1.1	+ 8 43.2	− 3.4	....	40.9
8237	26 28.0	....	....	....	35 8.5	+11 35.5	− 3.4	....	40.6
8284	5 41.0	21.0	27.0						
8322	29 78.7	15.0	32.0	....	34 8.9	+12 37.6	− 6.3	....	40.2
8330	26 98.0	15.0	32.0						
8374	16 40.0	35.0	12.0	....	41 9.9	+ 5 28.8	+ 1.7	....	40.4
4	20 36.8	....	....	....	43.13.4	+ 3 25.5	+ 1.7	....	40.6
51	24 75.5	24.5	25.0						
58	11 63.0	33.0	15.5	....	39 47.2	+ 6 47.9	+ 4.6	....	39.7
146	10 64.0	26.0	21.0	....	49 6.9	− 2 39.4	+11.2	....	38.7
153	26 31.0	....	....	....	40 59.9	+ 5 27.6	+ 4.2	....	38.7
166	15 77.0	41.5	5.5						
215	37 43.3	22.0	24.5						
239	11 49.0	18.0	28.0	....	60 9.3	−13 26.3	− 3.4	....	39.6

Observations and computations for latitude of Fort Fred Steele, Wyo.—Continued.

NOVEMBER 27, 1872.

Number of star.	Micrometer readings.	Level. N.	Level. S.	Remarks.	Half-sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
250	0 84.5	33.5	13.5						
282	13 56.8	18.0	28.0	....	41 40 2.9	+ 6 35.4	+ 2.7	....	41 46 41.0
299	10 71.0	24.0	23.0						
314	26 80.0	17.0	30.0	....	38 24.7	+ 8 20.1	− 3.3	....	41.5
330	12 12.0	31.0	16.0						
343	15 80.3	30.0	18.0	....	48 27.3	− 1 54.5	+ 7.4	....	40.2
409	16 5.0	34.0	12.5						
441	24 64.0	21.0	25.5	....	42 10.1	+ 4 27.0	+ 4.6	....	41.7
558	23 79.6	30.0	12.5						
569	19 26.3	10.0	33.0	....	44 22.7	+ 2 20.9	− 1.5	....	42.1
757	15 0.5	....	....	....	49 58.4	− 3 10.7	− 6.6	....	41.1
759	29 96.0	24.0	23.0	....	57 42.6	−10 55.5	− 6.6	....	40.5
816	8 87.0	11.0	36.0						
857	21 59.0	....	....	....	37 11.7	+ 9 27.9	+ 1.5	....	41.1
858	18 63.0	24.0	23.5	....	38 43.1	+ 7 55.9	+ 1.5	....	40.5
872	3 31.7	27.0	22.0						
885	14 0.2	21.0	27.0						
904	20 66.5	44.0	4.0	....	50 0.8	− 3 27.1	+ 9.3	....	43.0
915	25 2.7	19.0	28.0						
962	10 84.6	28.5	18.0	....	54 1 5	− 7 20.7	+ 0.4	....	41.2
1007	19 94.0	22.0	26.0	Must be 18t	45 23.3	+ 1 5.3	+10.4	....	39.0
1011	26 29.5	....	....	....	41 36.6	+ 4 53.9	+10.4	....	40.9
1017	16 84.0	45.0	3.0						
1052	24 96.0	22.0	25.0						
1058	12 55.0	24.0	23.0	....	53 5.9	− 6 25.7	− 0.5	....	39.7
1111	24 85.5	25.5	22.5	....	39 54.1	+ 6 33.8	+12.1	....	40.0
1133	16 81.3	....	....	....	44 3.9	+ 2 23.9	+12.1	....	39.9
1143	12 18.3	45.0	4.0						
1252	5 55.0	25.0	25.0						
1268	29 75.5	29.0	19.0	....	59 9.9	−12 32.3	+ 2.7	....	40.3
1305	27 61.5	28.0	20.0	....	39.49.5	+ 6 49.5	+ 1.8	....	40.8
1320	14 44.0	23.5	25.0						
1339	10 13.5	28.0	20.0	....	48 53.5	− 2 13.8	+ 1.8	....	41.5
1397	14 92.2	....	....	....	52 54.8	− 6 24.2	+ 9.9	....	40.5
1398	13 18.5	32.0	18.0	....	53 48.1	− 7 18.1	+ 9.9	....	39.9
1414	27 28.2	36.0	14.0						

Resulting astronomical co-ordinates.

The daily results, combining the observations of November 10, 18, 21, and 26, to one result, will be:

	No. of obs.	° ′ ″
November 4	31	41 46 40.30
6	27	40.18
8	30	40.41
12	28	39.99
10, 18, 21, and 26	24	40.00
24	30	40.37
27	36	40.42

Giving every mean the same weight, the final result for the latitude of Fort Fred Steele will be:

Latitude........ 41° 46′ 40″.24 ± 0″.05

Longitude........ 7*h.* 7*m.* 47*s.*25 or 106 56 48 .80 west of Greenwich.
1 59 35 .13 or 29 53 47 .00 west of Washington.

LARAMIE.

Longitude—105° 35′ 33″.60 W.
Latitude—41° 18′ 51″.8 ± 0″.08 N.

At Laramie, a point in an open lot northeast from and near the railroad depot was selected as the station. It was not a desirable locality, but was about the only alternative by reason of the position of the telegraph wires. There was no possible objection to the position so far as the surface of the land was concerned, for the entire vicinity is but a gently undulating plain; but the observatory being in the middle of the city, the view both north and south was intercepted at short distances by houses, making it impossible to lay out any extended meridian line. Laramie stands centrally on the great plateau bearing the well-known name "Laramie Plains," and to my notion is the most inviting town on the whole transcontinental route. These plains, though some 7,000 feet above the level of the sea, are well clothed in grass, (but destitute of other forms of vegetation,) and watered by the Laramie River, which flows with a gentle current northerly through the valley. Mountains are visible to the right and left, and though from 8,000 to 10,000 feet high, appear only as slight ridges and low peaks from this elevated plateau.

Meteorological.—Two weeks of December were spent here, and the meteorological conditions experienced found to be very similar to those of the previous month at Fort Steele. The same violent dust and snow-storms prevailed, and though not quite so cold as it had been, it was not possible to run the observatory without a stove. Here, as at Fort Steele, there were times when it required the best exertion of the observers to keep the observatory and all its appliances from being blown away.

Observatory.—The observatory consisted of a hospital-tent—the same that was used at Cheyenne. The assistants were also the same. The operator was Mr. Williams, of the Western Union line.

Instruments.—Precisely the same as were used at Cheyenne and Fort Steele.

Connections.—Connection was made with Salt Lake by a loop into the main wire of the Western Union line. Some observations for latitude were made on each of the nights of December 6, 7, 8, 11, 13, 15, and 17. On the nights of the 9th, 12th, and 16th, observations for time were made and exchanged with Salt Lake for difference of longitude. Of all the stations occupied by Assistant J. H. Clark this has proven the least satisfactory, by reason of smoke and dust, and the near vicinity of moving trains.

Instrumental values.—See report on the Cheyenne station.

Table containing the corrections of chronometers and their rates.

LARAMIE.

Correction of Salt Lake chronometer.

1872.	Local sidereal time.	Correction of chronometer.	Adopted rate.
	h.	*h. m. s.*	*h.*
December 9	2.2	−0 1 34.73	0.115
December 12	1.0	26.41	0.115
December 16	1.0	−0 1 15.28	0.116

Correction of Laramie chronometer.

1872.	Local sidereal time.	Correction.	Adopted rate.
	s.	h. m. s.	s.
December 9	1.75	−1 53 11.56	−0.107
December 12	3.00	3.78	−0.107
December 16	3.00	−1 52 54.72	−0.094

Grouping of time signals and corrections and resulting longitudes.

Signals sent from—	Recorded at—	Mean of signals sent and received.	Time corrections.	Corrected time.	Difference of longitude.	Double wave-time.	Means.
		h. m. s.	h. m. s.	h. m. s.	h. m. s.		
Salt Lake	Salt Lake	2 32 19.90	−0 1 34.70	2 30 45.20			
	Laramie	4 49 9.25	−1 53 11.41	2 55 57.84	0 25 12.64		
Laramie	Salt Lake	2 39 13.57	−0 1 34.69	2 37 38.88			
	Laramie	4 56 2.93	−1 53 11.40	3 2 51.53	12.65	....	12.64
Salt Lake	Salt Lake	2 39 5.32	−0 1 26.23	2 37 39.09			
	Laramie	4 55 55.49	−1 53 3.78	3 2 51.71	12.62		
Laramie	Salt Lake	2 45 16.19	−0 1 26.21	2 43 49.98			
	Laramie	5 2 6.36	−1 53 3.76	3 9 2.60	12.62	....	12.62
Salt Lake	Salt Lake	3 6 39.93	−0 1 15.04	3 5 24.89			
	Laramie	5 23 32.19	−1 52 54.67	3 30 37.52	12.63		
Laramie	Salt Lake	3 13 3.74	−0 1 15.03	3 11 48.71			
	Laramie	5 29 55.95	−1 52 54.66	3 37 1.29	12.58	....	12.61

Final difference of longitude: Laramie, east of Salt Lake, $0^h\ 25^m\ 12^s.623 \pm 0^s.008$.

Observations and computations for latitude of Laramie, Wyo.

DECEMBER 6, 1872.

Number of star.	Micrometer-readings.	Level.		Remarks.	Half sum of declination.	Corrections.			Latitude.
		N.	S.			Micrometer and reference.	Level.	Meridian.	
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
8174	9 15.8	28.5	28.5						
8188	27 25.5	12.0	44.0	....	41 9 40.3	+ 9 22.4	− 8.8	....	41 18 53.9
8248	21 87.0	31.0	26.0						
8273	15 81.0	17.0	39.0	....	23 3.4	− 3 8.3	− 4.6	....	50.5
8279	22 54.0	34.0	23.0						
8296	13 97.5	....	....	....	14 19.1	+ 4 26.2	+ 6.7	....	52.0
8301	18 52.5	34.5	21.0	....	16 29.0	+ 2 16.4	+ 6.7	....	52.1
68	19 12.0	31.0	23.0						
98	8 46.7	31.0	24.0	....	13 18.6	+ 5 31.1	+ 4.1	....	53.8
116	9 25.0	....	....	....	13 43.1	+ 5 6.7	+ 4.1	....	53.9
146	34 28.5	25.0	31.0						
164	3 83.0	53.0	3.0	....	2 50.3	+15 46.5	+12.1	....	48.9
201	19 72.0	32.0	23.0						
224	16 0.5	49.5	5.0	....	16 41.8	+ 1 55.4	+14.7	....	51.9
250	18 32.7	29.0	25.0						
255	19 21.5	12.5	42.0	....	18 34.4	+ 0 27.6	− 7.0	....	55.0
339	20 92.0	32.0	23.0						
401	16 76.0	42.0	11.0	....	16 31.9	+ 2 9.3	+11.0	....	52.2
430	10 3.5	32.0	20.0						
450	26 8.2	15.0	37.0	....	10 35.0	+ 8 18.7	− 2.8	....	50.9
533	15 76.2	21.5	29.5						
564	23 66.2	*27.0	27.5	....	14 50.2	+ 4 5.4	− 3.7	....	51.9

* Must be $22^d.0$.

Observations and computations for latitude of Laramie, Wyo.—Continued.

DECEMBER 6, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
666	20 93.2	27.5	24.5						
695	20 31.3	— 2.0	48.0	....	41 19 27.6	— 0 19.3	—12.9	....	41 18 55.4
943	20 27.0	24.0	30.0						
980	20 7.0	52.0	2.0	....	18 30.4	+ 0 6.2	+12.1	....	48.7
1017	10 79.0	30.0	25.0	30ˢ late ...					
1024	25 67.0	29.0	26.0	....	11 7.9	+ 7 42.5	+ 2.2	+0.1	52.7
1058	26 26.5	38.5	16.0	....	8 37.0	+10 7.3	+10.7	....	55.0
1107	6 72.5	36.5	20.0						
1117	22 86.8	26.0	31.0	....	10 26.7	+ 8 21.7	+ 3.2	....	51.6
1204	14 24.7	42.0	17.5						
1221	26 98.5	25.0	32.0	....	25 24.5	— 6 35.9	+ 4.8	....	53.4

DECEMBER 7, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Micrometer and reference.	Level.	Meridian.	Latitude.
863	33 85.0	25.0	22.0						
872	3 30.5	8.5	39.5	40ˢ late ...	41 3 10.2	+15 49.3	— 7.7	+0.1	41 18 51.9
948	18 77.2	28.0	19.5						
980	18 28.5	30.0	20.0	....	18 30.6	+ 0 15.1	+ 5.1	....	50.8
1017	11 72.0	29.0	20.0						
1024	26 90.0	....	....	....	11 8.1	+ 7 51.8	— 8.4	....	51.5
1035	18 54.2	4.5	44.0	....	15 27.7	+ 3 32.0	— 8.4	....	51.3
1058	86 91.0	18.5	31.0	....	8 37.1	+10 9.8	+ 7.5	....	54.4
1107	7 29.0	44.5	5.0						
1133	30 73.0	24.0	23.0						
1140	6 38.0	32.5	13.0	....	6 9.6	+12 36.8	+ 5.6	....	52.0
1204	12 82.0	27.5	20.0						
1221	25 81.5	39.0	7.5	....	25 24.4	— 6 43.9	+10.8	....	51.3
1238	11 60.0	26.0	20.0						
1261	24 52.7	10.0	37.0	....	12 12.8	+ 6 41.8	— 5.7	....	48.9
1286	13 75.2	26.0	23.0						
1316	23 49.0	21.5	26.0	....	23 54.7	— 5 2.7	— 0.4	....	51 6
1382	27 44.5	28.0	19.0						
1408	9 85.3	14.0	30.0	....	9 46.9	+ 9 6.7	— 2.0	....	51.6
1651	18 49.7	20.0	25.0						
1676	17 76.5	19.0	26.0	....	19 16.4	— 0 22.7	— 3.3	....	50.4
1721	21 98.0	25.0	20.0						
1726	18 34.0	....	....	....	17 2.5	+ 1 53.1	— 3.3	....	52.3
1734	15 45.5	15.0	32.0	....	15 32.0	+ 3 22.8	— 3.3	....	51.5

DECEMBER 8, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Micrometer and reference.	Level.	Meridian.	Latitude.
7824	12 6.5	18.5	22.0						
7843	7 82.3	23.0	16.0	....	41 16 6.8	+ 2 42.9	+ 1.0	....	41 18 50.7
7931	20 71.0	21.5	18.0						
7948	17 88.8	3.0	37.0	....	20 25.4	— 1 27.7	— 8.4	....	49.3
7994	27 39.5	18.0	23.0						
8023	30 70.5	19.0	22.5	....	17 12.9	+ 1 42.9	— 2.3	....	53.5
8079	19 98.0	42.0	10.0						
8083	20 1.0	0.0	52.0	....	18 58.2	+ 0 0.9	— 5.5	....	53.6

Observations and computations for latitnde of Laramie, Wyo.—Continued.

