REPORT OF THE SUPERINTENDENT

OF THE

COAST AND GEODETIC SURVEY

SHOWING

THE PROGRESS OF THE WORK

FROM

JULY 1, 1901, TO JUNE 30, 1902

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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LETTER

FROM

THE SECRETARY OF THE TREASURY

TRANSMITTING

The Report of the Superintendent of the United States Coast and Geodetic Survey.

TREASURY DEPARTMENT, OFFICE OF THE SECRETARY,
Washington, D. C., December 6, 1902.

SIR: In compliance with the requirements of section 4690, Revised Statutes, I have the honor to transmit herewith, for the information of Congress, a Report transmitted to this Department by Mr. O. H. Tittmann, Superintendent of the Coast and Geodetic Survey, showing the progress made in that work during the fiscal year ended June 30, 1902. It is accompanied by maps illustrating the general advance in the operations of the Survey up to that date.

Respectfully,

L. M. SHAW, *Secretary.*

The PRESIDENT PRO TEMPORE OF THE SENATE.

LETTER

FROM THE

SUPERINTENDENT OF THE UNITED STATES COAST AND GEODETIC SURVEY

SUBMITTING THE

Annual Report for the fiscal year ended June 30, 1902.

UNITED STATES COAST AND GEODETIC SURVEY,
Washington, D. C., December 6, 1902.

SIR: In conformity with law and with the regulations of the Treasury Department, I have the honor to submit herewith, for transmission to Congress, the Annual Report of progress in the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902. It is accompanied by maps illustrating the general advance in the field work of the Survey up to that date.

Respectfully,

O. H. TITTMANN,
Superintendent.

The Honorable the SECRETARY OF THE TREASURY.

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O. H. TITTMANN, *Superintendent.*
FRANK WALLEY PERKINS, *Assistant Superintendent.*

OFFICE OF THE SUPERINTENDENT.

D. B. Wainwright, *Assistant,* Oct. 25 to Jan. 31.
W. B. Chilton, *Clerk.*
H. M. Fitch, *Confidential Clerk.*

THE WORK OF THE YEAR.

Full details of the work of the year are given in the following pages, and they will show that gratifying progress was made in all directions in work devolved on the Survey. This is true of the work along new lines, as well as of the resurveys which are made necessary by the constant changes of the coast line and of the depths in rivers, harbors, and ocean bars, the increase in the draft of ships, and by the addition of new features continually added by commercial and other developments. Through the cooperation of the Chief of Engineers, U. S. Army, this Survey is enabled to make full use of the valuable information obtained of changes occurring in waters which are being improved by the Engineer Corps.

It is the policy of this Bureau to utilize to the fullest extent possible all available sources of information, and thus to avoid duplication of work.

Especial attention is called to the great progress made in the Philippine Islands under the able direction of Assistant George R. Putnam.

The regions in which work was done are briefly recapitulated as follows:

Astronomic determinations were made in Alaska, Massachusetts, on the Northwest Boundary, in Ohio, the Philippine Islands, and Wisconsin.

Base lines were measured in Alaska and the Philippine Islands.

Coast Pilot work was done in California, Maine, Maryland, Oregon, Philippine Islands, Virginia, and Washington.

Hydrographic work was done in Alaska, California, Florida, Georgia, Massachusetts, Maryland, New Jersey, New York, Oregon, Philippine Islands, Porto Rico, South Carolina, Virginia, and Washington.

Leveling work was done in Alabama, Indian Territory, Mississippi, Nebraska, New York, Oklahoma Territory, Texas, and Wyoming.

Magnetic Observations were made in Alaska, District of Columbia, Georgia, Hawaii, Kansas, Kentucky, Maryland, New Mexico, on the Northwest Boundary, in

Oklahoma Territory, Pennsylvania, Philippine Islands, Porto Rico, South Carolina, Texas, and Virginia.

Reconnaissance work in Alaska, Georgia, Kansas, Maryland, New York, Ohio, Oregon, Philippine Islands, Porto Rico, South Carolina, Virginia, Washington, and Wisconsin.

Tide Observations were made in California, District of Columbia, Florida, Hawaii, New York, Philippine Islands, and Washington.

Topographic work was done in Alaska, District of Columbia, Florida, Georgia, Maryland, New Hampshire, New Jersey, New York, Oregon, Philippine Islands, Porto Rico, Virginia, and Washington.

Triangulation was done in Alaska, Florida, Georgia, Indian Territory, Kansas, Maryland, Nebraska, New Jersey, New York, Oklahoma Territory, Ohio, Oregon, Philippine Islands, Porto Rico, South Carolina, South Dakota, Texas, Virginia, Washington, and Wisconsin.

In March two observing parties and a signal-building party were organized for work under one chief on the triangulation along the ninety-eighth meridian, and the work proceeded with unequaled speed and economy, compared with the primary triangulation previously executed. Twenty-eight stations were occupied before the close of the fiscal year. Details concerning this work and the instructions under which the observations were made can be found in Appendix 1 to this Report.

APPLICATION OF WIRELESS TELEGRAPHY.

The development of wireless telegraph systems during the year rendered it important that experiments should be made to determine whether it was practicable to use the wireless telegraph for the purpose of exchanging time signals in the longitude work of the Survey.

The importance of a successful wireless telegraph system to a chart-making organization like the Coast and Geodetic Survey can be understood when it is remembered that the method of determining longitude by lunar distances is unsatisfactory from the standpoint of accuracy and that by the chronometric method the cost of a longitude determination increases with the increased cost of travel between stations, and its accuracy decreases as the time required to make a round trip increases. It has been customary in Alaska to obtain the results from seven round trips of a steamer for the determination of the difference of longitude between important stations.

The errors pertaining to the two preceding methods are either abolished or reduced to a minimum by the telegraphic method. It meets all modern requirements for accuracy and is comparatively inexpensive. Unfortunately for the accurate and rapid construction of charts, telegraph lines and cables do not penetrate everywhere. Alaska is largely devoid of telegraph facilities, and yet a large fleet of vessels now annually traverses its coasts en route to the gold fields, and the charts by which they are navigated have depended for longitude on the older, slower, and less exact methods.

In view of these conditions, when Marconi's system of wireless telegraphy was made public, it was almost immediately realized that here was an opportunity for expanding the American method, and that it promised the means for rapidly extending exact determinations to the remote points of our maritime possessions.

Experimental work in the laboratory was at once taken up, more however for the idea of obtaining familiarity with the apparatus and its manipulation than with the expectation of making actual use of it in the field, since it had not reached that stage of development which would permit of having stations far enough apart to make its adoption an economical success.

It may be stated here that the requirements to be met by the system for longitude work are far less than those for commercial or military purposes. Interference from the apparatus is not likely, as its use will be confined to unsettled regions. The speed with which messages can be sent or received or whether multiplex apparatus can be used, is of no moment from our standpoint. Granting that with a suitable distance between two astronomic stations a few messages can be interchanged consisting of inquiries and replies as to the progress of the astronomic work, and also the interchange of a few sets of arbitrary signals, each set only occupying a minute's time, and the necessary conditions are fulfilled.

In October, 1901, the experiments were given a wider scope. Through the courtesy of the New York Herald the facilities afforded by the Herald's wireless telegraph station on Nantucket Island were utilized.