DECEMBER 8, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
8174	9 97.0	33.0	24.0						
8188	27 74.5	21.0	35.5	....	41 9 40.4	+ 9 12.5	− 1.5	....	41 18 51.4
8248	21 93.8	28.5	29.0						
8273	15 96.8	21.0	38.0	....	22 3.4	− 3 5.6	− 4.8	....	53.0
68	23 2.0	30.0	29.0						
98	12 24.8	29.0	32.0	....	13 18.7	+ 5 34.8	− 0.6	....	52.9
116	13 3.5	....	....	....	13 43.1	+ 5 10.3	− 0.6	....	52.8
146	34 49.0	23.0	37.5						
164	3 58.0	42.5	19.0	....	2 50 4	+16 0.7	+ 2.5	....	53.6
201	20 27.0	24.0	22.0						
224	16 25.0	28.0	18.0	....	16 41.9	+ 2 4.9	+ 3.3	....	50.1
290	22 81.0	31.0	14.0						
299	15 85.5	10.0	34.0	....	15 15.0	+ 3 36.2	− 2.0	....	49.2
339	20 82.0	27.0	18.5						
401	16 42.6	19.5	26.0	....	16 32.1	+ 2 16.6	+ 0.6	....	49.3
430	10 49.0	25.0	21.0						
450	26 95.5	0.0	47.0	....	10 35.0	+ 8 31.6	−11.9	....	54.7
474	16 78.7	25.0	22.0	....	20 24.8	− 1 34.3	− 0.5	....	50.0
437	21 90.0	....	....	....	17 44.9	+ 1 4.7	− 0.5	....	49.1
516	19 82.0	21.0	26.0						
533	15 10.5	23.0	24.0						
535	12 52.0	14.5	33.0	....	20 17.4	− 1 20.3	− 5.4	....	51.7
564	23 5.0	16.0	32.0	....	14 50.4	+ 4 6.3	− 5.4	....	51.3
863	33 57.2	25.0	25.0						
872	3 39.0	33.0	18.0	....	3 10.4	+15 38.0	+ 4.1	....	52.5
948	19 83.0	26.0	24.5						
980	19 17.0	28.0	22.0	....	18 30.7	+ 0 20.5	+ 2.1	....	53.3
1107	6 92.0	30.5	20.0						
1117	22 99.9	35.5	16.0	....	10 26.9	+ 8 19.7	+ 8.1	....	54.7
1133	31 21.5	31.0	18.5						
1140	6 99.4	31.0	17.5	....	6 9.8	+12 32.8	+ 7.2	....	49.8
1204	13 34.5	29.0	20.0						
1121	25 93.0	22.0	26.5	....	25 24.5	− 6 31.1	+ 1.2	....	54.6
1238	12 5.0	21.0	27.0						
1261	25 3.0	15.0	35.5	....	12 18.0	+ 6 43.4	− 7.3	....	54.1
1382	27 80.5	33.0	19.5						
1408	10 70.0	37.0	14.0	....	9 49.5	+ 8 51.6	−10.0	....	51.1

DECEMBER 11, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8317	15 25.5	22.0	24.0						
8337	32 1.0	10.5	35.0	....	27 39.8	− 8 40.8	− 7.3	....	51.7
68	23 19.0	20.0	26.0						
98	12 4.0	4.0	42.0	....	13 18.9	+5 46.5	−12.1	....	53.3
116	12 85.2	....	....	....	13 43.3	+5 21.3	−12.1	....	52.5
122	11 96.2	....	....	....	13 15.8	+5 49.0	−12.1	....	52.7
201	20 68.5	24.0	24.5						
224	16 35.2	15.0	32.0	....	16 42.1	+ 2 14.7	− 4.8	....	52.0
250	19 24.2	26.0	20.0						
255	20 4.8	9.0	37.0	....	18 34.6	+ 0 25.0	− 6.0	....	53.6

Observations and computations for latitude of Laramie, Wyo.—Continued.

DECEMBER 11, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half-sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
430	10 63.8	28.0	19.0						
450	26 86.0	4.0	43.0	....	41 10 35.3	+ 8 24.2	− 8.2	....	41 18 51.3
474	16 22.0	15.0	30.0	....	20 25.0	− 1 41.3	+ 5.7	....	49.4
487	21 37.0	....	....	....	17 45.2	+ 0 58.7	+ 5.7	....	49.6
516	19 48.0	42.0	6.0						
533	15 90.5	25.0	23.0						
564	24 4.0	5.0	44.5	....	14 50.7	+ 4 12.8	−10.3	....	53.2
698	27 9.0	28.0	22.0						
715	15 63.8	12.0	38.0	....	24 54.3	− 5 55.9	− 5.5	....	52.9
735	7 78.0	....	....	....	28 26.5	− 9 29.0	− 5.5	....	52.0
786	23 32.3	30.0	21.0						
827	12 31.0	0.0	51.0	....	24 44.7	− 5 42.3	−11.6	....	50.8
863	33 96.0	28.0	23.5						
872	3 56.0	18.0	34.0	....	3 10.7	+15 44.8	− 3.2	....	52.3
948	19 14.0	29.0	22.0						
980	18 79.0	42.0	7.0	....	18 31.2	+ 0 10.9	+11.6	....	53.7
1017	12 2.0	20.0	26.0						
1024	26 72.6	....	....	....	11 8.6	+ 7 37.1	+ 5.2	....	50.9
1035	18 36.2	35.0	10.0	....	15 28.3	+ 3 17.1	+ 5.2	....	50.6
1058	25 96.5	22.0	24.0						
1007	6 56.8	45.0	2.0	....	8 37.6	+10 2.9	+11.2	....	51.7
1133	39 29.3	25.5	21.0						
1140	6 66.0	13.0	34.0	....	6 10.1	+12 45.6	−4.5	....	51.2
1204	12 88.0	30.0	17.0						
1221	25 75.2	26.0	20.0	....	25 24.9	− 6 40.1	+ 5.2	....	50.0
1238	11 65.0	18.0	26.0						
1261	24 46.0	20.0	25.0	....	12 18.4	+ 6 38.1	+ 3.5	....	53.0

DECEMBER 13, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half-sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
68	21 63.6	23.0	15.0						
98	10 86.5	....	....	....	41 13 19.0	+ 5 34.8	− 1.1	....	41 18 52.7
116	11 66.7	13.0	25.0	....	13 43.3	+ 5 9.8	− 1.1	....	52.0
122	10 78.3	....	....	....	13 15.9	+ 5 37.3	− 1.1	....	52.1
201	19 44.8	31.0	26.0						
224	15 6.8	13.0	44.0	....	16 42.1	+ 2 16.1	− 7.2	....	51.0
250	16 93.0	29.0	29.0						
255	18 56.0	28.0	30.0	Must be 17t	18 34.7	+ 0 19.6	− 0.6	....	53.7
290	21 87.5	29.0	29.0						
299	15 17.8	42.0	17.0	....	15 15.5	+ 3 28.1	+ 6.8	....	50.4
533	16 10.2	29.0	28.0						
564	24 10.5	17.0	40.0	....	14 50.8	+ 4 8.7	− 6.1	....	53.4
620	32 54.5	27.0	27.0						
632	4 59.8	54.0	0.0	....	4 6.1	+14 28.6	+14.8	....	49.5
657	18 98.3	....	....	....	19 30.5	− 0 33.3	− 5.7	....	51.5
666	18 92.5	24.0	19.0	....	19 28.2	− 0 31.4	− 5.7	....	51.1
695	17 91.3	18.0	34.0						
752	19 32.5	24.5	25.0						
785	18 51.8	42.0	9.0	....	19 10.2	− 0 25.1	+ 8.9	....	54.0
948	18 61.0	31.0	23.0						
980	18 34.0	44.5	8.0	....	18 31.4	+ 0 8.4	+12.2	....	52.0

Observations and computations for latitude of Laramie, Wyo.—Continued.

DECEMBER 13, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half-sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
1017	12 0.0	34.0	17.0						
1024	27 17.0				41 11 8.9	+ 7 51.5	− 8.2		41 18 52.2
1035	18 76.0	2.0	49.0		15 28.5	+ 3 30.1	− 8.2		50.4
1062	20 48.0	42.0	9.0						
1095	11 78.0	15.5	36.0	20^s late	14 15.9	+ 4 30.4	+ 3.4	+ 0.1	49.8
1204	12 68.0	31.0	22.5						
1221	25 47.0	31.0	24.0		25 25.2	− 6 37.5	+ 4.3		52.0
1238	11 38.0	25.0	31.0						
1261	23 81.8	45.0	11.5		12 18.7	+ 6 26.6	+ 7.6		52.9

DECEMBER 15, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half-sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitude.
8079	19 21.5	17.0	28.5						
8083	18 88.0	33.0	13.0		41 18 58.0	− 0 10.4	+ 2.3		41 18 49.9
8174	9 31.5	23.0	21.0						
8188	27 13.8	18.0	26.5		9 40.1	+ 9 13.9	− 1.8		52.2
8248	21 16.2	20.0	24.0						
8273	14 85.0	30.5	14.0		22 3.4	− 3 16.2	+ 3.4		50.6
8279	23 13.0	29.0	16.0						
8296	14 42.0				14 19.1	+ 4 30.7	+ 2.6		52.4
8301	18 61.0	21.5	25.0		16 29.0	+ 2 20.5	+ 2.6		52.1
8310	9 68.0				30 17.2	−11 30.4	+ 4.6		51.4
8317	14 70.0	19.0	27.0		27 39.8	− 8 54.4	+ 4.6		50.0
8337	31 89.5	36.0	11.0						
8345	37 56.0	33.5	12.5						
28	1 0.3	11.5	38.0		40 59 58.6	+18 56.2	− 1.5		53.3
68	23 12.5	26.5	22.5						
98	12 37.0				41 13 19.1	+ 5 34.3	− 2.3		51.1
116	13 18.8	19.0	31.5		13 43.3	+ 5 8.8	− 2.3		49.8
122	12 28.5				13 15.9	+ 5 36.9	− 2.3		50.5
201	20 4.5	28.0	22.5						
224	16 7.5	33.5	13.0		16 42.2	+ 2 3.4	+ 7.2		52.8
250	17 61.0	21.5	25.0						
255	18 32.0	20.0	27.0		18 34.8	+ 0 22.1	− 2.9		54.0
290	21 74.0	37.0	9.0						
299	15 10.2	29.0	15.0		15 15.5	+ 3 26.3	+11.6		53.4
339	21 62.5	27.0	16.5						
401	17 45.3	35.5	7.5		16 32.5	+ 2 9.7	+10.6		52.8
430	9 73.0	23.0	20.0						
450	25 81.0	12.5	30.5		10 35.7	+ 8 19.8	− 4.4		51.1
474	15 93.5				20 25.4	− 1 36.7	+ 2.2		50.9
487	21 13.5	28.5	14.0		17 45.5	+ 1 5.0	+ 2.0		52.5
516	19 4.5	17.5	25.0						
533	15 35.0	19.0	23.0						
535	12 87.0			50^s late	20 18.0	− 1 17.1	− 9.5	+ 0.1	51.5
564	23 33.5	6.0	36.5		14 51.0	− 4 8.2	− 9.5		49.7
576	24 36.0				29 26.4	−10 31.1	− 5.1		50.2
580	33 5.2	20.0	23.0		33 10.9	−14 13.7	− 5.1		52.1
579	31 52.0				33 58.0	−15 1.3	− 5.1		51.6
587	4 5.3	14.0	29.5						
620	32 37.8	22.0	23.0						
632	4 20.0	37.0	8.5		4 6.2	+14 35.8	+ 7.6		49.6

Observations and computations for latitude of Laramie, Wyo.—Continued.

DECEMBER 15, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitue.
					° ′ ″	′ ″	″		° ′ ″
657	19 17.8	....	....	....	41 19 30.7	− 0 35.2	− 4.3	....	41 18 51.2
666	19 14.0	33.5	13.0	....	19 28.4	− 0 34.0	− 4.3	....	50.1
695	18 4.5	5.0	41.0						
752	19 20.0	25.5	24.5						
785	18 57.3	25.0	25.5	....	19 10.7	− 0 19.5	+ 0.1	....	51.3
863	32 96.0	32.0	19.0						
872	2 69.0	18.5	32.0	....	3 11.0	+15 40.8	− 0.1	....	51.7
948	19 42.0	25.5	25.0						
980	18 84.0	28.0	21.0	....	18 31.7	+ 0 18.0	+ 2.1	....	51.8
1052	26 45.0	25.0	21.5	....	21 21.0	− 2 22.1	− 5.5	....	53.4
1062	21 87.8	11.5	35.0						
1095	12 98.2	33.0	14.0	....	14 16.2	+ 4 36.5	− 1.2	....	51.5
1107	6 70.0	22.0	24.5						
1117	23 3.0	15.5	31.5	....	10 27.8	+ 8 27.5	− 5.1	....	50.2
1133	31 66.5	23.0	24.0						
1140	7 43.2	37.0	10.0	....	6 10.7	+12 33.2	+ 7.1	....	51.0
1204	12 46.0	26.0	24.0						
1221	25 46.0	39.0	10.0	....	25 25.4	− 6 44.0	+ 8.8	....	50.2
1238	12 31.0	25.5	23.0						
1261	25 11.0	16.5	32.0	....	12 18.9	+ 6 37.8	− 3.5	....	53.2
1286	13 39.0	23.5	25.0						
1316	23 54.6	42.0	8.0	....	23 55.7	− 5 15.6	+ 8.9	....	49.0
1382	27 20.3	30.0	18.5						
1408	10 10.3	35.0	13.0	....	9 50.5	+ 8 51.5	+ 9.2	....	51.2
1546	12 80.4	36.0	7.5						
1572	31 0.0	24.0	24.5	....	28 11.3	− 9 25.5	+ 7.7	....	53.5
1671	19 7.0	22.0	25.0						
1676	18 38.0	16.5	30.0	....	19 17.4	− 0 21.4	− 4.5	....	51.5
1721	21 75.5	28.0	19.0						
1726	18 19.0	15.5	32.0	45s late ...	17 3.4	+ 1 50.8	− 2.1	+ 0.1	52.2

DECEMBER 17, 1872.

Number of star.	Micrometer-readings.	Level. N.	Level. S.	Remarks.	Half sum of declination.	Corrections. Micrometer and reference.	Corrections. Level.	Corrections. Meridian.	Latitue.
250	18 51.8	20.0	24.5						
255	19 29.5	15.0	29.5	....	41 18 34.9	+ 0 24.1	− 5.0	....	40 18 53.5
290	22 38.0	24.5	20.0						
299	15 42.0	21.5	22.0	30s late ...	15 15.6	+ 3 36.3	+ 1.1	+ 0.1	53.1
339	19 97.0	28.5	14.5						
401	15 93.8	37.5	7.0	....	16 32.6	+ 2 5.3	+12.2	....	50.1
430	9 39.0	22.5	21.0						
450	25 30.0	23.0	20.0	....	10 35.8	+ 8 14.5	+ 1.2	....	51.5
474	15 82.5	....	....	....	20 25.6	− 1 49.6	+13.2	....	49.2
487	21 2.3	24.0	20.0	....	17 45.6	+ 0 52.0	+13.2	....	50.8
516	19 35.0	44.0	0.0						
533	14 11.0	18.0	24.0						
564	21 78.0	28.5	13.0	....	14 51.7	+ 3 58.4	+ 2.6	....	52.7
579	32 31.5	8.0	32.0						
587	4 82.0	20.0	20.0	....	33 11.1	−14 14.5	− 6.6	....	50.0
620	32 9.2	17.0	24.0						
632	3 96.7	44.0	3.0	Must be −3d.0.	4 6.4	+14 34.1	+11.0	....	51.5

Observations and computations for latitude of Laramie, Wyo.—Continued.

DECEMBER 17, 1872.