The station is situated on the southeast end of the island, and is provided with a set of Marconi instruments. Forty-eight miles distant in a southerly direction is the anchorage of the Nantucket Shoal light-ship, which is also provided with a Marconi apparatus.

The experiments at the shore station consisted in simulating the essential conditions of a field telegraph station and obtaining a record of the customary time signals.

Covering the period of the experimental work on Nantucket Island, time observations were made with a sextant and artificial horizon, and the data obtained for computing a difference of longitude which, though rough, is probably the first determination by wireless telegraph.

In June additional tests of the Marconi wireless telegraph apparatus were made, the tests being made possible by the liberality of the Marconi Wireless Telegraph Company of America, which furnished an operator and apparatus for the cost of its installation on board the Survey schooner *Eagre*. The tests were made between the Marconi wireless telegraph station at Sagaponack on the eastern end of Long Island, New York, and the *Eagre* at various distances. The *Eagre* established easy communication with the shore station and then proceeded away from it to determine how far this particular form of apparatus was available for sending such signals as are used in longitude work. The experiments were in progress at the close of the fiscal year.

INTERNATIONAL LATITUDE SERVICE.

Satisfactory results were obtained at the astronomical observatories under the direction of the Survey at the expense of the International Geodetic Association at Gaithersburg, Md., and Ukiah, Cal., for the purpose of determining the variations of latitude.

SPECIAL DUTY.

One officer continued to serve as a member of the Mississippi River Commission and another continued on duty retracing and remarking Mason and Dixon's Line, under an assignment requested by the States of Maryland and Pennsylvania. Two officers continued to serve as members of a commission appointed by the United States Supreme Court to retrace and mark the boundary line between the States of Tennessee and Virginia. Other officers represented the Survey in charge of the exhibit at the Pan-American Exposition at Buffalo, N. Y., and at the West Indian Exposition at Charleston, S. C. The speed-trial course in Delaware Bay was re-marked and the length of the Cape Cod speed-trial course was verified at the request and at the expense of the ship builders for whom they were established. A special anchorage survey was made off the mouth of the Withlacooche River for the Dunnellon Phosphate Company at the expense of the company.

Details in regard to the field work of the year can be found in Appendix No. 1 to this Report.

The appropriations for the United States Coast and Geodetic Survey on account of the fiscal year of 1902 amounted to $832 845. Of this amount the sum of $210 245 was for the pay of officers and men to man and equip the vessels of the Survey, and $54 600 for the repairs and maintenance of the vessels. The sum of $34 500 was for Office expenses, including the installation of a new electrotyping plant. The remainder of the appropriation was about equally divided between expenses of parties in the field and salaries of the field and Office forces.

The statement of expenditures during the year is given on pp. 26–51.

I. OFFICE OF ASSISTANT IN CHARGE.

ANDREW BRAID, *Assistant in Charge.*

The usual work in the Office was continued. The work of reducing the geographic positions in southeast Alaska from the head of Lynn Canal to Port Simpson, begun in the previous year, was completed.

The computation of the primary triangulation along the ninety-eighth meridian, from the thirty-ninth parallel northward to the Page Base in Nebraska, was completed.

The work of reducing the triangulation by the U. S. Lake Survey from western New York to the Olney Base in Illinois and along the Great Lakes and the St. Lawrence River to conformity with the triangulation by the Coast and Geodetic Survey already computed upon the United States Standard Datum, was completed.

Four appendixes, on the measurement of base lines along the ninety-eighth meridian, on the extension of tables for the computation of geodetic positions to the equator, on the determination of the relative values of gravity in Europe and in the United States, and on the results of the triangulation northward along the ninety-eighth meridian, were prepared for the Annual Report for 1901. A new chart showing the lines of equal magnetic declination and equal annual change was completed.

The United States Declination Tables and Isogonic Charts for 1902 was prepared for publication.

The volume of Tide Tables for 1903 was prepared for publication. The drawings for 20 new charts were completed. Three original copperplates for new charts were completed. Nine hundred and fifty-nine plates were corrected for printing and 68 963 impressions were made from the copperplates.

Editions of 32 new charts, 31 printed by photolithography and 1 from copperplate, were issued. Forty-eight new editions of charts, 34 printed from copperplate and 14 by photolithography, were also issued.

The total issue of charts for all purposes was 74 143. The usual monthly Notices to Mariners were prepared, published, and issued. Additional details of the work in the Office can be found in Appendix No. 2 to this Report.

II. OFFICE OF INSPECTOR OF HYDROGRAPHY AND TOPOGRAPHY.

H. G. OGDEN, *Inspector of Hydrography and Topography.*

A.—INSPECTION.

Personnel.

Name.	Occupation.
D. B. Wainwright	Assistant, Feb. 10 to June 30.
J. H. Roeth	Clerk.
R. D. Chase	Writer.

The records of the assignment of all officers to the vessels of the Survey, the enlistments and discharges of the men, and of all changes in rates of pay are kept in the Office of the Inspector of Hydrography and Topography, and he exercises personal supervision over the construction of vessels and the making of repairs, in addition to inspecting the work of the parties at work in the field whenever necessary. Numerous short trips of inspection of construction and repairs were necessary during the year to various points on the Atlantic coast where such work was in progress.

The pay rolls of the enlisted men on the ships were examined and certified as to the time of enlistment and the rate of pay, and other routine work of the Office was kept up to date.

The general work of the Coast Pilot party in the field and Office also falls under his direction. During the year the progress made in revising the Coast Pilot publications has been most satisfactory, and it is believed that within another year this important work will have fully recovered from the interruptions occasioned by the withdrawal of the naval officers at the outbreak of the Spanish war.

The following general statement concerning the vessels and the hydrographic and topographic work of the year is taken from the report of the Inspector. No work in the Philippine Islands, except the work of the *Pathfinder*, is included in this statement:

THE VESSELS AND THEIR HYDROGRAPHIC WORK.

THE STEAMER BACHE.

On July 1, 1901, this vessel was at the shipyard of the Townsend & Downey Shipbuilding Company, Shooters Island, New York Harbor, where she had been sent in December, 1900, to be rebuilt.

The company built a new hull of composite construction for this ship on designs drawn under the supervision of the Inspector by Mr. L. B. Friendt, of Baltimore, Md. A new boiler was also supplied, but the machinery and equipments from the old ship were transferred into the new hull.

The new hull was launched on September 21 and the vessel was accepted from the contractors on January 18 and left the yard on February 28, under the command of Assistant P. A. Welker, who had joined the ship on December 18 to take charge of the outfitting of the vessel preparatory to her sea trial trip.

She sailed from New York on March 3 and arrived in Baltimore a few days later. Some minor alterations were made to the machinery while in Baltimore, and on April 14 she sailed for the Gulf of Mexico to conduct a hydrographic examination of the west pass of Appalachicola Bay and the entrance to St. Andrews Sound. Great changes had been reported at both of these localities, and sufficient work was secured to correct the charts for the purposes of navigation.

The vessel returned to Baltimore on June 19 and was at that port at the close of the year.

THE STEAMER BLAKE.

On July 1 this vessel was at Baltimore refitting for work on the New England coast, having but recently returned from Porto Rico. She sailed for Hyannisport, Mass., on July 14, under the temporary command of Assistant O. B. French, to make hydrographic examinations required by the Navy Department in connection with the maneuvers of the fleet in that locality. Her first work was the development of the Cross Rip Channel, south of the Horse Shoe, which was completed by the time that the fleet reached there.

Assistant P. A. Welker relieved Assistant French of the command of the vessel on August 10 and subsequently made a hydrographic survey of the eastern entrance to the Sound, passing Great Point. This survey, compared with the work of 1895, shows that no material change has taken place.

It is pleasing to note that on the conclusion of the maneuvers of the fleet a complimentary letter was transmitted to the Office by Admiral Higginson, referring to the assistance rendered him by the *Blake* during the season.

On the conclusion of her work in Nantucket Sound the *Blake* started on her return to Baltimore, but stopped on the way to make examinations of reported dangers at Quicks Hole and Robinsons Hole, and also dangers at the eastern entrance of Long Island Sound and localities along the north shore of the Sound.

She arrived at Baltimore on September 30 and was immediately put under repairs to strengthen her hull for the winter's cruise in Porto Rico.

On December 14 Assistant R. L. Faris relieved Assistant Welker of the command of the ship, and on December 21 she sailed for San Juan, P. R. She left San Juan on June 3 and arrived at Baltimore on the 10th, and remained there until the close of the fiscal year.

Her work in Porto Rican waters comprised the development of the southeast end of the island from Point Figuras to Ensenada Honda, the limit of the work of the schooner *Eagre* during the preceding winter. She extended her work eastward and northward in Vieques Sound to the vicinity of Port Mulas. Later in the season, on the west coast of the island, a thorough hydrographic survey was made of Mayaguez Harbor.

The hydrography of the east coast of the island has now been plotted and shows a passage around this end of the island of 5 fathoms in the channel along the shore. By passing to the westward of Palominos and Outer Piraguas Rock, thence northward of the Mosquito Shoals and Arenas Point Sands, on the western end of Vieques Island, a practicable channel can be buoyed with a least depth of 6 fathoms.

A number of new ledges with a depth of less than 3 fathoms were discovered between Vieques Island and the main island approaching from the southward, and some shoaler soundings were obtained in the development of localities where the soundings indicated shoals or dangers in the work of the schooner *Eagre* of the previous year.

THE SCHOONER EAGRE.

This ship sailed from Baltimore on July 1, Assistant J. B. Boutelle commanding, arriving at Shooters Island on the 7th, where she was engaged in completing a hydrographic survey of the Kill von Kull in that vicinity.

On August 9 she moved to Peekskill to continue a revision of the work in that locality. On October 25 she closed work on the Hudson River and reported at the Erie Basin, Brooklyn, where she was refitted with a new set of rigging that had been ordered earlier in the season.

While in the basin the party determined the positions of several of the beacons in the lower harbor, and an examination was made to determine the extreme end of Sandy Hook, which had been reported as having been greatly extended.

On January 18 she sailed for Oxford, Md., and took up the hydrographic survey of the Choptank River.

On June 17 she sailed again for New York to take part in the experiments to test the applicability of the Marconi system of wireless telegraphy in the transmission of time for telegraphic longitude work. These experiments were in progress at the close of the fiscal year.

THE STEAMER ENDEAVOR.

At the beginning of the year this vessel, Assistant F. A. Young commanding, was engaged in a hydrographic examination of the lower Chesapeake Bay. The great amount of work that would be required to thoroughly resurvey Chesapeake Bay led to the suggestion to run experimental lines in the main bay to determine if radical changes had taken place in the depths, necessitating a resurvey. A section of the bay between Thomas Point and the mouth of the Potomac River had been examined, with this end in view, two seasons before, and it proved so highly satisfactory in demonstrating that the greater depths of the bay had not suffered any material change that similar work was taken up on the lower bay as soon as the triangulation points had been furnished. The lines run are generally about three miles apart, both across and up and down the bay, and, when plotted in combination with the hydrographic sheets of the original survey, form an excellent check upon the old work. The result has been most gratifying, and clearly demonstrated that the deep-water channels represented by the original surveys have not changed in either location or depth.

Incidentally the comparison develops a number of interesting facts. Depressions or holes of slightly greater depth than the surrounding areas, and also lumps or isolated shoals, crossed by the new lines, have almost invariably been found the same as represented by the original work.

Many of the new lines have crossed the 3-fathom curve of the shoals extending out from the shore, showing that this curve wherever it has been checked has not changed.

The large erosions from the shores of the bay, which became apparent when the shore line was rerun, have cast a mass of material into the bay that might reasonably have been expected to have accumulated and perhaps formed into new shoals, but up to this time no discovery has been made of a locality in the lower bay where there has been a new deposit. In the bays and creeks some changes have been noted, but none of them of a material nature. Eastern Bay was resurveyed with a great deal of care, and the reduction represents the channels without substantial change and but slight changes on the shore.

This examination by the *Endeavor* was completed on December 19 and the ship returned to Baltimore to be overhauled. She was opened out and inspected by the United States local inspector, in company with the Inspector of Hydrography and Topography, with most gratifying results. Her frames were discovered to be in excellent condition, but it was deemed advisable to refasten her below the water line and then remetal her. On March 17 she sailed for the Kettle Bottoms, on the Potomac River, to make a thorough resurvey of that locality, but on April 5 this work was suspended and she was ordered to Barren Island to furnish facilities for Assistant D. B. Wainwright to reerect the water signals of the speed trial course, as had been requested by the Secretary of the Navy. This work was completed on the 21st, when the ship returned to her headquarters at Colonial Beach, Va. At the close of the year she was still engaged upon a survey of the Kettle Bottoms.

THE STEAMER HYDROGRAPHER.

This vessel was built by the James Reilly Repair and Supply Company of New York City, under plans furnished by this Office. She is a wooden vessel, has triple expansion engines and Roberts boiler. She registers 79 tons.

The ship was launched from the yard of James E. Bayles, at Port Jefferson, N. Y., on September 25 and left that port on October 2 for New York City, making a satisfactory trial trip on the way and developing a speed of 11 knots. Mr. John Ross, nautical expert, was assigned to command her. He completed her outfitting in New York, and she was accepted from the contractor on November 6, sailing for Chesapeake Bay the next day. She immediately entered upon a field revision of Part VI of the Atlantic Coast Pilot, covering Chesapeake Bay. This work was completed by January 15, when she arrived at Baltimore and was refitted for a cruise on the south Atlantic coast.

On January 17, 1902, Assistant F. F. Weld relieved Mr. Ross of the command of the ship, and on February 11 sailed for the South. During the season a hydrographic survey was made of the bar at Sapelo Sound, Georgia, and an examination of the main channel into St. Helena Sound. These surveys were completed by May 14, when she returned north and reported at Washington on May 20, and was immediately refitted for Coast Pilot work on the New England coast. Mr. Ross was again assigned to the command, and on June 2 she sailed from Washington for Eastport, Me., arriving there on the 25th, and immediately began a revision of Parts I and II of the Atlantic Coast Pilot, upon which work the ship was engaged at the close of the fiscal year.

THE SCHOONER MATCHLESS.