Number of star.	Micrometer-readings.	Level.		Remarks.	Half-sum of declination.	Corrections.			Latitude.
		N.	S.			Micrometer and refr.	Level.	Meridian.	
	t. d.	d.	d.		° ′ ″	′ ″	″		° ′ ″
657	19 25.2	18.0	20.0	....	41 19 31.0	— 0 34.6	— 4.4	....	41 18 52.0
666	19 16.0	....	....	....	19 28.7	— 0 31.7	— 4.4	....	52.6
695	18 14.0	12.0	26.0	....					
752	18 41.0	16.5	25.0	....					
785	17 75.2	30.0	14.5	....	19 11.1	— 0 20.5	+ 1.9	....	52.5
863	33 56.8	26.0	17.5	....					
872	3 14.2	10.0	32.5	35ˢ late...	3 11.3	+15 45.6	— 3.8	+ 0.1	53.2
948	19 82.3	23.5	17.5	....					
980	19 38.0	33.0	6.0	....	18 32.0	+ 0 13.8	+ 9.0	....	54.8
1017	11 49.0	18.0	21.0	....					
1024	26 52.0	....	....	....	11 9.3	+ 7 47.1	— 4.9	....	51.5
1035	18 17.0	12.0	27.0	....	15 29.0	+ 3 27.6	— 4.9	....	51.7
1052	25 40.0	18.5	21.0	....	21 21.4	— 2 31.4	+ 2.1	....	52.1
1062	20 53.0	25.0	15.0	....					
1095	11 76.0	19.0	20.0	....	14 16.6	+ 4 32.6	+ 2.1	....	51.3
1133	30 92.4	20.0	18.5	....					
1140	6 66.7	31.0	8.0	....	6 11.0	+12 33.9	+ 6.7	....	51.6
1204	12 27.5	26.0	14.5	....					
1221	25 43.0	37.0	3.0	....	25 25.7	— 6 48.8	+12.5	....	49.4
1238	11 6.8	16.0	22.0	....					
1261	23 90.5	13.0	25.0	....	12 19.2	+ 6 39.0	— 4.9	....	53.3
1286	13 36.7	23.0	15.0	....					
1316	23 65.8	42.0	— 4.0	....	23 55.9	— 5 19.8	+14.8	....	50.9

Resulting astronomical co-ordinates.

The following table contains the daily means for latitude:

1872.	No. of obs.	Mean latitude obtained.
		° ′ ″
December 6	18	41 18 52.43
7	13	51.50
8	24	51.93
11	21	51.83
13	17	51.81
15	40	51.46
17	22	51.79

The mean of the daily results gives 51″.82; the mean of all observations made, 51″.78.

Adopted latitude .... 41° 18′ 51″.80 ± 0″.08
Longitude .... 7ʰ 2ᵐ 22ˢ.24 or 105° 35′ 33″.60 west of Greenwich.
1 54ᵐ 10ˢ.12 or 28° 32′ 31″.80 west of Washington

The following points are proposed for occupation as main astronomical stations during the field-season of 1874:

1. Las Vegas, N. Mex.
2. Cimarron, N. Mex.
3. Sidney Barracks, Neb.
4. Julesburgh, Neb.
5. Crossing of the Union Pacific Railroad by the one-hundredth meridian, or at the North Platte station, Nebraska.

The above will be sufficient during the coming year to answer all the wants experienced in checking belts of triangles to be extended over the area to be surveyed, and will continue the work upon the astronomical base.

The usual field-astronomical observations will be kept up, in accordance with the elaborated scheme of survey determined upon for the prosecution of further geographical work by the officers in executive charge of the several parties.

GEODETIC AND ASTRONOMICAL.

The character of the observations made in this most important branch of the survey has been improved and perfected so far as consistent with the policy of covering large geographical areas during a single field-season. The problem of conducting a geographical survey over mountainous areas by methods at once thorough and rapid presents many grave difficulties, prominent among which is the uncertainty as to the extent of the physical obstacles to be encountered. The present organization will, however, during the coming season prosecute its labors in accordance with a certain plan conditioned upon the character of the several portions of the area to be entered, and founded upon a comprehensive system of triangulation developed from bases whose extremities and azimuths are well determined, the former by astronomical methods. These series of triangles network the entire area, and in addition thereto the horizontal and vertical values of the drainage-lines of the several main and sub basins are determined.

The progress of the geodetic survey of the character proposed is somewhat slower than by the methods employed prior to the season of 1873; but when confined to areas of the public domain that are attracting attention on account of their mineral or other resources developing, and about to be developed, where the Indian tribes are quiet, the decrease in cost because of the smaller number of persons required in each party for reasons of safety makes apparent the fact that a well-established policy as to the character of the surveys over such areas may be reached. I have reason to believe that such a course is about to be adopted, and in consequence hereafter some of the parties of the survey, at least, may annually be sent to areas not occupied by hostile Indians; while other parties may be directed to more inaccessible portions of mountain-territory, where reconnoissance-work alone is required, and where escorts will be needed.

In the season of 1873, the astronomical co-ordinates of points, and the determination of meridional lines through them, were determined at Hughes', Colorado Springs, and Trindad, Col., and Fort Union, N. Mex., all on the eastern base of the Rocky Mountain range, and a series of triangles developed from bases at these points into portions of Colorado, New Mexico, Eastern Utah, and Eastern Arizona. The labors of the season of 1874 will take up the triangulation at the points where it was left in the preceding season, for the purpose of completing it over the area extending from the latitude of Denver southward to the thirty-second parallel. The several belts will be joined to a number of points, all of which are along nearly the same meridian east of the Rocky Mountain ridge. The bases are measured by compensated steel tapes, referred to a standard, and a sufficient number of repetitions made to guarantee a small probable error. The azimuths are also carefully determined.

At the extremities of the developed bases, angular measurements are taken to the most prominent points of the adjacent triangulation-belt, which points are natural objects—usually high mountain-peaks.

The extension of the triangulation is made from point to point in accordance with the plan made at the beginning of the season, and the azimuth of at least one side of every triangle determined.

Within the main or principal triangles there is measured a series of minor triangles, covering the entire mountain-area, checked latitudinally at specified points. The checks used for the remaining detailed operations of the survey are by latitudes along the meanders, and by the connection of station-points with three or more main or prominent points within the horizon of each. The belts of triangles are further controlled by interior check-bases at distances not exceeding one hundred and fifty miles from the primary astronomical point. By these methods, forty-four main triangulation-points were occupied in New Mexico and Arizona and thirty-six in Colorado during the season of 1873.

When the connection is made between the two sets, their publication will indicate the character of the results, which have so far proven very satisfactory, since the geographical position of most of the points used could not be sufficiently ascertained in advance to always insure certainty as to resulting well-conditioned triangles.

A part of the topographic work of 1873, especially that in Colorado, demands a representation upon a scale of one inch to four miles, because of the intricate character of the several drainage-lines within the Rocky Mountain system. This will in no wise interfere with the regular and systematic plan proposed for the atlas of the region west of the one hundredth meridian. Since the final publication of the same, may be made upon a scale of one inch to eight miles.

The remarkably fruitful results from the topographical work of the past season are a matter of much congratulation to me, since the several areas were widely distributed and the different points of departure comparatively remote. Certain of the topographical assistants, too, were inexperienced; yet, notwithstanding all this, and the multitude of physical obstacles constantly in the path of each one of the parties, the area covered has been notably large, and almost equal to that of the season of 1871, when it was principally by reconnoissance-methods that the results were obtained.

It has been alone due to the untiring vigilance of the officers in charge and the industry of the several topographical assistants that the material for the important contributions to the geography of so large a part of our western interior has been gathered.

METEOROLOGICAL BRANCH.

The general method of the previous seasons has been followed during that of 1873. Hourly observations have been taken at the primary astronomical stations with the cistern-barometer, psychrometer, and anemometer. As many cistern-barometers, aneroids, and psychrometers as could be used to advantage have been distributed among the different field-parties, and a system of observation has been so adapted to camps, triangulation, topographical, and other stations, as to insure the determination of the greatest possible number of altitudes. The record of all these observations, up to the close of the field-season of 1873, has been transcribed upon computation-sheets, corrected and reduced, and the computation of altitudes is going forward.

It is proposed to group these altitudes, in accordance with the main topographical features of the country, in tables, which will appear in volume 3 of the series of publications.

The contents of this volume will be—

1st. A synopsis of the general plan for meteorological observations, the methods of reduction and computation, and the application of the results.

2d. The tables of altitudes, with general description of the locality of each group.

3d. Contour-maps of the atlas-sheets, with the curves at such intervals of altitude as are warranted by the results in barometric hypsometry, in conjunction with the elevations and vertical distances determined by the topographers.

4th. Tables and plates deduced from the hourly observations at the astronomical stations. These will comprise the abnormal and horary oscillations, and the changes in temperature and humidity of the atmosphere, with their effect upon the mercurial column.

With these will be published all facts that have been observed concerning the climate and climatal oscillations, with a description of the physical geography of the region of territory surveyed.

This branch of the survey is indebted to the cordial co-operation of the United States Signal-Service.

It has not been practicable, with the limited force that could be employed in working up the meteorological observations, to prepare this matter for publication; but, as time can be spared from other branches, this will gradually be brought forward.

Being an auxiliary to the other branches of the survey, it is in all respects subordinate to, and most of its results incorporated with, them.

GEOLOGICAL BRANCH.

Four professional geologists have, for different periods, been employed to accompany the several geographical parties and examine the structure of the region traversed. Of these, Mr. G. K. Gilbert was engaged in 1871, and has continued with the survey up to the present time; Mr. A. R. Marvine was employed during a portion of the first year only; Mr. E. E. Howell during the second and third, and Prof. J. J. Stevenson during the third year.

In 1871, Mr. Gilbert traveled mostly with the main field-party, crossing portions of Nevada, California, and Arizona, and making the voyage of the Colorado. Mr. Marvine, who spent but two months at geological work, began his observations at St. George, Utah, and continued them, via Prescott, Camps Verde, and Apache, to Tucson, Ariz.

The succeeding year, Messrs. Gilbert and Howell were employed principally in Western and Southern Utah; but their examinations also reached into Eastern Nevada and Northern Arizona.

For the greater portion of the season Mr. Gilbert accompanied Lieutenant Hoxie, and Mr. Howell the main division; but, upon the return-march, Mr. Howell joined Lieutenant Hoxie's party, while Mr. Gilbert was detached, and traveled alone by way of the valley of the Sevier to the final rendezvous at Salt Lake City.

In 1873, Mr. Howell accompanied Lieutenant Hoxie throughout the season, spending the earlier portion of it in Southern Central Utah, and the latter in Western New Mexico; Mr. Gilbert traveling with divisions of the main party in New Mexico and Eastern Arizona, and Professor Stevenson with the party commanded by Lieutenant Marshall in Colorado.

In all cases the geologists were assigned to separate topographical parties, and their routes arranged, so as to give them opportunity to acquire the most comprehensive ideas of the character of the country, and to obtain the fullest collection of data in a little-known region.

To get a right understanding of the results of their work, it is necessary to appreciate a broad distinction that exists between two regions of country that were entered. Almost the entire region included between "the Plains" and the Pacific Ocean is mountainous; that is, the rocks which are its foundation are bent and broken and uplifted into ridges, which ridges are mountain ranges. But there is one exceptional area in which the beds of rock lie level, or nearly so, and this was named by myself in the year 1871 the "Colorado Plateau" region. In its general features, it contrasts very strongly with the surrounding mountain country. It consists of a system of tables, in places rising above each other in step-like order, and elsewhere divided by narrow, deep, and often impassable gorges. A large portion of this region is drained by the Colorado and its tributaries, but other parts send their waters to the Sevier Desert and via the Rio Pecos to the Rio Grande.

Of the political divisions, it comprises portions of Utah, Colorado, Arizona, and New Mexico, and its physical boundaries are the Uintah Mountains at the north, the Rocky Mountains at the east, and at the west and south the regions of the Cordilleras.

Through the labors of the topographers and geologists, the general dimensions of this area are now for the first time known, and its western, southern, and southeastern boundaries, making a line 900 miles long, are drawn on the map.

Within it are exceptional opportunities for the study of certain special geological subjects, and to these their attention has been turned. One of them is that of erosion by running water, which finds its superlative expression in the cañons of the Colorado, and is there contrasted with erosion by rain and compared with erosion by drifting sand.

Another subject is that of the origin of mountains; for, although the plateaus are distinctively not mountains, they contain certain simple dislocations which are the germs of mountains, and bear the same relation to dynamical geology that embryos bear to biology. These dislocations are faults and simple folds, and they have been traced and studied for hundreds of miles.

Another subject to which great attention has perforce been given is that of volcanic phenomena.

Every State and Territory west of the plains, every physical division the Rocky Mountains, the Plateaux, the Cordilleras, are crowded with the products of volcanic action, ancient and modern. Hardly a mountain range lacks them.

The largest consecutive areas without them are among the plateaux; but in that same province, also, are some of the largest lava-fields.

In Southern Utah there are connected floods of lava, covering an area of 5,000 square miles; and of this area the geologists of the expedition have obtained data for geological maps.

They have also approximately defined the limits of a similar area in Arizona and New Mexico not less than 20,000 square miles in extent, and never before recognized as a connected belt.

Of the conclusions which they draw from their accumulation of volcanic data, one, at least, is of general interest, namely: that eruptions in our western territory will be again resumed, which occurrences may take place at any time. In the past, they have occurred so recently that it is, indeed, surprising that there is no human record of them.

The distribution of the geological formations has been made out with a good degree of accuracy in the portions of the plateau country and Rocky Mountains that have been examined; but in the region of the Cordilleras less has been accomplished, for the reason that all relations there are more complicated and no strata can be traced continuously for great distances. Among the contributions to stratigraphical knowledge are the determination of the Tertiary age of the Sam Pitch coals of

Utah, of the Cretaceous age of the coals of Castle Valley and Southern Utah, and of the Cretaceous age of the disputed coal-series of Colorado. Tertiary, Cretaceous, Jurassic, Carboniferous, and Silurian rocks have been identified by fossils in Utah, and all of these but the Jurassic in New Mexico; in Colorado and Arizona, Cretaceous, Carboniferous, and Silurian; in Nevada, Jurassic, Carboniferous, and Silurian; and in Southern California, Carboniferous and Silurian.

The age (heretofore in doubt) of the shale and sandstone at the base of the series of strata exposed in the Grand Cañon of the Colorado has been ascertained to be primordial.

Of special subjects of study, one of the most interesting has been that of the glacial epoch. The southern limit of the ancient system of glaciers has been ascertained through the entire extent in longitude of the survey, and an attentive examination has been made of the record of an expansion of Great Salt Lake, which occupied the valleys of Utah, while its highest mountain-gorges were choked with ice.

The elaboration of these results into reports for publication has occupied the geologists during the winter-months.

The report of Mr. Marvine is in manuscript, ready for the press, and the same may be said of the report of Mr. Gilbert for the field-work of the seasons of 1871 and 1872, and of that of Mr. Howell. A portion, however, of the notes of the latter gentleman have been put into the hands of Mr. Gilbert to combine with some closely-related examinations of his own, and embody in the report, upon which he is now engaged, of his examinations in 1873.

Professor Stevenson has completed and submitted his report, with the exception of a single chapter. The whole will fill, when printed, about 350 quarto pages.

In the preparation of these reports, the itinerary form, so easy to write, but so inconvenient for use, either by the general reader or by the future student in the same field, has been avoided, and all the material presented has been thoroughly classified. Facts of common character have been brought together, and where their importance warranted, have been briefly discussed in their relations to each other and to cognate facts in other fields; and it is believed that the arrangement is such that the various data will be *readily* accessible to those who shall have occasion to use it.

An atlas of geological maps is in preparation, to accompany the reports.

The general facts of rock-distribution are to be indicated by colors laid upon the topographical-atlas sheets, and special maps will be constructed to illustrate some other features, such as the distribution of glacial phenomena and of thermal springs.