On July 1 this vessel, Assistant George L. Flower, commanding, was in Baltimore refitting, having but recently returned from a season's operations in Porto Rico. She sailed for Tangier Sound, on the lower Chesapeake Bay, on August 19, and was engaged in a general survey of the Sound, including triangulation, hydrography, and topography, until the close of the fiscal year.

THE STEAMER GEDNEY.

At the beginning of the fiscal year this ship was engaged in a survey of Icy Strait, Alaska, in conjunction with the steamer *Patterson*, including shore-line and hydrography. She closed field work on October 17, sailing for Seattle, Wash., and arrived there on November 1.

On December 5 Assistant J. F. Pratt relieved Assistant Dickins of the command of the ship, and on the 17th the ship was put out of commission.

She was delivered at the yard of Moran Brothers, Seattle, on the 28th of the following March for the installation of the new boiler that had been built for her during the winter.

She was put in commission again on the 1st of June and preparations were made for work in Alaska.

THE STEAMER M'ARTHUR.

This vessel, Assistant F. Westdahl, commanding, was on her working grounds in the vicinity of Sannak Islands, Alaska, at the beginning of the fiscal year, engaged upon triangulation, topography, and hydrography in conjunction with the steamer *Pathfinder*. She closed work on October 1 and sailed for Seattle, via Juneau, joining the *Patterson* and *Gedney* at the latter place, and thus enabling all three of the vessels to return to Seattle with one pilot.

On November 23 she arrived at Oakland, Cal., and was put out of commission on November 30.

The necessary repairs were made to the vessel during the winter, and on May 1 she was again put in commission. She sailed for her working grounds in Prince William Sound on May 30, arriving at Orca on June 30.

THE STEAMER PATTERSON.

On July 1 this ship, Assistant J. F. Pratt, commanding, was at work in Cross Sound and Icy Strait, S. E. Alaska, carrying forward the triangulation, topography, and hydrography. Work was completed for the season on October 10 and she sailed for Seattle, via Juneau, arriving at Seattle on October 31.

She was then laid up in ordinary, pending arrangements for extensive repairs, and was put out of commission on December 31.

The repairs under the contract with Moran Brothers Company, of Seattle, were commenced in March and completed before the close of the fiscal year. This ship had developed a structural weakness during her cruise to Bering Sea in the summer of 1900 that had rendered her unfit to return to these waters until she had been materially strengthened. The repairs consisted essentially of renewing the main deck waterways, covering board, and the main and spar decks with heavier material; also the installation of spar-deck shelving all around the ship and thwart ship bulkheads of iron plating. A new boiler that had been built for the ship during the previous summer was also installed and her engines thoroughly overhauled.

On May 26 the vessel was again put in commission and preparations were made for work in Alaska.

THE STEAMER PATHFINDER.

On July 1 this ship, Assistant J. J. Gilbert, commanding, was on her working grounds in the vicinity of Dutch Harbor, Alaska, where she was engaged in making a survey of the Fox Island Passes, including the triangulation, topography, and hydrography. The work of the season rectified many errors of position in the shore lines, and in conjunction with the work of the steamer *McArthur* afforded material for the publication of a new chart extending from Dutch Harbor to the Sannak Islands, of much greater accuracy than those heretofore published.

On October 7 she sailed from Dutch Harbor for Manila, P. I., via Yokohama and Nagasaki, arriving at Manila on November 18, and immediately began the work of correcting the charts of the Philippine Islands.

On April 12 she sailed from Manila to Amoy, China, for a general overhauling. While at this place an ice plant that had been sent from New York was installed in the ship, and also new motive power in the launches.

The ship returned to Manila on May 26, and on June 6 sailed for San Bernardino Straits to make a survey of that locality.

During the season in the Philippines the most important surveys made were at Romblon, Cebu, San Bernardino, and Ormoc.

THE STEAMER TAKU.

This vessel was assigned for the convenience of the party of Assistant Ritter, and was at work under his command on July 1 in Prince William Sound, Alaska. A gasoline launch was also employed by him under contract. He closed his field work in October and resumed operations in the spring of 1902, utilizing the *Taku* as before, and a steam launch that had been sent from San Francisco to take the place of the gasoline launch.

THE TOPOGRAPHIC WORK.

The principal topographic work executed during the year was on the eastern shore of Chesapeake Bay, completing the shore line southward to the Maryland-Virginia boundary line, to meet requisitions from the Geological Survey of the State of Maryland and the United States Geological Survey. Five parties were employed on this work during the summer, including the party on the schooner *Matchless*, and by the beginning of the cold weather all of the work requested had been completed. The work was continued during the winter by a party under Assistant Stehman Forney, filling in the margin of the topography to the same limit.

Assistant John Nelson completed the topographic survey in the vicinity of Portsmouth, N. H., and in the fall of the year proceeded to Porto Rico, where he continued the triangulation and topography on the north shore of the island from San Juan to San Juan Head, the extreme northeastern point.

The party on the *Blake* during the same time filled in the gap at the southeastern end of the island, thus completing the shore line of the whole group, with the exception of the islands in Mona Passage.

In Alaska, a large part of the shore line of Icy Strait and Cross Sound was obtained by the parties on the *Patterson* and *Gedney*, and Assistant Ritter extended his work of the previous year in Prince William Sound to cover Valdes Arm, the northern extremity of the Sound.

THE COAST PILOT WORK.

The preparation and revision of the Coast Pilot has continued during the year under the immediate supervision of Mr. John Ross, nautical expert. Field work was done in Chesapeake Bay with the steamer *Hydrographer*, as before mentioned, and an examination was made of the Pacific coast by Mr. Harry L. Ford, nautical expert, from San Diego, Cal., to and including Puget Sound. As there was no vessel available for the work north of San Francisco, Mr. Ford had to resort to such means of transportation as were locally available. This retarded the work very much, but nevertheless afforded a sufficient opportunity for a very careful scrutiny of the coast to ascertain the essential changes that had taken place.

The steamer *Hydrographer*, in charge of Mr. Ross, left Washington about the 1st of June for a field revision of the Coast Pilot volumes covering the New England coast, as far south as Narragansett Bay.

In conclusion the Inspector expresses his appreciation of the hearty cooperation that he received from the chiefs of the field parties in carrying out the details of the superintendent's directions.

He also calls special attention to the loyal assistance rendered him by the Coast Pilot party and the clerical force of his office.

B.—COAST PILOT PARTY.

Personnel.

Name.	Occupation.
John Ross	Nautical expert.
H. C. Graves	Do.
H. L. Ford	Do.
C. A. Thompson	Watch officer; July 12 to Aug. 5.
V. R. Lyle	Watch officer; July 29 to Aug. 10 and May 3 to May 10.
W. F. Glover	Watch officer; Aug. 15 to Oct. 23.
Talbot O. Pulizzi	Writer.

The copy for the fourth edition of United States Coast Pilot, Pacific Coast, Alaska, Part I, was sent to the printer on July 10.

The plans for the construction of the steamer *Hydrographer* were revised and estimates in detail were prepared for the equipment. The proof of the Alaska Coast Pilot was read and a Geographic Dictionary of Alaska, prepared by the United States Geological Survey, was examined and notes were made on discrepancies in spelling for the use of the United States Board on Geographic names.

United States Coast Pilot, Atlantic Coast, Part VI, Chesapeake Bay and Tributaries was revised from the notes made in the field and office, and on March 4 the copy for the second edition of this volume was sent to the printer.

A new edition of Bulletin No. 40, relating to Bering Sea and the Arctic coasts of Alaska was revised, brought up to date, and prepared for the printer.

The proof of these publications was read and ordered printed. The charts of the region covered by Bulletin No. 40 were compared with Geographic Dictionary of Alaska and corrected, so that in all new charts the spelling will be uniform.

The preparation of the fifth edition of the Pacific Coast Pilot, California, Oregon and Washington, was begun and about one-fourth completed before June 30.

The necessary material was collected and preparations were made for the revision of Parts I–II and III of the United States Coast Pilot Atlantic Coast. The routine work of the party in keeping a record of all changes, reported dangers to navigation, hydrographic examinations, and new information for use in the compilation, revision, and correction of Coast Pilot volumes, and the correction of these volumes to date of issue by the Office, required much time and constant attention.

A supplement to United States Coast Pilot, Part VII, Chesapeake Bay entrance to Key West, was prepared and sent to the printer.

The following officers were on field duty during the year, as stated:

John Ross, nautical expert, September 24 to January 17, May 27 to June 30.
H. C. Graves, nautical expert, October 30 to January 17, June 1 to June 30.
H. L. Ford, nautical expert, July 1 to March 9.
T. O. Pulizzi, writer, November 12 to January 17.

The account of the work performed by them while on duty in the field is given in Appendix 1 to this report.

III. OFFICE OF INSPECTOR OF GEODETIC WORK.

J. F. HAYFORD, *Inspector of Geodetic Work.*

The duties of the Inspector of Geodetic Work were performed at the Office in Washington, and only two trips to the field on inspection were necessary during the year.

The duties consisted in a careful examination of all correspondence with officers in the field on this subject and an examination of all records and computations of observations made in the field and transmitted to the Office.

On January 25 Assistant Hayford left Washington and proceeded to Clarks Hill, S. C., where the triangulation party under the direction of Assistant Fairfield was at work, for the purpose of testing the action of the acetylene signal lamps which had been prepared for use in making observations at night.

Four triangulation stations are visible from Clarks Hill, namely, McKnight, Bunce, Williams, and Lincoln Mountain, and the distance to these stations ranges between 12 and 30 miles.

The following is quoted from the report of Assistant Hayford:

On the 27th the first part of the evening was clear and three of the four signal lights showed, namely, at McKnight, Williams, and Lincoln Mountain. The light on Lincoln Mountain, distant about 30 miles, was visible to the unaided eye most of the time for three hours, after which time it disappeared, apparently shut out by rain. All three lights were splendid objects for telescopic pointings during the whole time they were visible. The manner in which the lights showed on this evening indicates that they are sufficiently powerful to be used as signal lights in triangulation, and that the accuracy of the pointing required is not so great as to require special skill in tending them. The three lights seen had all been posted by compass bearings only, and a study of the lights at close range indicates that it is not necessary to point it as accurately even as a heliotrope. The various tests which have been made by Assistant Fairfield's party as to steadiness and reliability of the light and the ease with which it may be kept in operation, and similar tests which had heretofore been made at the Office, indicate that the acetylene lights are fully satisfactory. I feel justified, therefore, in recommending that a sufficient number of these acetylene lights be made for use in the ninety-eighth meridian triangulation.

On March 25 Assistant Hayford again left Washington and proceeded to Bowie, Tex., for the purpose of inspecting the triangulation and leveling work in progress in the vicinity. In order to know accurately how the field work was being done, to test proposed plans and to illustrate them, he took part in the work of each chief of party visited, such as observing, computing, and instructing the light keepers.

The two triangulation parties, the signal-building party, and the leveling party were each visited at such times as would most conveniently serve the purpose in view.

The work of the triangulation parties was slow at first on account of lack of experience and other causes, but a more perfect organization was rapidly effected, and an unequaled output of work for the season was the result.

The following is quoted from the report of Assistant Hayford:

The leveling party under Aid W. H. Burger had completed 35 miles of leveling at the end of their first two weeks of observation. The party usually leaves the boarding house at about 7 a. m. and reaches it again at 5 p. m., and a full hour is taken for lunch in the middle of the day. The rapid progress indicated above is, therefore, not due to long hours of work.

With the form of precise level now in use it is necessary that the telescope should conform nearly to the condition that when the eye end is moved in or out to focus the telescope the motion of the middle horizontal line of the diaphragm shall be a straight line passing through the optical center of the objective. Theoretical considerations and shop tests had indicated that this condition was fulfilled with more than necessary accuracy. In order, however, to leave no doubt in regard to this matter, a special series of 30 readings were made on the forenoon of April 14, following a scheme especially devised to bring out the error due to the cause indicated above. The test was repeated in the afternoon of the same day. These sixty-rod readings, taken with the rods at distances of from 5 to 95 meters from the instrument, and furnishing 6 determinations of the relative heights of 10 points, agreed so closely after correction by the usual field method for curvature and refraction and for "C," the constant of the instrument, that it is impossible to prove from them that the motion of the eye end is not perfect. It is certain that the departure from perfection in this particular instrument in this respect is so slight that the errors introduced into the results by assuming "C" a constant, even if the difference between fore and back sight is allowed to be as great as 70 to 90 meters, is very small as compared with the accidental errors of observation. In the actual leveling no foresight is allowed to differ from the corresponding back sight by more than 10 meters, and errors from this cause are correspondingly small.

IV. OFFICE OF THE INSPECTOR OF MAGNETIC WORK.

L. A. BAUER, *Inspector of Magnetic Work.*

The work for the year consisted mainly in the duties incidental to the supervision of the work in the field, such as the preparation of the necessary directions and information for the use of the various field parties, the critical examination of the records of the observations made, and the preparation of summaries and reports of progress.

Personal inspection of the field work in Kansas and Texas was made between July 25 and August 8, and the work at the Cheltenham Observatory was inspected every month as occasion required. The inspector was at the Baldwin, Kans., Observatory from July 27 to August 1.

The cause of some erratic values obtained from observations made with magnetometer No. 3 was finally traced to the four brass screws which were used to attach the sides of the wooden suspension box. These were found to have magnetic properties which indicated that the brass of which they were made was not wholly free from particles of iron.

Special instructions were given to one of the magnetic observers temporarily attached to the observatory at Baldwin, and the inspector then proceeded to Texas and inspected the work of the parties in that State. The entire activity in the work in the field may be briefly summarized as follows:

The determination of the absolute value of the magnetic elements was made in 191 different localities embracing 201 stations, 21 of which were in localities previously occupied, distributed over 15 States and Territories, and in British Columbia, as shown in the following table:

Summary of magnetic survey work executed between July 1, 1901 and June 30, 1902.