The illustrations with the text will consist of fourteen plates, derived chiefly from photographs of peculiar geological features, and of a large number of wood-cuts, the major part of which are now drawn.

The wood-cuts are chiefly diagrams and sections representing rock-structure, and are strictly explanatory of the text.

The geological collections (without including the fossils and ores) number 2,700 specimens. One of their chief uses has been already subserved in enabling the geologists to study, during the preparation of their reports, peculiarities of texture and composition that could not receive full attention in the field; but a larger portion of them have a permanent value also as material for special lithological study.

It is hoped that at some future day the volcanic rocks, which outnumber all others in the collection, can be placed in the hands of a competent specialist for study.

PALEONTOLOGY.

The fossils number 4,500 specimens, and come from all portions of the area examined. They have had their first (geological) use in identifying the several formations in a great number of localities, and promise to reward richly their paleontological study. A preliminary examination has been made of the invertebrates by Mr. F. B. Meek, the paleontologist, and upon his judgment an estimate has been made of 150 quarto pages of text and 30 plates for the description of the new forms.

The vertebrate remains, including bones of mastodon, horse, camel, rhinoceros, &c., have been submitted to Prof. O. C. Marsh, who will report upon them.

The collections were made by the geologists and mineralogists of the expedition, and by Assistant George M. Keasby, who accompanied one of the parties in New Mexico in the last season with the special errand of gathering vertebrate remains.

MINERALOGY.

During the field-season of 1871, Acting Assistant Surgeon W. J. Hoffman accompanied the expedition as naturalist and mineralogist, and in 1873 Dr. O. Loew joined the survey as mineralogist and chemist.

Besides the collections of these gentlemen, a great many specimens of minerals and especially of ores have been gathered by the officers in charge of parties and by the geologists.

The entire accumulation numbers 1,600 specimens. Dr. Loew has prepared a report to be included in the geological volume, comprising, with a *résumé* of the results of previous years, a full account of his chemical and other investigations. It is now ready for the press, will fill 45 pages, and includes—

1. A report on the agricultural capacities and lands of portions of New Mexico and Arizona, with notes on the geographical distribution of plants, and on several cosmical phenomena.

2. The analyses of all mineral springs encountered, of saline efflorescences and incrustations; also analyses of soils and plants, of coal-specimens, ores, kaolins, and of a fossil resin hitherto unknown.

3. A description of the volcanic rocks of New Mexico and Arizona, with numerous analyses. In some of these rocks, cobalt and nickel were found, an occurrence heretofore not observed.

4. Tables comprising the minerals collected, their occurrence in Nevada, Utah, Arizona, New Mexico, and Colorado. These comprise the collections of the last four years, and are arranged after the chemical system of Professor Dana.

Numerous mining-districts in Colorado and New Mexico were visited, the ores and their geological occurrence described, and specimens collected.

In Colorado, especial attention was paid to the mines of Gold Hill, Central, and Georgetown.

The predominating ores of Gold Hill are the tellurides of gold, silver, and lead; those of Central, auriferous pyrites; those of Georgetown, argentiferous galena.

The principal gold-mines of New Mexico are situated in the Placer Mountains, 30 miles south of Santa Fé, where the precious metal is found free in placers as well as in iron-pyrites.

The chief silver-mines noted in this Territory are those at Silver City and Fort Bayard, where chloride of silver occurs in gypsum and slate, associated frequently with cerassite, galena, and malachite. These ores are chiefly deposits, no true fissure-veins having as yet been developed. Similar ores occur on the Sierra Madalena, (Socorro mines,) together with frequent deposits of argentiferous cerassite.

True fissure-veins of argentiferous galena occur at La Joya on the Rio Grande Extension, and valuable copper-mines are worked in the Burro Mountains, at Santa Rita, and on the Rio San Francisco in Arizona.

Silicate, carbonate, red oxide, and sulphide of copper are the principal forms in which the copper is encountered. Colorado and New Mexico abound in mineral springs. These springs may be classified, as to their thermal conditions, into hot and cold, or, according to their prominent compounds, into soda, iron, salt, sulphur, lime, and siliceous springs.

Hot salt-springs occur on the Rio San Francisco in Arizona; hot lime and soda springs at Ojos Calientes on the Jemez Creek, New Mexico; cold soda springs at Cañon City, Col.; iron springs on the Arkansas River (Carlisle), and in the Greenhorn Mountain Range a sulphur-spring.

Spectroscopic investigations have always been combined with the analysis, and thus the presence of lithia was detected in most of the classes of springs above mentioned.

NATURAL-HISTORY BRANCH.

The force at disposal has been directed with a view to the accomplishment of the largest possible results, which have proven entirely satisfactory.

Considering the character and extent of the area entered, the attendant expense has been comparatively small.

The subjoined report from Acting Assistant Surgeon H. C. Yarrow, U. S. Army, sets forth the objects, operations, and results more fully.

REPORT OF ACTING ASSISTANT SURGEON H. C. YARROW, U. S. ARMY.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE 100TH MERIDIAN,
Washington, D. C., June 30, 1874.

SIR: I have the honor to submit the following brief *résumé* of the results of operations in the branch of natural history of the survey under your charge, during the past year, introducing incidentally facts bearing upon the results of the two previous years.

Such a sketch would appear particularly desirable at this time, since as yet, excepting in two instances, the natural-history branch has been unable to publish either notes or descriptions of the specimens collected and studied during the period in question, notwithstanding many hundred pages of manuscript have long been prepared.

The general plan for studying the natural history of the Western Territories has been to collect everything calculated to throw any light on the subject and add to our somewhat limited knowledge of the geographical distribution of animals and plants, and afterward to submit such collections to specialists for study, and a report of the results of their investigations; the specimens finally being presented to the National Museum at the Smithsonian Institution, by which establishment they are distributed to different institutions of a similar character throughout the world.

For the last-mentioned reason, therefore, especial attention has been directed to procure duplicates, in order that, instead of our industry appearing selfish, numbers of learned institutions might partake of the knowledge thus acquired.

Some years since it was held that the possession of scientific acquirements should be only for a favored few; but at the present day more thorough systems for the dissemination of scientific knowledge have been inaugurated.

To the corps under whose auspices this expedition was projected, and is still carried on, is due, to a great degree, the popularization of the study of natural history in this country.

The operations of the natural-history branch of this survey may be briefly stated as follows:

In 1871, the services of Dr. W. J. Hoffman, U.S. Army, and Mr. Ferdinand Bischoff were secured, the former as surgeon and naturalist, the latter as collector, by whose joint efforts many hundreds of specimens were secured in zoology and botany, among which were quite a number hitherto unknown to science. Of this collection, the botanical portion was placed in the hands of Prof. Sereno Watson, of Cambridge, who kindly named the new species, and submitted a report upon the collection, which has been received, and will prove a valuable contribution to our knowledge of the flora of the interesting section of country visited.

The mammals collected have been reported upon by Dr. Hoffman; the birds, by Mr. Ridgway of the 'Smithsonian,' Mr. Henshaw, and myself; the reptiles and fish, by Prof. E. D. Cope and myself; and the insects, of which many thousands were secured, by Mr. Ulke, Professor Thomas, Professor Uhler, and others. In addition to those received at this office, many other specimens were collected, which, however, unfortunately, were either lost in transit from the West or destroyed in the great Chicago fire.

The collection of 1871, while not as large as either that of 1872 or 1873, is extremely interesting, from the fact that many of the rarer forms of zoological life were met with as well as important data obtained relative to their general distribution and occurrence. This entire collection has been deposited in the National Museum.

In 1872, recognizing the great value of the collections already made by the Engineer Corps of the Army, and being assured that to the scientific world researches in natural history, especially on our western frontier, would add greatly to our knowledge of the zoology of that region, you permitted unusual facilities for the prosecution of such labor, the results proving the wisdom and foresight of such a course, since a collection was made seldom rivaled by that of any similar expedition having but two collectors.

It is but proper, however, to add that several of the members of the survey contributed largely to the general stock of specimens.

In this collection there were about eight hundred bird-skins, most of them rare and valuable; a large number of mammals; several hundred fish, of which no fewer than sixteen species were new to science; and many reptiles, insects, shells, plants, &c., embracing in all probably 5,000 specimens. Not the least important specimens in the collection were a number of Indian crania, obtained at considerable risk from the Ute burial-places and ancient mounds in the valley of the Great Salt Lake, as well as numerous implements, both ancient and modern, used by the aborigines.

This entire collection has been apportioned among eminent specialists for determination, most of whom have already reported, their manuscripts awaiting publication.

The mammals have been identified and reported upon by myself: the birds, by Mr. Henshaw and myself, with the assistance of Mr. Ridgway, of the Smithsonian Institution; the reptiles and fishes, by Prof. E. D. Cope and myself; the insects, by Mr. Ulke, Professor Uhler, Professor Cresson, Dr. Hagen, Baron Osten-Sacken, Professor Thomas, and Mr. Edwards; and the shells by Mr. G. W. Tryon, jr., of the Philadelphia Academy of Natural Sciences.

The botanical collection has been worked up by Prof. Sereno Watson, of Cambridge, who had charge of, and reported upon, the collection of 1871.

The Indian crania have been forwarded to the Army Medical Museum, and we are assured by the officer in charge that the donation is a valuable one.

In 1873, the natural-history party was enabled to take the field early, and, through the indefatigable exertions of the collectors, results were secured even exceeding those of the previous year; the official record showing the following number of specimens:

"Seven Indian crania.
"One hundred and sixty mammals.
"One thousand and two hundred bird-skins.
"Five hundred birds eggs.
"Twenty-five birds nests.
"Fifty birds crania, skeletons, and sterna.
"One hundred and forty-five reptiles.
"Five hundred and five fish.
"Five hundred beetles, (*Coleoptera.*)
"One hundred and fifty butterflies, (*Lepidoptera.*)
"Five hundred grasshoppers, (*Orthoptera.*)
"Thirteen lots of flies, (*Diptera.*)
"Thirteen lots of bugs, (*Hemiptera.*)
"Twelve lots of worms, leeches, larvae, &c.
"Seven lots of ants, (*Formica.*)
"Fifty-five lots of shells, land and fresh-water.
"Twenty-four lots of dragon-flies, (*Neuroptera.*)
"Twenty-eight lots of bees and wasps, (*Hymenoptera.*)
"Twenty-six lots of spiders, scorpions, &c., (*Arachnida.*)
"Fifteen thousand plants, embracing at least one thousand and five hundred species."

This collection contains many new as well as many rare species, seldom to be found in public museums. As in former years, the plan has been continued of distributing the specimens to eminent scientists, and from the majority of these gentlemen reports have already been received and are now ready for printing.

Thanks are due to the following gentlemen, who have so kindly aided in many ways, in every case giving their valuable services gratuitously to the elucidation of scientific material connected with the expedition, viz: Prof. Joseph Henry, Prof. S. F. Baird, Prof. E. D. Cope, Prof. S. A. Allen, Prof. A. E. Verrill, Prof. O. C. Marsh, Dr. H. Allen, Dr. H. Wood, jr., Dr. George A. Otis, U. S. A., Dr. J. J. Woodward, U. S. A., Prof. A. Agassiz, Dr. H. A. Hagen, Mr. W. H. Edwards, Mr. Theodore L. Mead, Dr. P. H. Uhler, Mr. H. Ulke, Prof. Cyrus Thomas, Prof. Townend Glover, Mr. Robert Ridgway, Mr. G. Browne Goode, Prof. E. T. Cresson, Mr. W. G. Binney, Mr. G. W. Tryon, jr., Prof. Sereno Watson, Mr. George Thurber, Prof. Thomas. P. James, Dr. George Vasey, Baron Osten-Sacken, Mr. G. N. Lawrence, Mr. Thomas Bland, Prof. S. Olney, Mr. R. H. Stretch, Mr. Aug. R. Grote, Dr. William Holden, Mr. Edward Norton, Dr. Elliott Coues, U. S. A., Prof. Asa Gray, Mr. J. H. Milner, Dr. A. S. Packard, jr., Mr. S. C. Scudder, and others.

In conclusion, I beg leave to express thanks for the great interest manifested in this branch of the work committed to your charge as well as for the facilities you have always afforded for making collections.

With the hope that, as in the past, the future may find you alive to the importance of the natural-history wants of the period, I have the honor to be, very respectfully, your obedient servant,

H. C. YARROW,
Surgeon and Naturalist to Expedition.

Lieut. G. M. WHEELER,
Corps of Engineers, U. S. Army.

PHOTOGRAPHS.

As heretofore, a photographer has accompanied the expedition, following a route from Santa Fé westward, via Fort Wingate; thence to Camp Apache, and the vicinity of the Sierra Blanca range, Arizona; thence northward, *via* old Fort Defiance, Moquis Pueblos, and the Cañons of the Colorado.

A great variety of negatives, of which a few prints have been taken, were secured, illustrative of natural scenery, the habits and customs of the Indian tribes, ancient ruins, &c.

During the season, the executive officers of parties have gained valuable experience in the subjects of observation intrusted to their charge.

The property, purchasing and disbursing branches have been faithfully and efficiently filled by Assistants Francis Klett and George M. Lockwood.

OFFICE.

While the expedition of 1873 was in the field, three draughtsmen and one computer were employed in the office, and completing results to the close of the season of 1872, both topographical and meteorological, and those of 1873 are well advanced.

The great mass of geographical information obtained annually obliges this method, which proves to be most economic.

CONCLUSION.

The progress and improvement of the survey have passed through successive stages since its commencement in 1869. It is believed that in its present efficient state it answers a want of the War Department and the country, and has at its foundation a judicious economy.

The results are available to other executive departments of the Government than the War Department, and incidentally to the industries of the region surveyed. While suggesting the propriety of the continuance of the survey, a few of the many classes of information are here noted, the results from which are believed to be of constant necessity and usefulness in the War Department:

1st. The published maps, profiles, and compiled distances over present and future routes of communication and supply that look to a saving in cost of transportation of all materials and munitions of war and other supplies forwarded through the Quartermaster's Department of the

Army. As a correct understanding of the topographical features of a country is necessary to all military operations, either in times of war or peace, the necessity for the acquisition of this information in a systematic form at the War Department, and its dissemination through the different branches of the military service, becomes apparent.

2d. The establishment of routes of communication necessary for the supply of interior posts. For an understanding of the above, the interlying country requires thorough examination.

3d. Critical routes to be followed in the interchange of troops between distant stations when demanded.

4th. New and shorter routes for forwarding recruits to their companies and stations.

5th. Routes for scouts pursuing hostile or unfriendly Indians.

6th. The selections of sites for new military posts established in advance of, or as safeguards to, civilization.

7th. Routes for troops when called out for the protection of miners or settlers.

8th. A knowledge of the resources of the country surrounding the military establishments, and its capacity for furnishing supplies.

9th. Routes of transit when troops are ordered to remote points in aid of the civil law.

10th. A knowledge of the character and habits of the several Indian tribes, and their disposition toward each other and toward settlers.

The above are a few of the classes of examinations necessary and valuable to the several Bureaus of the War Department and to the commanders of troops in their pioneering into the unoccupied and comparatively inaccessible portions of the western interior.

To obtain such information that should be at all times immediately available for the uses of the War Department, such observations as are necessary for an *accurate delineation and description of the surface and resources of the area surveyed* must be made. This calls for geographical surveys in their highest and broadest sense.

The position of the cognate branches of science in carrying on so important a work must naturally be subservient to the exact science necessary to the delineation of the surface with accuracy. Meanwhile, the co operation of specialists in the branches above referred to will, without largely increasing the cost, enhance that portion of the results relating to the resources of the region surveyed, and to them the best facilities for the prosecution of their inquiries are afforded, as also most excellent opportunities for the proper application of their results.

In order that the survey may be continued at the standard proposed in the Progress Report for 1872, the estimate below submitted will be required to be appropriated, so that one of the units of force may take the field, and within the year, or shortly thereafter, publish its entire and complete results.

The survey is capable of expansion to meet the wants of the Government, but its operations cannot be made satisfactory except at least one of the units of force is appropriated for.

The law for the present year admits of the prosecution of the survey with the force at its disposal in any portion of the area west of the one hundredth meridian.

The special area for the season of 1874 has been authorized by the War Department.

Of mountainous areas very little known, whose present and prospective mining developments indicate that this industry will soon enter them, are portions of New Mexico, represented by that part of atlas-rectangles 77, 84, 78, and 85, west of the Rio Pecos and east of the Rio

Grande; also, in rectangles 47, 48, and 57, and portions of 65, along the east base of the Sierra Nevada range.

It is not deemed essential or advisable to have limited long in advance special areas to be occupied in any one year, although, so far as practicable, the areas of several years should be made to conjoin, yet the survey should be held as an intact organization, prepared to carry on its work in any portion of the interior west of the one hundredth meridian into which it shall be ordered by the War Department.

As the surveys of the General Land-Office are being extended into the mountainous mining-districts, and as there are boundary-lines between political divisions yet to be marked, I would suggest the propriety of an interchange of results between the General Land-Office and this survey.

The use of details of the former prevents the necessity of duplication of work in certain valley-areas, while points could be furnished checking standard meridians and bases, prominent points on boundary-lines, initial points for the surveys of mining claims and areas, &c.

The amount required for the prosecution of the field and office work of the survey for the fiscal year ending June 30, 1876, by the unit of force proposed, is $95,000. No less sum than this can be used with the same resulting degree of economy.

The probable distribution of expenditures under this appropriation would be as follows:

Expense of nine parties in field and office	$58,000
Transportation, including purchase of animals	8,500
Purchase of materials, outfits, &c	6,500
Subsistence of parties in the field	6,400
Forage, including winter-herding	7,500
Repairs of instruments	1,500
Office-rent, fuel, storage, &c	3,100
Contingencies, including erection of monuments and observatories at astronomical stations	3,500
Total	95,000

Amount appropriated to continue explorations and surveys west of the one hundredth meridian for the fiscal year ending June 30, 1875	$30,000 00
Amount allotted from balances existing June 30, 1873, and made available by act approved June 23, 1874	60,000 00
Amount remaining on hand at close of fiscal year ending June 30, 1874	25,889 45
Amount required for field and office for fiscal year ending June 30, 1876	95,000 00

All of which is respectfully submitted.

GEO. M. WHEELER,
First Lieutenant Corps of Engineers, in charge.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. Army.

F F 2.

PLAN FOR PUBLICATION OF REPORTS AND MAPS, WITH ESTIMATES.—SUMMARY OF PUBLICATIONS TO PRESENT TIME.

UNITED STATES ENGINEER OFFICE,
GEOGRAPHICAL EXPLORATIONS AND SURVEYS
WEST OF THE 100TH MERIDIAN,
Washington, D. C., June 30, 1874.

GENERAL: The estimate of $95,000, submitted as the amount necessary to continue the work under my charge for the fiscal year ending

June 30, 1876, covers the expense only of the field and office work of the survey, but not the publication of maps or illustrations for the survey-reports.

In the act approved June 23, 1874, the amount of $25,000 was appropriated for the fiscal year ending June 30, 1875, for illustrations for the volumes to be published.

The greater number of the manuscripts for the six volumes proposed (see Annual Report of the Chief of Engineers for 1873, p. 1717) are ready for the press, and only await the preparation of the illustrations for the same, which will be begun early in the coming fall.

The necessary changes, in the manner proposed in the last annual report, for the form and scope of the volumes are as follows: Volume 1 is to include the general report of 1873, and condensed reports upon all the mining-districts visited since the year 1871. It should be complete soon after the return of the expedition of 1874. Volume 2 is to include reports upon the astronomical stations of 1873. The manuscript will be ready for the press as soon as the observations necessary for the connection of the astronomical observatory at Ogden, Utah, with the U. S. Naval Observatory at Washington, D. C., are computed. Volume 3 is to embrace the subjects proposed in the annual report of this year. It is somewhat doubtful whether it can be published during the present fiscal year. Volume 4, as indicated in the main body of the report, approaches completion, and ought to be ready for the press by October 10. The examination of fossils and the preparation of reports upon paleontology are going on while the parties are in the field, and ought to be well advanced by the 1st of October. This volume will also contain a report upon the vertebrate fossils collected in 1873. Manuscript reports for volume 6 are nearly ready, and can go forward to the printer during October.

It has been found impossible to include in the present annual report total results up to date in the astronomical, meteorological, and topographical branches, as stated in my last annual report. They are all brought closely to completion, however; and the reports relating to the cognate branches of the survey, as therein indicated, will be hereafter brought out in special form.

The present field-season must necessarily be a short one, and during the coming year it is deemed possible to establish a complete harmony between field and office work and results so that, as nearly as possible, within the fiscal year, the final results shall be placed in publication-form.

PUBLICATIONS.

Since the inception of the work under my charge, the following separate publications other than maps relating thereto have appeared: Preliminary Report, 1869, (octavo;) Preliminary Report, 1871, (quarto;) Table of Camps, Distances, &c., 1871 and 1872, (quarto;) List of Mining-Questions; List of Mining-Districts Visited, 1871, 1872, and 1873; Landscape and Stereoscopic Views taken in the years 1871, 1872, and 1873; Preliminary Report upon the Fishes, 1871 and 1872, by Prof. E. D. Cope, (pamphlet;) Annotated List of the Birds of Utah, collected in 1872, (pamphlet.)

The following reports have been submitted to the Engineer Department, with a request for their publication, and it is believed have gone forward to press: Progress Report, 1872; Report upon the Botanical Collections of 1871, 1872, and 1873; Report upon the Ornithological Collections of 1871 and 1872.

A Report upon the Determination of the Astronomical Co-ordinates of the Stations at Cheyenne, Wyoming, and Colorado Springs, Colorado, quarto, was issued in January, 1874.

MAP-PUBLICATIONS.

Topographical atlas.—An advanced-sheet issue of this atlas has been photolithographed during the year. It contains (1) title-sheet, (2) legend-page, (3) basin-chart, (4) progress-map, and sheets Nos. 50, 58, 59, and 66. A 2,000-copy edition has been published, and 486 sets distributed; 500 copies of sheets Nos. 50, 58, 59, and 66 have been printed on thin paper for preliminary distribution.

Proofs have been presented of sheets Nos. 50, 59, and 66, executed by the crayon-process. No. 59 is within a few days of completion. In addition, there are in the hands of the lithographer, of which proofs are to be furnished soon, (1) index-map, (2) general topographical map of the area west of the Mississippi River, and (3) an explanation-sheet. Sheets 49 and 67 are in an advanced state of preparation, and go forward soon to the lithographer. Sheets 57, 65, 75, 76, 83, and portions of 77 and 84, are in process of construction on a scale of one inch to eight miles. The southeastern, northeastern, and southwestern parts of sheet 61, and the southeastern quarter of sheet 52, are being constructed on a scale of one inch to four miles.

All of the sheets above mentioned will doubtless be completed and published during the coming year. The several photographic copies of the preliminary maps for office-use are printed by the photographer of the expedition. There have been made, during the year, issues of the preliminary maps of 1869 and 1871 and of the office-map of 1872.

There is a large and increasing call for maps of the comparatively unknown regions west of the one hundredth meridian, and the edition already authorized will be insufficient to meet the wants of the present fiscal year. The atlas of geological maps is referred to in the main body of the report. From material gathered, fourteen sheets are proposed for publication.

The following estimate for the publication of maps and illustrations for the reports is submitted for the fiscal year ending June 30, 1876. The amount is the same as that appropriated for the present fiscal year.

For preparation, photolithographing, engraving, and printing atlas and other topographical maps, including the field-work of 1874	$15,000
For preparation, photolithographing, engraving, and printing geological maps, to include the work of the field-season of 1873	2,500
For engraving and printing plate and other illustrations for reports	7,500
Total	25,000

The amount appropriated for engraving and printing illustrations for the reports of explorations and surveys west of the one hundredth meridian, for the fiscal year ending June 30, 1875, is $25,000.

Amount required for the preparation, engraving, and printing of topographical and geological atlas, maps, and illustrations for reports for the year ending June 30, 1876, $25,000.

A copy of the progress-map is herewith, showing approximately the areas surveyed up to the close of the field-season of 1873.

Very respectfully, your obedient servant,

GEORGE M. WHEELER,
First Lieut. of Engineers, in charge.

Brig. GEN. A. A. HUMPHREYS,
Chief of Engineers, U. S. Army.

APPENDIX FF 3.

REPORT ON PALEONTOLOGY.

UNITED STATES ENGINEER OFFICE,
EXPLORATIONS AND SURVEYS WEST OF THE 100TH MERIDIAN,
Washington, D. C., October 15, 1874.

GENERAL: I have the honer to forward herewith a special report received from Prof. E. D. Cope, paleontologist to the expedition of this season, embodying some of the results of his labors in portions of New Mexico, up to the 27th of September. This report contains new and valuable information relative to vertebrate fossil remains.

Very respectfully, your obedient servant,

GEO. M. WHEELER,
Lieutenant of Engineers, in charge.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. Army.

REPORT OF PROF. E. D. COPE, PALEONTOLOGIST.

CAMP ON GALLINAS CREEK, *September* 27, 1874.

SIR: In accordance with your instructions to forward a report of proceedings, I beg leave to state that I returned to this camp from Tierra Amarilla on the 15th of the month, and have remained here ever since. We have been mostly employed in examining the bad lands of the Eocene of the divide between the Chama and San Juan Rivers, and in collecting the vertebrate fossils which their beds contain. A little time has been devoted to the Cretaceous beds forming the rim of the Basin. From the Eocene beds, more than seventy-five species of vertebrates have been obtained, many of which are new to science, and others are largely illustrated by additional remains. Four species of a new order, the *Toxodontia*, have been discovered, and our knowledge of the structure of other peculiar forms enlarged. Interesting relations between the Cretaceous and Tertiary beds have been observed.

Mr. Shedd has been assisting in making collections and taking his meteorological observations at the stated times.

The health of the party continues good, and we hope to move camp to another point ere long.

Very respectfully, your obedient servant,

EDW. D. COPE,
Paleontologist.

Lieut. GEO. M. WHEELER,
Corps of Engineers, U. S. A.

NOTES ON THE EOCENE AND PLIOCENE LACUSTRINE FORMATIONS OF NEW MEXICO, INCLUDING DESCRIPTIONS OF CERTAIN NEW SPECIES OF VERTEBRATES, BY PROF. E. D. COPE, PALEONTOLOGIST TO THE EXPEDITION.

PART I.

One of the results of the examinations made during the field-season of 1874 is the discovery of an extensive series of deposits of Eocene age. These indicate the existence, during early Tertiary time, of an extensive lake of fresh water in that part of New Mexico now drained by the tributaries of the Chama River on the east and the San Juan River on the west. This lake received the remains of the fauna of its shores and other regions adjacent, which have been preserved and obtained by the members of the expedition detailed by Lieutenant Wheeler for its investigation, in considerable numbers.

The shore of this lake was formed by rocks of the Cretaceous formation of an age near the No. 3 of Meek and Hayden. In approaching it from the east, we traverse the sandstones of Cretaceous No. 1, both horizontal, and tilted at various angles, and find No. 2 resting upon it frequently unconformably, and tilted at higher angles, frequently 45°, sometimes 50°, to the west and southwest, and containing numerous fossils, as *Inoceramus*, etc. The upper sandstones of this formation pass into a brackish or fresh-water formation, which includes a bed of lignite, of sometimes 50 feet in thickness. Above this rests, conformably where seen, a moderate thickness of rather soft marine rocks, containing numerous shells, *Acephala*, *Gastropoda*, and *Cephalopoda*, including *Oysters*, *Baculites*, and *Ammonites* resembling *A. placenta* most, with sharks' teeth. Resting unconformably on these, with a much reduced dip, is a mass of brown and reddish sandstones, some 1,500 feet in thickness, inclining perhaps 10° south and southeast. These pass continuously into the superincumbent red and gray marls, alternating with brown and white sandstone of the fossiliferous beds of the Eocene. The observed part of these beds is about 1,500 feet in depth.

A considerable number of species of *Vertebrata* have been obtained, a large majority of which are *Mammalia*. While it is premature to attempt to determine fully the character of the fauna, enough has been ascertained to indicate marked differences from that of the Bridger group of Wyoming. It is peculiar in the entire absence of the genus *Palæosyopsos*, so characteristic of the former, and its replacement by *Bathmodon*, which has never been recorded from the Bridger formation. The abundant species of *Hyrachyus* of the Bridger are here represented by a single one of small size, which occurs but rarely, while its companion, *Hyopsodus*, is very rare or wanting. While gar-remains are abundant in both, the *Amiidæ* and *Siluridæ* have not yet rewarded our examinations. The characteristic genera of the New Mexican fauna are *Bathmodon*, Cope; *Hipposyus*, Leidy; and *Phenacodus*, Cope, genera which it shares with the *Bathmodon* bed of the Green River formation of the Bear River Wyoming. There is in all respects so close a resemblance between these deposits as to lead to the belief in their horizontal identity, and with other reasons, to give to the southern basin a higher antiquity than belongs to the celebrated Bridger series. The interesting fact that the teeth of six or seven species of sharks and one *Ostrea* have been deposited with the mammalian remains indicates that the marine Cretaceous rocks formed the coast-material of this lake, and the earlier period of its deposit is probable on various grounds, to be considered at a future time. The facts are all confirmatory of the view already expressed by the writer that the population of the Bridger epoch was derived by migration from a southern region.

Perhaps the most important addition to paleontological science obtained during the course of the investigation is the discovery of four species of two new genera, *Calamodon* and *Ectoganus* of *Toxodontia*, an order which has not been heretofore identified as having existed on the North American continent.

DESCRIPTION OF SPECIES.

ECTOGANUS GLIRIFORMIS, *gen. et sp. nov.*

Char. gen.—This genus rests on a number of remains of the crania of three species, ncluding principally teeth, in a good state of preservation, all found in appropriate relations by the writer. The teeth include incisors, molars, and premolars, it is believed, of both superior and inferior series.

There are two types of gliriform incisor-teeth, and of one of these in the largest species three sizes. In the one, the teeth are elongate, compressed, convex in both directions on the anterior; are convex or angulate in section at the posterior face. In all, the enamel is confined to a band on the anterior face, extending more or less on one side or the other, the naked dentine extending prominently backward at the middle and basal portion of the shaft.

In the larger size, this portion is subacute behind; in the smaller, obtuse. Teeth of this type are of three sizes, the smaller two the most compressed and with narrowest enamel. Those of the second type are of one, an intermediate size, and are shorter than those of the others and less compressed. One of their faces is concave in both directions, and is covered with enamel from the apex of the tooth for some distance posteriorly. From its terminus on the concave side, the enamel borders retire to the sides of the convex front.