State or Territory.	Number of localities.	Number of stations.	Old localities reoccupied.	Declinations observed.	Inclinations observed.	Intensities observed.
Alaska	27	27	4	27	5	5
British Columbia	7	7		7		
District of Columbia	1	1	1	5	5	5
Georgia	1	1		1	1	1
Hawaiian Islands	1	11	1	11	11	11
Kansas	2	2	1	2	2	2
Kentucky	6	6		6	6	6
Maryland	2	2	1	2	1	1
New Mexico	22	22		22	22	22
Oklahoma	1	1		1	1	1
Pennsylvania	20	20	2	20	20	20
Philippine Islands	5	5		5	1	
Porto Rico	3	3		3		
South Carolina	4	4	1	4	4	4
Texas	52	52	6	52	52	52
Virginia	37	37	4	37	34	34
Total	191	201	21	205	165	164

The two new magnetic observatories, one at Sitka, Alaska, and the other near Honolulu, H. I., were completed, and the observatory work, involving continuous registration of the magnetic variations and the determination of the absolute elements was inaugurated at Sitka on November 25, 1901, and at Honolulu Observatory on January 1, 1902. The expense involved in the construction of these observatories necessarily curtailed to some extent the extension of the magnetic survey of the country.

Continuous registration of the magnetic variations at the magnetic observatories situated at Cheltenham, Md., and Baldwin, Kans., was obtained throughout the year, and determinations of the absolute elements were made at intervals of one week.

The four magnetic observatories participated in the international work on the 1st and 15th of each month after January 1, 1902.

Magnetic occurrences of special interest and importance were recorded at the four observatories at various times, and especially in connection with the numerous earthquakes toward the end of the fiscal year, and the volcanic eruptions in the island of Martinique. A special study of these in connection with the observations made during the same period at foreign observatories, copies of which have been courteously furnished, will be made.

V. OFFICE OF THE DISBURSING AGENT.

SCOTT NESBIT, *Disbursing Agent.*

Personnel.

Name.	Occupation.
N. G. Henry	Confidential clerk and cashier.
Ida M. Peck	Typewriter and clerk.
Jennie H. Fitch	Clerk.
Louis C. Ritchie	Captain's clerk (temporarily detailed in connection with the accounts of vessels).

The disbursement of the funds of the Coast and Geodetic Survey is made not only by payments directly from the Disbursing Agent, but also largely through the medium of its Assistants and other officers when acting as chiefs of parties. These officers, on approval of the Superintendent, receive advances of public funds from the Disbursing Agent in lump sums, under authority of an Executive order dated March 26, 1886.

In conformity to this order there are now 56 officers of this Survey bonded in the sum of $2 000 or more each. When acting as chiefs of parties these officers receive from time to time such advances of public funds from the Disbursing Agent as are required to meet the necessary current expenses of the work in hand.

A ledger account is kept in the office of the Disbursing Agent with each chief of party receiving an advance, each one being charged with all advances made to him, and, on the other hand, receiving credit for all proper expenditures made by him when presented on regularly supported vouchers after such accounts have been audited in the office of the Disbursing Agent and found to be correct. All of these accounts, with their supporting vouchers, are then sent to the First Auditor of the Treasury for examination and audit by him.

This system has met the needs of this service, and results, in the main, in economy and good order in its expenditures.

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902.

[Prepared pursuant to the act approved March 3, 1853.]

SALARIES—PAY OF FIELD OFFICERS, 1902.

To whom paid.	Time employed.	Amount.
SUPERINTENDENT.		
Otto H. Tittmann	One year	$5 000.00
ASSISTANTS.		
Aug. F. Rodgers	One year	4 000.00
Frank Walley Perkins	.....do	3 613.01
Andrew Braid	.....do	3 200.00
A. T. Mosman	.....do	3 000.00
Herbert G. Ogden	.....do	3 000.00
Will Ward Duffield	.....do	3 000.00
John F. Hayford	.....do	3 000.00
W. D. Alexander	.....do	3 000.00
Erasmus D. Preston	.....do	1 875.00
Cephas H. Sinclair	.....do	2 500.00
William Eimbeck	.....do	2 499.98
Frank D. Granger	.....do	1 588.40
L. A. Bauer	.....do	2 500.00
J. J. Gilbert	.....do	2 350.00
Henry L. Marindin	.....do	2 200.00
John F. Pratt	.....do	2 200.00
Edmund F. Dickins	.....do	2 200.00
Dallas B. Wainwright	.....do	2 200.00
Isaac Winston	.....do	2 200.00
William C. Hodgkins	.....do	2 200.00
Phillip A. Welker	.....do	2 200.00
James B. Baylor	.....do	2 147.85
John Nelson	.....do	2 000.00
Fremont Morse	.....do	2 000.00
Stehman Forney	.....do	2 000.00
Gershom Bradford	.....do	2 000.00
Oscar W. Ferguson	.....do	2 000.00
John E. McGrath	.....do	2 000.00
Edwin Smith	.....do	2 000.00
George R. Putnam	.....do	1 947.77
Walter B. Fairfield	.....do	1 800.00
W. Irving Vinal	.....do	1 800.00
Homer P. Ritter	.....do	1 708.68
Fred A. Young	.....do	1 600.00
Ferdinand Westdahl	.....do	1 600.00
John B. Boutelle	.....do	1 600.00
Robert L. Faris	.....do	1 508.19
E. B. Latham	.....do	1 400.00
Charles C. Yates	.....do	1 400.00
Owen B. French	.....do	1 308.64
Geo. L. Flower	.....do	1 200.00
William Bowie	.....do	1 200.00
Harry F. Flynn	.....do	1 200.00
Frank W. Edmonds	One month and twenty-two days	172.84
Frank M. Little	One year	840.39
Hugh C. Denson	.....do	1 200.00
R. B. Derickson	.....do	1 200.00
Harry W. Rhodes	Five months	496.70
F. F. Weld	.....do	496.70

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

SALARIES—PAY OF FIELD OFFICERS, 1902—Continued.

To whom paid.	Time employed.	Amount.
AIDS.		
Harry W. Rhodes	Seven months	$527.50
F. F. Weld	....do	527.50
Benjamin E. Tilton	....do	204.18
Hugh C. Mitchell	One year	900.00
John A. Fleming	....do	900.00
Frank H. Brundage	Eleven months and thirteen days	857.94
William H. Burger	One year	794.50
B. A. Baird	....do	794.50
Walter C. Dibrell	....do	780.50
Wm. E. Parker	....do	728.34
Ora Miner Leland	....do	720.00
Geo. E. Selby	Eleven months and eighteen days	696.30
John Kenneth Mills	Two months and twelve days	144.68
Carl E. Morford	Seven months and twenty-nine days	477.34
W. A. Naghton	One year	512.08
Charles R. Sanderson	One month and ten days	74.65
Archie P. Breeden	Four months and twenty-three days	282.04
Jose Vano Reyes	Five months and eighteen days	334.00
John A. Richardson	Nineteen days	47.50
Ossian E. Carr	Two months and twenty-nine days	177.94
Merk Dunn	Thirty days	55.76
Gilbert Young	One month and thirty days	103.30
Richard W. Walker	Three months and twenty-four days	228.00
Glen V. Brown	Thirty days	31.65
Carroll M. Sparrow	Twenty-four days	47.47
F. B. Loren	Eighteen days	35.60
William B. Keeling	Twenty-seven days	53.41
L. B. Smith	Twenty-five days	49.45
E. L. Scott	Ten days	19.78
Wm. T. Carpenter	Twelve days	23.74
Samuel J. Barnett	....do	23.74
Harold D. King	Ten days	19.78
W. C. Shepard	Six days	11.87
Earl B. Shaw	Eight days	15.82
Don R. Jewell	Six days	11.87
Expenditures		112 566.88
Appropriation		127 260.00
Expenditures		112 566.88
Unexpended balance		14 693.12

SALARIES—PAY OF OFFICE FORCE, 1902.

DISBURSING AGENT.		
Scott Nesbit	One year	$2 200.00
CHIEF OF DIVISION OF LIBRARY AND ARCHIVES.		
Edw. L. Burchard	One year	1,800.00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

SALARIES—PAY OF OFFICE FORCE, 1902—Continued.

To whom paid.	Time employed.	Amount.
CLERKS.		
William B. Chilton	One year	$1 800.00
Nicholas G. Henry	do	1 800.00
William C. Maupin	do	1 650.00
Herbert M. Fitch	do	1 650.00
Adelbert B. Simons	do	1 377.18
J. Henry Roeth	do	1 369.37
George A. Fairfield	do	1 400.00
William R. Grey	Six and one-half days	24.73
Ida M. Peck	One year	1 378.89
John A. Smoot	One month and three days	110.88
Eugene B. Wills	One year	1 200.00
James M. Griffin	do	1 200.00
Harlan C. Allen	do	1 200.00
Joseph B. Quinlan	do	1 177.08
Kate Lawn	do	1 178.75
Jennie H. Fitch	do	1 132.59
Alice G. Reville	do	1 000.00
Jefferson H. Millsaps	do	989.43
Calvin W. Jones	do	966.25
CHART CORRECTORS.		
Henry R. Garland	One year	1 200.00
Lily A. Mapes	do	1 200.00
Mary L. Handlan	do	714.12
Virginia E. Campbell	do	720.00
WRITERS.		
Albert F. Zust	One year	900.00
El Bie K. Foltz	do	880.88
Eugene Meads	do	839.28
Archie Upperman	do	800.00
Susie C. Mahany	Ten days	19.57
Lillian Hellen	Thirty days	58.70
Merk Dunn	do	58.70
Edith Meredith	do	58.70
Bertha M. Brown	do	58.70
H. C. Gibbs	do	58.69
William Gardiner	Twenty-nine days	56.74
N. J. Sparklin	Seventeen days	33.26
Etta H. Ferguson	Twenty-nine days	56.74
Charles F. De Woody	Seven months and three days	425.17
Barnett W. Bembry	Eight months and nine days	497.01
Sarah J. Ogden	Ten days	19.57
Belle Dixon	Fifteen days	29.35
Thomas S. Mallon	Three months and twelve days	203.86
Carl J. Hellerstedt	Seven months and twelve days	444.08
Jeremiah G. Maupin	Three months and twenty-eight days	236.00
Bettie J. De Sale	Twenty-seven days	52.42
Essie Chamberlain	Thirty days	59.34
Mary A. Grant	One year	600.00
BUOY COLORIST.		
A. B. Simons, jr	One year	718.04

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

SALARIES—PAY OF OFFICE FORCE, 1902—Continued.

To whom paid.	Time employed.	Amount.
DRAFTSMEN.		
Edwin H. Fowler	One year	$2 400.00
Henry Lindenkohl	do	2 200.00
Adolph Lindenkohl	do	2 000.00
W. C. Willenbucher	do	2 000.00
Ernest J. Sommer	do	1 800.00
Frank C. Donn	do	1 800.00
David M. Hildreth	do	1 800.00
Charles H. Deetz	do	1 600.00
Edmund P. Ellis	do	1 600.00
John T. Watkins	do	1 400.00
Harlow Bacon	do	1 400.00
James P. Keleher	do	1 200.00
Paul Erichson	do	1 000.00
Sully B. Maize	do	951.08
J. Newton Baker	do	1 000.00
Charles M. Hahn	do	900.00
James W. McGuire	do	900.00
Charles Mahon	Six months and eight days	354.15
Thomas C. Bradley	Four months and twenty-four days	281.02
COMPUTERS.		
E. H. Courtenay	Eleven months and three days	1 851.68
Myron H. Doolittle	One year	2 000.00
L. P. Shidy	do	1 809.94
Rollin A. Harris	do	1 609.31
Daniel L. Hazard	do	1 600.00
Albert L. Baldwin	do	1 600.00
John C. Hoyt	do	1 600.00
Artemus Martin	do	1 409.33
Lilian Pike	do	1 209.34
R. L. Rhoton	Thirty-one days	84.24
Charles R. Duvall	One year	1 009.35
Wm. H. Dennis	do	1 000.00
Deane S. Bliss	Two days	5.43
Charles A. Littlefield	Twenty-nine days	78.80
Charlotte C. Barnum	Nine months and twenty days	804.35
Frank H. Brundage	Seventeen days	46.69
COPPERPLATE ENGRAVERS.		
Wm. A. Thompson	Twenty-two days	119.57
Henry M. Knight	One year	2 000.00
Theodore Wasserbach	do	2 000.00
Wm. H. Davis	do	1 980.36
Edward H. Sipe	do	1 800.00
Harry L. Thompson	do	1 780.48
William F. Peabody	do	1 600.00
William A. Van Doren	do	1 580.38
Wm. Mackenzie	do	1 360.87
Alfred H. Sefton	do	1 200.00
Peter H. Geddes	do	1 200.00
Geo. Hergesheimer	do	1 000.00
Frank G. Wurdemann	do	990.24
Wm. H. Holmes	do	900.00
Hugo Franke	do	900.00
Roland H. Ford	Nine months	675.00
Franklin Geoghegan	One year	880.48
John W. Thompson	Ten months and twenty-two days	654.83

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

SALARIES—PAY OF OFFICE FORCE, 1902—Continued.

To whom paid.	Time employed.	Amount.
PHOTOGRAPHER.		
C. F. Blacklidge	One year	$1 600.00
PLATE PRINTERS.		
D. N. Hoover	One year	1 800.00
Eberhard Fordan	....do	1 200.00
Charles J. Harlow	....do	1 200.00
Charles F. Locraft	....do	1 200.00
Wm. M. Conn	Six months and five days	587.32
R. J. Fondren	One year	1 200.00
E. F. Campbell	....do	941.15
PLATE PRINTERS' HELPERS.		
Charles Buckingham	Five months and eleven days	296.70
Raoul F. le Mat	One year	688.59
Wm. B. Mehler	....do	700.00
Edwin M. Kline	....do	700.00
E. L. Jordan, jr	One month and seven days	70.21
Wallace W. Kirby	Five months and sixteen days	320.81
Rudolph V. H. Jama	Five months and seven days	303.31
INSTRUMENT MAKERS.		
Ernest G. Fischer	One year	1 800.00
Clement Jacomini	....do	1 200.00
Thomas A. Gibson	....do	1 200.00
W. R. Whitman	....do	1 000.00
M. Lauxmann	....do	1 000.00
Otto Storm	Five months and twenty-nine days	494.46
Robena Atkinson	Thirty days	75.00
Allen G. Jennings	One day	2.50
Charles Zimmisch	Two months and twenty-five days	210.45
James A. Clark	Two months and twenty-seven days	215.19
Herman G. Fischer	Three months and twenty-four days	285.00
Ovid St. Marie	Six months and thirty days	564.13
ASSISTANT ELECTROTYPERS AND PHOTOGRAPHERS.		
Louis P. Keyser	One year	1 200.00
Roy Thomas	....do	694.30
CARPENTERS.		
Horace O. French	....do	1 200.00
Geo. W. Clarvoe	....do	1 000.00
C. N. Darnall	....do	1 000.00
WATCHMEN.		
David Parker	....do	880.00
J. W. Drum	....do	880.00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

SALARIES—PAY OF OFFICE FORCE, 1902—Continued.