There are three molars of the superior and many of the inferior series available for present determination. The superior are all remarkable for the great exposure of their external faces as compared with their internal, and the extension of the enamel on the outer face of the very thick external root, which is not distinguished from the crown. The true molar has three roots, and the crown is longer antero-posteriorly than transversely. It consists of two transverse tubercular ridges, connected by a medium oblique longitudinal ridge. The premolars have two of the roots connate, forming a support to the greater part of the crown. The worn surface is in form something like the Greek ω, the deep emargination being internal. The inferior molars have greater antero-posterior than transverse diameters. The enamel is more extended on one side than the other, covering the exposed portions of the roots. The grinding surface is plane, and has the form of a horizontal ϖ; the limbs being angulate, as in the Greek Σ.

It isimpossible to determine the affinities of this curious genus with the material at present in my hands, but it is evidently nearer to the South American *Toxodon*, Owen, and *Typotherium*, Gervais, than anything yet discovered in the North American Tertiaries. It is no doubt related to the *Anchippodus*, Leidy, and *Tillotherium* Marsh, (which Marsh observes may be identical,) but differs from both in many points of the dentition.

Char. specif.—All the incisors are regularly convex in front. The surface of attrition of the large ones truncate, of the small ones oblique. The section of the large ones near the base is diamond-shaped, with one acute angle truncate and the other rounded. There are some shallow grooves on the sides, and on one side a more pronounced longitudinal shallow angulation. The enamel of these and of all the molars is smooth, and there are no cingula on the latter. The transverse crests of the unworn true molars support two tubercles, and the inner extremities of the crests of the premolars are produced in accordance with the oblique wearing of the incurved crown in mastication.

Measurements.

		M.
Length of incisor, largest, type 1		.043
Width of incisor, largest, type 1		.013
Depth of incisor, largest, type 1		.018
Length of incisor, medium, type 1		.034
Width of incisor, medium, type 1		.006
Depth of incisor, medium, type 1		.014
Depth (?) of incisior, last, type 1		.009
Width of incisor, last, type 1		.004
Length of incisor, type 2		.031
Width of incisor, type 2		.006
Diameter of crown of premolar	longitudinal	.010
	transverse	.010
Length of enamel of face externally		.013
Length of enamel of face posteriorly		.005
Length of crown of posterior upper molar		.016
Width of crown of posterior upper molar		.012
Length of crown of posterior lower molar		.012
Width of crown of posterior lower molar		.009

Size about that of a fully-grown hog, (*Sus scropha.*)
Portions of several individuals have been found.

CALAMODON SIMPLEX, *gen. et sp. nov.*

Char. gen.—Molar teeth subcylindric, prismatic, rootless; the crown only distinguished by its investiture of enamel, which exhibits a weak marginal inflection for a portion of the length. Enamel extending in a band on one or both sides of the tooth to the base. Incisors rodent-like, curved, with a band of enamel on the anterior face, and obliquely-truncate extremity.

A number of specimens, probably representing this genus, have been found, and I select as typical those of an individual in which the molar and incisor teeth occurred together. The form is evidently allied to *Ectoganus*, as the close resemblance of the incisor teeth demonstrates, but the molars are of a much more simple type than anything yet discovered in this group, imitating superficially those of some *Edentata.*

Char. specif.—Molar (?superior) longitudinally bent, the convex (outer) face covered with enamel to the base. Enamel extending a much shorter distance on the inner face, and soon worn through by attrition on one of the other faces. Section of the base of crown a subquadrate oval. A slight inflection of enamel on the inner and a still weaker one on the (?)posterior border of the triturating face. Enamel with slight longitudinal ridges. Incisor much curved, strongly convex in transverse section, the enamel obscurely longitudinally ridged on both sides near the border. Section of one side slightly concave.

These and other specimens indicate an animal at least as large as the American tapir.

Measurements.

	M.
Length of a molar	.042
Diameter of the same	015
Diameter of incisor, transverse	.019

CALAMODON ARCAMŒNUS, *sp. nov.*

This *Troxodont* is represented by a portion of the skeleton of a specimen including several teeth, and most probably by portions of another, which includes a large and perfect inferior incisior-tooth. The former displays the alveoli for molars and incisors, showing the one-rooted character of those of the lower jaw, and the deep implantation of the incisor below the antepenultimate molar. The number of molars indicated by the ramus is five, the anterior in close contact with the single large incisor. The molars are subquadrate in section, the last a little longer than broad. The only one in which the crown is preserved exhibits a short crown, with its inferior enamel border notched on two, and oblique on two sides, and the external layer of the root swollen above it all round. The summit of the crown is worn, and is divided subequally by a transverse, rather shallow, groove. One division of the crown exhibits two dentinal areas in transverse line, the other three small ones in a curved line. The extremity of the curved incisor is rodent-like, and regularly convex on the anterior face and entirely smooth. The posterior or grinding face is convex in cross-section.

A large lower incisor of another individual is about five inches in length and one and a half in depth, without the increase of elevation of the superior or interior edge, as is seen in *Ectoganus gliriformis*. This edge is obtusely rounded, and instead of being obliquely leveled to meet the masticatory surface of the extremity, is abruptly truncate, the masticating face turning off at one side of the shaft. The enamel is smooth and of equal width and convexity throughout.

Measurements.

	M.
Elevation of crown of molar	.013
Length of crown of molar	.015
Width of crown of molar	.013
Diameter of incisor^{m}. 010 from tip	.013
Length of series of five molars	.090
Depth of jaw at third molar	.055
Thickness of jaw at third molar	.035

CALAMODON NOVOMEHICANUS, *sp. nov.*

Represented by a superior incisor-tooth of a species of smaller size than either of those already described, and differing in various respects from those of the *C. simplex*, of which a fine specimen has been obtained since it was first described. Both anterior and posterior edges are protected by a convex band of enamel; and the triturating surface is tranverse in the direction of the depth, and oblique in that of the width. The shaft increases in depth toward the root and is longitudinally concave on one face and convex on the other. The enamel bands are most extended on the convex face, and unite on that side round the triturating face and present an abrupt emargination on the middle of their convex border. The other, being formed of dentine only, is deeply worn by attrition.

Measurements.

	M.
Length of fragment	.038
Depth at fracture	.018
Depth at grinding face	.011
Width at grinding face	.009

This species differs from the supposed *C. simplex* in this incisor in other respects than in the smaller size. The latter is concave on both sides, and on the lower border; the former convex on one side, and on the lower border.

ESTHONYX BISULCATUS, *gen. et sp. nov.*

Char. gen. (?).—Incisors of two forms; the inferior subgliriform, but not growing from persistent pulps; the enamel covering a long and narrow external vertical face, and terminating above the alveolus, thus distinguishing crown and root. The other form of (?)incisor with the apex encased in enamel, but extending much farther on the outer than the inner side; the crown compressed, not wider than the root. Molars supporting two V's with rounded apices directed outward, the posterior soon wearing into a triangle lower than the anterior. The anterior elevated and transverse only distinguished from a triangle by a notch on the inner side. Last lower molar with this anterior transverse triangle, a diagonal ridge and a heel with raised border.

The type of this genus is *Ectoganus bisulcatus*, Cope, and a second species is *E. burmeisterii*, Cope. It differs from *Ectoganus* as well as from *Anchippodus* in the far less gliriform character of the incisor teeth, which may be compared with the extremities of the slender fingers of some monkeys with narrow nails.

Char. specif.—A species about the size of the *Capybara* is represented by the greater part of the dentition of the lower jaw, which includes representatives of both kinds of incisors already described under the characters of the genus. The rodent-like form is less typical of the genus than in the *E. gliriformis* in being rather shorter and furnished with a less extensive external enamel-plate. The dentinal column projects well internally, giving the tooth a regularly oval section. The incisor of the second form has the internal as well as the external enamel-face, and the former possesses a longitudinal angle bounding its concavity. The grinding-face of the molars and some of the premolars is ∞-shaped as in the other species, but the anterior limb of the figure is much thickened on the inner face, so as to have a triangular form, the base being inward. This base is notched by a second groove of that side of the tooth, which interruption is obliterated by prolonged attrition. This portion of the crown is elevated above the posterior, in consequence of the more rapid removal of the latter by trituration. The large internal and external grooves continue nearly to the base of the crown, as in the larger species. The last inferior molar is longer than the others, and is three-lobed, forming by its base nearly an isoceles triangle. The heel is formed by the backward production of the posterior convexity of the ∞, the central line of the figure forming a diagonal ridge across the middle of the tooth.

The mandibular ramus is of a deep compressed form.

Measurements.

	M.
Length of three consecutive molars	.0250
Length of last two molars	.0210
Length of penultimate molar	.0084
Width of penultimate molar	.0062
Length of last molar	.0112
Width of last molar	.0070
Length of incisor, second form	.0250
Diameter of incisor, second form	.0050
Diameter of incisor, first form, transverse	.0030
Diameter of incisor, first form, antero-posterior	.0070

ESTHONYX BURMEISTERII, *sp. nov.*

A species more nearly allied to the *E. bisulcatus* than to the type of the genus is represented by a portion of the right mandibular ramus, with the last molar tooth in perfect preservation. While the jaw is of depth similar to that of the *E. bisulcatus*, it is more slender in its proportions. The molar, also, while of nearly the same length, is relatively narrower, especially in its anterior portion. The crown of this tooth is worn in the specimen, and the anterior portion is elevated above the posterior, and displays a trace of the notch of the inner margin already observed in the species last described. The composition of the tooth is similar in other respects. No cingular; enamel smooth.

Measurements.

	M.
Length of last lower molar	.009
Length of last lower molar from anterior tubercles	.0060
Width { anteriorly	.0050
Width { posteriorly	.0025
Depth of ramus at last molar	.0240

This species is dedicated to Prof. Hermann Burmeister, director of the museum of Buenos Ayres, who has studied the group of *Toxodontidæ*, and given us an excellent account of their osteology.

ESTHONYX ACER, *sp. nov.*

Char. specif.—Established on a portion of the lower jaw, in which the last four premolars remain. They resemble those of the species already named, except in the anterior one of the series. This tooth in *E. acer* assumes the form of a premolar, the posterior V becoming a curved median cutting edge, and the anterior V opening into a crescentoid section; it rises to an acuminate apex, having thus a rather sectorial character. In the last three molars, there is a small tubercle at the inner base of the posterior limb of the anterior V. Posterior V much lower; enamel smooth.

Measurements.

	M.
Length of four last molars	.035
Length of three last molars	.026
Length of penultimate molars	.008
Width of penultimate molars	.005
Length of last molar	.011
Width of last molar	.005
Depth of jaw at last molar	.020

This species differs from the *E. bisulcatus* in the modified form of the last premolar; in the latter, it is relatively larger and more like the true molars. The last molar of *E. acer* is more like that of the *E. burmeisterii*, but the mandibular ramus of that species is relatively much deeper and similar to that of *E. bisulcatus*.

ESTHONYX MITICULUS, *sp. nov.*

Represented by portions of mandibular rami of three or four individuals of much smaller size than any of those referred to the species already described. There are represented two premolars and three molars; other teeth are lost. The molars differ from those of the three species named in lacking the notch or groove on the inner side of the anterior triangle of the crown, which constitutes it a V in those species, giving the worn surface a more simply sigmoid form; the anterior portion is, moreover, not materially more elevated than the posterior. The last molar has a large heel, an inner and two anterior tubercles when little worn. The premolars preserved are each two-rooted, the last is like the correponding one in *E. acer*, the penultimate without heel or inner tubercles.

Measurements.

	M
Length of three true molars, (No. 1)	.0120
Length of two last premolars, (No. 2)	.0064
Length of first true molar, (No. 1)	.0040
Width of first true molar, (No. 1)	.0030
Depth of ramus at first true molar, (No. 1)	.0080

The worn surfaces of the first and second true molars are much like those of the corresponding teeth of *Menotherium*, Cope. That genus differs in the reduced form of the last inferior molar and in the premolars.

MENISCOTHERIUM CHAMENSE, *gen. et sp. nov.*

Char. gen.—Molars three, with two continuous external crescents and two internal tubercles, except on the posterior, where there is but one, the anterior conic tubercle. The posterior tubercles on the other molars crescentoid in section. A well-developed crescent between the anterior tubercle and anterior crescent, and an oblique crest extending from the latter to the adjacent horn of the posterior inner tubercle. Two external crescents on the last premolar.

This genus presents a curious combination in the structure of its molars of the character of *Palæosyops*, *Hyopotamus*, and *Hipposyus*. It is exceptional among the ungulates of the same fauna in the number of crescents of the molars.

Char. specif.—Last molar with the oblique inner posterior crest terminating at the posterior margin of the crown. Prominent external ribs at the point of connection of the external crescents of the crown. No cingula; enamel entirely smooth.

Measurements.

	M.
Length (externally) of last four molars	.029
Length of true molars	.022
Length of penultimate	.009
Width of penultimate	.010

This animal was about the size of the raccoon, and probably had the habits of the tapirs.

BATHMODON SIMUS, *sp. nov.*

Represented by the remains of a great number of individuals, including all parts of the skeleton, dentition, &c., but especially by one of the most complete of these, which possesses, among other portions, the premaxillary bones. These indicate a species very distinct from the *B. radians*, Cope, and one approaching the *Metalophodon armatus* in the structure of the molar teeth.

The canine teeth have cylindric roots and trihedral crowns, the section of the latter forming a nearly equilateral spherical triangle. The crown of the inferior canines are shorter, and have one concave side. The superior molars support two crests, which are nearly parallel on the single and last tooth of this type. The posterior crest is composed of two portions, the posterior conic and the anterior flatter, and which becomes the external posterior crescent on the penultimate molar. The anterior cingular crest is very well developed on the last lower molar.

The premaxillary bone is short and stout, and descends steeply from an elevated front, presenting its three teeth downward. The canine follows closely from an elevated rib on the side of the face. Behind it is a considerable diastema. The humerus is a very stout bone, and the femur is rather slight in comparison with it.

Measurements.

	M.
Length of bases of last three molars	.083
Length of basis of last molar	.026
Width of basis of last molar	.035

	M.
Diameter of canine at base	.025
Length of penultimate inferior molar	.030
Width of penultimate inferior molar	.021

Individuals of larger size than the above are more common. Measurements of one of these are:

	M,
Length of last superior molar	.032
Width of last superior molar	.043
Diameter of crown of canine, (another species)	.030

This is the especially characteristic large mammal of this fauna, and must have existed in herds.

BATHMODON MOLESTUS, *sp. nov.*

Established on remains of one species and probably respresented by those of others in possession of the expedition. The teeth differ in several important respects from those of *B. radians* and *B. simus*. Thus the canine is quite compressed in the coronal portion, and is narrow triangular in section, the narrow base of the triangle being concave; that is, the section of a strong groove, which is bounded by a sharp edge on each side. The edge proper of the crown is also duplicated by a ridge of the enamel, which joins it at an acute angle. The last upper molar is characteristic in its wide crown, the posterior usually transverse crest being curved so as to represent the segment of a circle, the convexity posterior. The ramus of the lower jaw is very slender. The posterior inferior molar is large, and has subequal transverse crests. The posterior cingulum, which descends from the external angle, is moderately developed on both of the crests.

In a young specimen of this or an allied species of *Bathmodon*, the deciduous tooth which is replaced by the last premolar has two external crescents; an interesting point of resemblance to the *Perissodactyle* ungulates.

Measurements.

	M.
Width of anterior crest of last inferior molar	.023
Width of anterior crest of superior molar	.039
Length of superior molar	.029
Antero-posterior diameter of crown of canine	.022
Transverse diameter of crown of canine	.013
Depth of mandible at last lower molar	.050

BATHMODON LOMAS, *sp. nov.*

The very numerous remains of the genus *Bathmodon* obtained are referrible to several species, as indicated especially by the teeth. The present form is characterized among other points by the form of the last inferior molar. The anterior crest is much more elevated than the posterior, with its inner apex almost a cone, with anterior, thick, revolute border. The usual oblique cingulum descends from the outer apex forward. The longitudinal ridge connecting the crests is low but distinct, while the posterior cingular ridge is remarkably large. This, which constitutes one of the specific marks, is extended horizontally so as to form a broad ledge, whose border is a segment of a circle. Enamel roughened with five ridges on all the external surfaces. Tooth well worn by prolonged use.

Measurements.

	M.
Length of crown	.041
Width of crown anteriorly	.027
Width of posterior crest	.022
Elevation of posterior crest	.011
Elevation of anterior crest	.024

BATHMODON ELEPHANTOPUS, *sp. nov.*

The most abundant species of the New Mexican Eocene formation, and of the largest size, exceeding in this respect both the *B. simus* and *B. molestus*. I describe at present the last molars of both superior and inferior series. The former is a transverse oval, slightly swollen on the posterior border external to the middle point. The two crests are parallel, the anterior as usual curving round to the inner extremity of the shorter posterior, and leaving a wide interval between them. The posterior is not divided, but is elevated at the extremities. Anterior cingulum strong, posterior obsolete, excepting on the external border, where it sends a low ridge to the elevated extremity of the anterior crest. Exteroanterior to this ridge is a shallow fossa. Enamel very slightly rugose. The posterior lower molar exhibits a great disparity of elevation of the crests, the anterior being high, and terminating on the inner side in an elevated cone. The connecting ridge is low, and there is only a trace of a descending posterior cingulum on the posterior crest.

Measurements.

	M.
Width of last superior molar	.040
Length of last superior molar	.030
Length of last inferior molar	.039
Width of last inferior molar	.026
Elevation of posterior crest of inferior molar	.015
Elevation of anterior crest of inferior molar	.025

A remarkably fine skeleton of a species of this genus, discovered by my friend and assistant, William G. Shedd, exhibits characters heretofore only inferential, and demonstrates the correctness of a number of positions heretofore based on a few fragmentary bones. The feet exhibit proboscidian characters throughout. They are very short and plantigrade, and there are five digits on the hind foot. The calcaneum is recurved inward, and the astragalus flat above. The navicular is transverse and very thin, while the cuboid is subequilateral. The metatarsals are short, and the phalanges much wider than long. The cranium remarkably resembles that of a carnivorous animal in its massive expanded zygomas and huge canine tusks. It differs remarkably from this type, and shows its affinity to *Uintatherium* in the broad plane of the upper cranial wall, with overhanging marginal crests for the attachment and protection of the temporal and neck muscles. These crests do not support horns. The muzzle is contracted at the diastema, thus rendering more prominent the ridges which mark the position of the alveoli of the tusks. The latter are directed downward, giving the profile the pick-ax-like form of that of *Uintatherium*, though more robust in its proportions than the latter. The length of this skull is 19 inches; the width at the zygomas 13.

PHENACODUS PRIMÆVUS, Cope.*

Char. gen.—The genus *Phenacodus* was first recognized by the writer in a posterior inferior molar of a mammal of about the size of a hog, of unknown affinities, which was named *P. primævus*. Specimens of the same species, embracing the dentition of both jaws, having been procured in the Eocene of New Mexico, I am prepared to add to the characters of the genus.

There are three molars in each jaw, and the specimens include two premolars, which form a continuous series, as in *Achænodon*. There are four principal tubercles on the inferior molars and sometimes a third small one between the posterior pair, always on the last one, which is, however, not largely developed. The first inferior premolar presents a broad heel, a double medium tubercle, and an anterior tubercle, (in *P. primævus*.) The crowns of the superior molars are low and broad, and support numerous tubercles; these are low and vary in number, but there are two near the external border which are quite constant. They have general resemblances to those of hogs, bears, and monkeys. The first true molar is broader than long, and there are no diastemata between it and the premolars, or between the latter, which are quadri-, and tri-cuspid, respectively. The forms of these teeth are entirely different from those of the corresponding teeth in *Elotherium*.

Char. specif.—The posterior molar of the left side is wide in front and regularly oval in posterior outline, and has two equal anterior and three unequal posterior tubercles. One of the posteriors is situated near the middle of the outer side, and is separated from the adjacent anterior by a deep groove. The corresponding inner tubercle is more posterior; anterior tubercles low, trihedral, and connected by a shelf-like cingulum across the front of the tooth; rudimental cingula on outer side of crown. The penultimate molar has three tubercles on the posterior border; and a deep fissue, corresponding to that of the last molar, separates one of them from the anterior tubercle.

Measurements.

	M.
Length of last molar	.015
Width { anteriorly	.011
Width { between two posterior tubercles	.005
Elevation of anterior cusp from base	.008
Width of penultimate molar behind	.010

From the same locality as the preceding species.

PHENACODUS OMNIVORUS, *sp. nov.*

Superior molar with low and broad tubercular crown, with outline of base parallelogrammic, with one end oblique; the oblique end with two principal low tubercles,

*Paleontological Bulletin, No. 17, p. 3, October 25, 1873.

which form the extremities of two series of similar ones, some of which arise from the strong cingulum which forms part of the summit of the crown.

Char.—Molar without cingulum on the (?) outer side only; elsewhere very strong and crenate, at one point rising into a stout, low tubercle. The largest tubercle is near this, on the inner summit of the crown, and is connected with the larger outer by a low, broad tubercle. A smaller one intervenes between the cingular tubercle and the smaller external. The outer tubercles low and broad, a smaller one opposite the internal between them in the position of a cingulum. Enamel coarsely rugose.

Measurements.

	M.
Transverse diameter	.014
Longitudinal	.010
Distance between apices of inner and outer tubercles	.007
Elevation of cingulum	.004
Elevation of outer cusp	.005

The tooth described is about the size of the posterior inferior molar of the black bear, (*Ursus americanus.*)

PHENACODUS SULCATUS, *sp. nov.*

Represented especially by the molar tooth corresponding to that above described under the head of *P. omnivorus*, in good preservation. It is a species considerably less than half the size of the one just named, and presents several important differences of structure. Of the two outer tubercles, one is very small, and there is a third adjacent to the larger, produced by the enlargement of the cingulum. As in *P. omnivorus*, the cingulum extends entirely round the remainder of the crown, and is tubercular on the side of the least outer tubercle. The inner tubercle is connected with the larger outer by an intermediate of elongate form, so that the series when worn down resembles the transverse ridge of the superior molar of *Hyposyus*, and which is separated by a groove from the cingular ridge on each side.

Measurements.

	M.
Transverse diameter	.008
Longitudinal diameter	.006
Distance between apices of inner and outer tubercles	.004
Elevation of cingulum	.002
Elevation of outer cusp	.003

Size similar to that of the corresponding tooth of a *Coati.*

OXYÆNA LUPINA, *gen. et sp. nov.*

Represented by a portion of the cranium, which includes the greater part of the dentition. The generic characters are, three premolars and four molars above and below; lower premolars with anterior cone and posterior cutting heel; last premolar and all the molars of the superior series with an internal heel; the last molar transverse; first and second upper molars with an anterior cone and posterior cutting lobe; the penultimate with two anterior acute cones, the posterior forming a sectorial edge with the posterior lobe; last superior molar trenchant.

Mandibular dentition, I., 0; C., 1; P. M., 3; M., 3; the canine teeth directed forward and upward without intervening incisors. First premolar one-rooted; second and third consisting of an anterior elevated cone, and posterior heel, which is elevated in the middle.

The first true molar is nearly similar, with the posterior tubercle sharp edged. Last two molars with an anterior elevated portion and small low heel; the former consisting of three acute tubercles, of which the largest or interior forms with the anterior a sectorial blade oblique to the axis of the mandibular bone.

This genus has one less molar with double median cones than *Prototomus.* It is one of the flat-clawed group, of which two forms have already been described, *Mesonyx*, Cope, and *Synoplotherium*, Cope, which present in their dentition a nearer resemblance to the genus *Hyænodon* than to any other of later age. It differs from both the genera named in having only six molar teeth, and the triangular type of inferior sectorial teeth has not yet been obtained among them. The *O. forcipata* is the larger species; the smallest one described by me is the *Oxyæna morsitans.* In *Stypolophus brevicalcaratus*, I find three sectorials of the form described instead of two only.

Char. specif.—The posterior cutting lobes of molars 1 and 2 elevated and rather obtuse, that of molar 3 lower and more acute. Molar 2 has a well-marked anterior tubercle; molar 4 consists of an outer cutting edge and inner cone. The inner tubercle of molar 3 is smaller than in the three teeth preceding. First lower premolar well developed with one root. Enamel of all the teeth, especially of the canines, rugose.

This species is allied to those of the genus *Pterodon.*

Measurements.

	M.
Length of four posterior superior molars	.055
Length of first true molar	.016
Width of first true molar	.015
Length of second true molar	.016
Width of third (transverse) molar	
Length of five anterior inferior molars	.054

This species is intermediate in size between the *O. forcipata* and *O. morsitans.* The penultimate inferior molar differs from that of both these species in the much weaker development of the internal lateral tubercle and more obtuse anterior tubercle; in *O. forcipata* the blade is continued on the front of this tubercle.

Two specimens embracing five series of teeth have been examined by the writer; the measurements given are those of the smaller.

OXYÆNA MORSITANS, *sp. nov.*

The genus of flesh-eating mammals, described in 1872 under the name of *Stypolophus,* presents a type of dentition which is further illustrated by the present addition of new species much larger than any hitherto known to possess it. Those described are in the order of size: *S. insectivorus, S. pungens,* and *S. brevicalcaratus,* Cope. The present new species is twice the bulk of the last. It is represented by broken mandibles with molars and canines of two specimens, and part of the maxillary dentition of a third. The molar, which is typical of the genus, in its subtriangular basis supporting three elevated cusps, and a short heel, is evidently functionally the sectorial, whatever its homological relations may be. In the present instance, the inner posterior cusp is much reduced, while there is a small additional cusp on the front of the anterior near its basis. The trihedral outer posterior forms a cutting edge with the large outer anterior, which is produced forward. A posterior molar exhibits a corresponding tricuspidate portion, and a more elongate heel, with acute circumference. In a premolar, the posterior heel becomes trenchant and median. The canine is very stout and compressed at basis. The enamel in all the teeth is more or less rugose.

Measurements.

	M.
Length of base of crown of sectorial tooth	.014
Width of base of crown of sectorial tooth	.009
Elevation of principal cusps	.015
Elevation of inner posterior cusps	.007
Length of basis of posterior molar	.012
Width of basis of posterior molar	.007
Length of heel of posterior molar	.005
Elevation of principal cusps	.011
Elevation of anterior cusps	.006
Long diameter of canine at base	.018

The maxillary series belongs to a still larger animal. The sectorial presents the same form as that of the mandibular series, and is more robust in form than in existing *Carnivora.* The section of the middle crests is very convex on the inner side, so that the shear is oblique. The heel is small and low. The premolar preceding has a large, broad heel. In another premolar, the heel supports a median crest, while the anterior part of the crown is a slightly-compressed cone, with a small tubercle at the anterior base. Other specimens indicate that this species lacks the inferior incisor teeth.

OXYÆNA FORCIPATA, *sp. nov.*

Char. specif.—Mandibular rami robust and deep, with the symphysis short, and the chin contracted. The canine tooth forms a vertical oval in section. The first one-rooted premolar is a stout tooth; there is no anterior basal tubercle on the second and third premolars, but a distinct one on the first true molar. There is a small tubercle at the base of the anterior lobe of the last or second sectorial molar. This tooth is larger than the penultimate. The enamel of all the teeth is quite rugose, although they are well worn by use.

Corresponding characters are exhibited by four specimens of this species, one of which includes portions of the upper jaw. All the bones are particularly massive, and there is a high parietal crest, a fair indication of the size of the temporal muscles.

Additional specimens of the *Oxyæna morsitans,* Cope, show that it differs in the reduced size of the sectorial molars, and the very small first premolar, which is quite rudimental.

Measurements.

	M.
Length of inferior dental series	.103
Depth of ramus at last molar	.040
Depth of ramus at second premolar	.030
Diameter of canine tooth	.019
Length of premolar series	.035
Length of base of penultimate molar	.016
Length of base of last molar	.019
Width of base of last molar	.012
Elevation of crown of last molar	.019
Length of superior last molar	.020
Width of superior last molar	.013

This animal differs in specific characters from the Wyoming carnivores, already referred to, in the greater robustness of all its parts. From *Synoplotherium lanius*, it also differs in the regular increase backward in the size of the molars. In the Wyoming species the penultimate is largest in the lower jaw.

The fragments of the *Oxyæna forcipata* are as large as corresponding parts of the jaguar.

PACHYÆNA OSSIFRAGA, *gen. et sp. nov.*

Char. gen.—Established on a single superior molar tooth of a large carnivore, apparently allied to the group of flat-clawed *Carnivora.* It is either the last premolar or first true molar. It is characterized by the absence of the cutting edge seen in the allied genera, and its replacement by a conic tubercle.

The principal lobe is also a cone, and the inner one a perfect cone, a little less elevated than the principal one.

Char. specif.—Crown with well-developed anterior and posterior basal tubercles; no cinguli, either internal or external. Enamel slightly rugose.

Measurements.

	M.
Length of crown	.020
Width of crown	.018
Elevation of anterior basal tubercle	.006
Elevation of central cone	.011
Elevation of interior cone	.010

This is the largest carnivore yet observed in this formation, and of peculiar character; its structure indicating a diet not purely carnivorous.

PROTOTOMUS VIVERRINUS, *gen. et sp. nov.*

Char. gen.—Three true molars in the maxillary bone; premolars compressed, the last of the upper series triangular in form; each angle enlarged; the center of the crown with a compressed conic tubercle. First and second true molars triangular, with a tubercle at each angle, and two adjacent cones in the center. The tubercle of the posterior angle forms a slight sectional edge with the posterior of the central pair. Last (third molar) transverse, with a median cone. Supposed mandible with the posterior two molars tubercular; the anterior tubercles similar to the posterior.

This genus is evidently allied to the *Viverridæ*, differing from *Viverra*, so far as known, in the simple character of the last two inferior molars. From *Limnocyon* it differs, according to Professor Marsh's descriptions, in possessing three instead of two superior true molars, or, if we include with these the last premolar, as does Professor Marsh, four instead of three. According to Professor Marsh, the tubercular molars in his *Vulpavus* are generally similar to those of the existing genus *Canis*. *Prototomus* presents the number of superior molars seen in *Amphicyon*.

Char. specif.—The *P. viverrinus* is established on a considerable part of the cranium and skeleton of one individual in good preservation. The last upper premolar is triradiate, having concave and subequal sides. The first molar is as broad as long, and is triangular, presenting a right angle outward and forward.

The second molar is broader than long, and presents an acute tubercle on the anterior border between the inner and anterior median cones. There is a tubercle at the inner and outer extremities of the base of the last molar. No cingulum on the posterior or outer sides of the last premolar. External cones of the last two inferior molars subcrescentic in section; anterior inner obsolete; posterior inner prominent.

Measurements.

	M.
Length of last five molars	.0250
Length of true-molar series	.0135
Length of last premolar	.0060
Width of last premolar	.0050
Length of penultimate molar	.0050
Width of penultimate molar	.0068
Width of last molar	.0047
Length of last two inferior molars	.0090

About the size of the domestic cat.

PROTOTOMUS INSIDIOSUS, *sp. nov.*

Represented in the collections of the survey by parts of the maxillary bone and both mandibular rami with teeth. The species is much less than the preceding, and differs materially in the forms of the teeth. The two anterior tubercles of the tubercular molars are similar and approximated; the posterior slightly divergent, and on the last tooth inclosing a third of small size. The last premolar has a broad heel and stout anterior cone, but no anterior tubercle. The tooth immediately preceding is much smaller, and also possesses a heel. The mandibular ramus is particularly slender, and the angle is not inflected.

Measurements.

	M.
Length of last two inferior molars	.0060
Length of last molar	.0034
Width of last inferior molar	.0020
Depth of ramus at last inferior molar	.0045
Length of last premolar	.0030
Elevation of last premolar	.0028

PROTOTOMUS JARROVII, *sp. nov.*

This *Carnivore* is of considerably larger proportions than either of the preceding. It is readily recognized as pertaining to the same genus by the identical form of the last two inferior molars, which are quite different from the corresponding ones in *Oxyæna* and other genera. These indeed, with the portion of the mandibular ramus which supports them, are the only well-preserved remains of this animal as yet in our possession. They indicate an animal of the size of the gray fox. In the last molar, the inner anterior tubercle is double, though low and obtuse. It differs from that in the species last enumerated in the presence of only two tubercles on the posterior portion of the crown instead of three, one being terminal and the other on the middle of the outer side. There are but two on the posterior end of the penultimate tooth, and all are low and unconnected excepting by the distinct rim of the crown. The center of the crown is thus concave. The rim is interrupted by notches between the tubercles on the outer side. No cingulum on inner, a weak one on outer side. Enamel smooth.

The form of the molars is rather stout, and the ramus is thick and not deep, and with broad, simple, lower border below the molars.

Measurements.

	M.
Length of last lower molar	.0070
Width { anteriorly	.0045
Width { posteriorly	.0020
Width of penultimate behind	.0050
Elevation of anterior cusp of last	.0030
Depth of ramus at last molar	.0140

This species is dedicated to my friend Henry C. Yarrow, M. D., to whom was committed the charge of that party of the survey to which I was attached, and to whose zeal in the cause of the natural sciences the success of the special expedition is largely due.

LIMNOCYON PROTENUS, *sp. nov.*

A civet-like Carnivore represented by one entire and a portion of the other mandibular ramus, with teeth well preserved, agrees in generic characters with the species referred by Professor Marsh to his genus *Limnocyon*, but differs from them all in its superior size. The molars are $\frac{4}{3}$, but the first molar is like the premolars of the *Canidæ*, except in a slight widening of its posterior basis by the development of a broad cingulum on the inner side and round the basal lobe behind. From this point it extends forward on the outer side to the beginning of the anterior basal lobe, and there ceases. The second molar has the anterior portion elevated, supporting three cusps and a large heel, with lateral and sub-median cutting edges. The last molar is smaller, elongate, oval, and two-rooted, with marginal posterior, intermarginal external, and two anterior tubercles, of which the inner is bifid. The ramus is slender, and the symphysis elongate. The angle is not incurved. First premolars one-rooted.

Measurements.

	M.
Length of dental series	.0680
Length of four premolars	.0340
Length of first molar	.0105
Length of second molar	.0100
Width of second molar	.0055
Length of third molar	.0080
Width of third molar in front	.0040
Depth of ramus at third premolar	.0130
Depth of ramus at last molar	.0150

ALLIGATOR CHAMENSIS, *sp. nov.*

Represented by portions of the mandibular arch of a small crocodilian resembling in some respects the *A. heterodon* of the Wyoming beds. The posterior teeth have the same short, expanded, sessile, bean-shaped crowns, with a median longitudinal ridge, and more delicate lines radiating close together from it to the border of the crown. The anterior teeth differ in being cylindric instead of compressed. There is a large canine preceded and followed by teeth of much smaller size.

Measurements.

	M.
Length of symphysis	.019
Length of alveoli of six teeth from symphysis	.022
Width of ramus just behind symphysis	.010
Long diameter of posterior tooth	.005

The specimens selected as type is one of the smallest. The surface of the bones is roughened with pits.

PLASTOMENUS LACHRYMALIS, *sp. nov.*

The largest species of the genus, and abundantly represented in the Eocene of New Mexico. The costal bones are rather finely punctate, the posterior as well as the anterior. The anterior costal bones are crossed by numerous ridges from side to side obliquely; the obliquity increasing posteriorly. On the posterior bones, they are broken into vertical bars, separated by considerable intervals, and of linear form. The posterior costals reach a thickness of $0^{m}.006$ and a width of $0^{m}.025$.

The pitting of the posterior part of the carapace distinguishes this species from the *P. œdemius.*

PART II.

In addition to the investigations pursued in the regions already indicated, and of which some of the new species have been described, it may be stated that a careful examination was made of the extensive lacustrine deposits in the valley of the Rio Grande.

These deposits are supposed to commence to the northward of Taos, N. Mex., and continue to an unknown distance southward, certainly at least fifty miles beyond Santa Fé, and occupy that portion of the valley between the Rocky Mountains in the east and the Jemez range in the west, and have been stated as late Tertiary, but without special determination or co-ordination with the other known lacustrine formations of this continent.*

Abundant material having been obtained by the party, it is easy to determine the fauna, whose remains are entombed in it, to be a part of that already described by Dr. Leidy and the writer as occurring in Dakota and Colorado under the name of Pliocene. This conclusion is indicated by the presence of the genera *Hippotherium*, *Protohippus*, *Procamelus*, *Cosoryx*, and *Merychippus*, and known Pliocene species of other genera, among which may be mentioned *Canis*, *Aceratherium*, &c. In addition to species already known, a number new to science were obtained, of some of which descriptions are here given.

MARTES NAMBIANUS, *sp. nov.*

Represented by a mandibular ramus, which supports three teeth. The anterior blade of the sectorial is rather obtuse.

* The new species described from the valley of the Rio Grande were discovered from August 20 to September 1, 1874.

The first premolar is one-rooted; the second and third are without posterior coronal lobes, but exhibit small basal lobes, both anterior and posterior. The anterior of the second is rather elevated, and the entire crown is directed obliquely forward. Canine compressed; mental foramina below the second and third premolars.

Measurements.

	M.
Length of three premolars	.006
Elevation of anterior lobe of sectorial	.002
Depth of ramus at anterior lobe of sectorial	.003

This species is of smaller size than the *M. mustelinus*, Cope, and the sectorial tooth less elevated and trenchant.

COSORYX RAMOSUS, *sp. nov.*

Char. gen.—Inferior molars prismatic, $\frac{3}{3}$; the premolars all sectorial, last with short branch-crests. Molars with basal intercolumnar tubercles. Horns superciliary, solid, branched. This genus was indicated by Dr. Leidy from a horn of the species known to him, the *Cosoryx furcatus*, from the Pliocene beds of the Niobrara. The same or a similar species has left abundant remains in the Santa Fé marls, and, in connection with the more numerous *C. ramosus*, has enabled me to determine the dental and other characters of the genus. After a careful examination of the horns of these species in my possession, those of eighteen individuals (at least I find that of ten where the basal portion is preserved) the beam has been broken off and reunited by anchylosis in six. In most of these the spot is marked by a ring of exostosed tuberosities, like those constituting the burr of the deer's horn. On a specimen of this character, pertaining to a third species, Professor Leidy based his *Cervus warrenii*, which may now be called *Cosoryx warrenii*. It is abundant in the Santa Fé marls.

The fracture has taken place in every instance at a point as far above the frontal bone as the burr of deer is situated, and is irregular in outline, higher on the one side than the other. In some of the specimens the smaller antlers are also broken, and exhibit a similar burr, but the terminal portion is usually lost. In one specimen, a broken antler is anchylosed in the usual manner of overlapping ends. The horns are solid, the center having a narrow, spongy axis. The surface is dense and marked by arterial grooves, but not pierced by noticeable foramina.

It is evidently a question whether this genus should be referred to the hollow or solid-horned *Ruminantia*; to the *Bovidæ*, or *Cervidæ*. The horns might be regarded as those of deer were it not for the occasional specimens without burr, while the teeth are both cervine and bovine. We may here draw such inferences as we can respecting the nature of the covering of the horn. That the fractured beam should not be lost indicates the presence of some kind of covering to retain it. That this covering was not horny is probable from the fact that the horns are branched, a structure impossible to the *Bovidæ*, since antlers effectually prevent the usual mode of increase of horn by additions at the base and removal at the extremity. That such covering protected arteries, which aided in the production of burrs, is also probable. We may thus believe it to have been dermal like that of the giraffe, or the *Antilocapra*, at the period of immaturity of its horny sheath.

It may be concluded, then, that the genus *Cosoryx* represents the ancestral type of the *Cervidæ*, and explains the origin of the remarkable type of horns of that family as follows: Ruminants with fixed horns of structure more dense and brittle than others of the same type, in their annual combats at the rutting-season, very frequently broke the beams off not far above the base. The usual location of nutrition followed, which, being annually repeated, became as periodical in its return as the activity of nutrition of the reproductive system. This activity ceasing, the horn, being dense, lost its vitality, the more so as the normal covering would have already perished in its distal portions. The natural consequence, the separation of the dead from the living bone by suppuration, would follow. This process would, however, probably require a longer time for the establishment of its periodical return than the fracture and attachment of the existing horn.

This appears to be the only explanation of the origin of the phenomena exhibited by the horns of the *Cervidæ*, and is suggested by the specimens of *Cosoryx* to be described.

Char. specif.—This species is larger than the *C. furcatus*, Leidy, and differs from the *C. warrenii* in possessing two antlers instead of one, of which the first is given off at a point much farther from the base than in that species.

The beam near the base is curved a little inward, and is semicircular in section, the outer face being slightly concave, the inner very convex. The base is situated a short distance within the free superciliary border. The beam becomes more cylindric, and then, expanding in a fore and aft direction, gives off an antler at right angles nearly parallel to the cranial axis. At a distance little over half the elevation of the first antler, the beam gives off a second in a plane tranverse to the axis of the skull. The terminal portion of the beam is cylindric, curved, and acute at the apex.

Mandibles, with teeth of two species of this genus, were found, the smaller of which occurring with the other portions of *C. furcatus*, belong to it. The larger differs in the elevation of the intercrescentic column of the first molar, which is worn into a loop at ordinary maturity; this may, however, be but an individual variation. The diastema is long and the ramus of that point quite slender.

Measurements.

	M.
Long diameter of base, No. 1	.016
Long diameter of base, No. 2	.020
Elevation of first antler from base, No. 1	.080
Elevation of second antler from first, No. 3	.042
Length of terminal part of beam, No. 4	.095
Length of molars 2–5, No. 5	.037
Length of molars 4–5, No. 5	.022
Length of fifth molar	.012
Width of fifth molar	006

COSORYX TERES, *sp. nov.*

Established on the connected frontal bones, supporting the horns of one specimen, and represented by portions of horns of two others. The former individual is larger than any one belonging to the other species, and the species is doubtless the largest of the genus. The horns stand above the posterior part of the orbit, which excavates its base, and presenting a considerable face, descending into the temporal or zygomatic fossa. There is no free superciliary rim outside of the base as in *C. ramosus*, Cope. The section of the beam near the base is a regular oval; the long axis directed longitudinally and a little outward in front. The beam is erect, with a slight curvature outward at the inner base only. So far as preserved, it does not branch, but may do so in its distal portion, which is lost. The tissue is more spongy interiorly than in the other species; supraorbital foramen far within the superciliary border.

Measurements.

	M.
Outer width between bases of horn-cores	.112
Inner width between bases of horn-cores	.055
Width of temporal fossa behind horns	.053
Long diameter of horn-core	.028
Short diameter of horn-core	.021
Length of part preserved	.033

This species was as large as the *Antilocapra americana* of the plains.

HESPEROMYS LOXODON, *sp. nov.*

An entire mandibular ramus, with all the teeth preserved, was found in the same deposits as the preceding species. Molars subequal, short-crowned; triturating surface sigmoid. The apices of the sigma on the inner side tubercular, and anterior to the outer apices. First molar with an additional transverse crest in front. Incisor compressed; outer angle of enamel face rounded smooth. Molar series oblique, rising anteriorly.

Measurements.

	M.
Length of molar series	.0050
Length of first molar	.0018
Depth below last molar, (inner side)	.0030
Depth below first molar	.0045
Depth of incisor	.0015
Depth at diastema	.0027

PANOLAX SANCTÆFIDEI, *gen. et sp. nov.*

Char. gen.—Molars prismatic, transverse, except the first and last; each divided by a plate of enamel extending transversely from the inner side. Anterior molar longitudinal; posterior molar composed of two columns.

This genus is represented by numerous teeth and portions of the cranium. It evidently belonged to the *Leporidæ*, and is allowed to both *Lepus* and *Palæolagus*. As the teeth are mostly separate, it is not easy to determine which is the posterior and which the anterior molar. Judging by the analogy of the known species, the determination as here made is correct; should the relations be reversed, the species will be referred to *Palæolagus*.

Char. specif.—The teeth are curved, the convexity inward. Inner face grooved, the groove occupied by cementum, the outer border compressed either without or with very shallow groove. First molar with triturating surface twice as long as wide, with an entering loop of enamel on the inner side anteriorly narrower. Last molar as wide antero-posteriorly as transversely, the shaft curved backward, the posterior column sub-cylindric half the diameter of the anterior.

Measurements.

		Inch.
Diameter of middle molar	antero-posterior	.093
	transverse	.187
Diameter of first molar	antero-posterior	.140
	transverse	.062
Diameter of last molar	antero-posterior	.100
	transverse	.065
Length of crown of last molar		.250

This species is about the size of the northern hare.

CATHARTES UMBROSUS, *sp. nov.*

Represented by numerous portions of nearly all parts of the skeleton, in excellent preservation. The beak from the frontal bone to near the apex is preserved; it displays the depression just anterior to the nares, which marks the anterior boundary of the cere. The culmen is nearly horizontal to just beyond this mark, and then exhibits a gradual decurvature to the apex. The beak is strongly compressed, and the tomia strongly decurved, forming an open festoon, whose middle point marks one-fourth the length of the beak from the nares. The latter are directed obliquely downward and forward, narrowing anteriorly and having a prominent inferior bounding ledge.

The mandible is weak, the symphisis-marking on half the length of the beak from the anterior angle of the nares.

The bones of the anterior extremities exhibit large and powerful proportions, as compared with the posterior, appropriately to capacity for sustained flight. The head of the humerus is much compressed, and the articular face is nearly divided into two by the deep bicipital groove. The head of the femur is small, and the rotular face a wide and deep groove.

The tibia is slender, the shaft much compressed, with a prominent ridge. The cnemial crest is short, and not produced downward on the shaft. The distal posterior bridge is narrow and oblique. The tarso-metatarsus has a strong exterior crest, which constitutes half the width of the shaft.

Measurements.

	Inch.
Length of beak from base of culmen, (axial)	1.90
Length of beak from cere to apex, (axial)	1.20
Depth of beak at culmen	.87
Depth of premaxillary at festoon	.75
Length of symphysis	.69
Length of nares	.37
Width of palate at festoon	.50
Width of head of humerus	1.37
Width of condyles	1.13
Width of distal end of femur	.94
Width of head of tibia	.81
Width of condyles of tibia	.66
Width of condyles of tarso-metatarsus	.75
Length of a first phalanx	1.12
Length of seven sacral vertebræ	1.87
Length of two dorsal vertebræ	1.12
Depth of a dorsal vertebra, (total)	.93
Depth of a dorsal vertebra to roof of arch	.44
Depth of centrum of roof of arch	.25
Width of centrum of roof of arch	.32
Length of two cervical vertebræ	1.12
Depth of two cervical vertebræ to apex of neural spine	.44
Depth of articular face of centrum	.17
Width of articular face of centrum	.25

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