To whom paid.	Time employed.	Amount.
MESSENGERS.		
Thomas McGoines	One year	$880.00
Charles Over	do	820.00
C. H. Jones	do	820.00
William R. McLane	do	820.00
William H. Butler	do	820.00
William J. Diercks	do	700.00
Attrell Richardson	do	700.00
J. W. Hunter	do	640.00
FIREMAN.		
Horace Dyer	do	640.00
LABORERS.		
Frank Thomas	do	630.00
Harrison Murray	do	630.00
Hans Bowdwin	Nine months and twenty-four days	514.02
John H. Mason	One year	630.00
Jeremiah Hawkins	One month and thirty days	103.82
Samuel B. Wallace	One year	550.00
Ransom Smart	do	550.00
Charles H. Strothers	do	550.00
Virginia McGlincy	do	365.00
John W. Brown	do	365.00
Expenditures		143 967.95
Appropriation		145 240.00
Expenditures		143 967.95
Unexpended balance		1 272.05

RECAPITULATION.

Pay of field officers	$112 566.88
Pay of office force	143 967.95
Expenditures	256 534.83
Total sum appropriated for salaries, 1902	272 500.00
Total sum expended for salaries, 1902	256 534.83
Unexpended balance	15 965.17

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902.

TIDES, ETC.

To whom paid.	On what account.		Amount.
Adams Express Co	Transportation		$1.07
R. L. Faris	Baltimore tidal		116.69
H. F. Flynn	Seattle tidal		175.85
F. A. Kummell	Philadelphia tidal		732.09
W. C. Meyer	Seattle tidal		2.00
J. F. Pratt	do		593.80
Aug. F. Rodgers	San Francisco tidal		1 031.23
L. P. Shidy	Washington tidal		14.83
J. G. Spaulding	Fort Hamilton tidal		1 105.40
B. W. Weeks	Fernandina tidal		603.50
Ferdinand Westdahl	Seattle tidal		4.00
Expenditures			4 380.46
Appropriation			5 000.00
Less 10 per cent transferred to State surveys, etc		$500.00	
Expenditures		4 380.46	
			4 880.46
Unexpended balance			119.54

OFFSHORE WORK, ETC.

To whom paid.	On what account.		Amount.
H. L. Ford	Services		$1 500.00
H. C. Graves	do		1 800.00
Talbot Pulizzi	do		1 080.00
John Ross	Services and coast pilot		2 521.14
E. H. Wyvill	Services		1 500.00
Expenditures			8 401.14
Appropriation			10 100.00
Less 10 per cent transferred to State surveys, etc		$1 010.00	
Expenditures		8 401.14	
			9 411.14
Unexpended balance			688.86

STATE SURVEYS, ETC.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	$67.99
L. A. Bauer	Magnetics	4 021.11
J. Baumgarten & Sons	Rubber stamps	7.40
Blue Line Transfer Co	Transportation	36.59
Wm. Bowie	Triangulation	10 295.41
Wm. Burger	Leveling	1 376.69
W. G. Cady	Services	1 000.00
T. Cook & Sons, limited	Magnetic instruments	400.03

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

STATE SURVEYS, ETC.—Continued.

To whom paid.	On what account.	Amount.
M. G. Copeland & Co	Repairing tent	$4.50
S. A. Deel	Services	240.00
W. C. Dibrell	Leveling	3 145.50
Alfred W. Dover	Magnetic instruments	82.40
M. T. Edelman	do	2 634.32
H. M. W. Edmonds	Magnetics	6 109.60
J. R. Edwards	Rent of store room	10.50
W. B. Fairfield	Longitudes	530.35
J. A. Fleming	Magnetics	4 358.45
J. P. Friez	Magnetic supplies	4.50
J. L. Gilbert & Bro	Lumber	149.63
F. D. Granger	Triangulation	2 718.53
Henry J. Green	Magnetic instruments	19.80
Gunther & Tegetmeyer	do	119.90
Bent Hart	Pasturage	41.81
John F. Hayford	Traveling expenses	112.30
L. G. Jennings	Storage	6.00
C. C. King	do	7.50
F. M. Little	Magnetics	767.40
F. P. May & Co	Wind mill for Cheltenhan Observatory	65.00
Jos. W. Miller, jr	Services	225.00
A. T. Mosman	Triangulation	3 490.35
E. D. Preston	Magnetics	1 112.64
Jules Richard	Magnetic instruments	171.35
Aug. F. Rodgers	Magnetics	91.60
Schneider Bros	Magnetic instruments	19.00
L. G. Schultz	Services	558.80
A. J. Seitz	Storage	3.00
Geo. E. Selby	Leveling	1 799.77
Edwin Smith	Longitudes and triangulation	1 051.02
Philip Smith	Piers for Cheltenham Observatory	90.00
R. M. Stanton	Storage	1.80
W. Stebbins & Sons	Piping for Cheltenham Observatory	97.61
Stoltze & Co	Magnetic supplies	19.80
Ludwig Tesdorpf	Magnetic instruments	273.23
The Geo. W. Knox Express Co.	Transportation	127.19
Otto Toepfer & Son	Magnetic instruments	288.58
U. S. Express Co.	Transportation	69.10
R. W. Walker	Services	480.00
Wm. F. Wallis	Magnetics	1 453.05
Wm. Weinrich, jr	Services and magnetics	1 340.25
J. M. Zerbe	Keep of horses	42.00
Amount disbursed		51 138.35
Railroad accounts referred to Auditor for settlement		498.92
Expenditures		51 637.27
Appropriation		50 000.00
Add 10 per cent from tides, etc.		500.00
Add 10 per cent from offshore work, etc		1 010.00
Add 10 per cent from objects not named		400.00
		51 910.00
Expenditures		51 637.27
Unexpended balance		272.73

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

OBJECTS NOT NAMED.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	$12.95
F. H. Ainsworth	Traveling expenses	7.67
Benedict & Burnham Manufacturing Co.	Copper tubing	17.50
J. B. Boutelle	Wireless telegraphy	467.50
Gershom Bradford, 2d	Traveling expenses	12.95
F. S. & J. L. Brown	Experimental sounding machine	174.75
C. O. Dougherty	do	4.00
Wm. Eimbeck	Traveling expenses	43.53
J. F. Elim & Co	Sounding apparatus	4.16
E. G. Fischer	Traveling expenses	93.25
L. B. Friendt	Inspection service	793.55
Harry A. Hann	Experimental sounding machine	20.50
John F. Hayford	Traveling expenses	16.20
J. J. Hayman	Experimental sounding machine	10.75
McCay Engineering Co	do	180.00
R. McD. Moser	Traveling expenses	27.49
People's Hardware Co	Experimental sounding machine	9.78
Quimby Engineering Co	Test pump	62.00
Aug. F. Rodgers	Tide indicator and astronomic work	61.55
F. J. Sloane & Co	Experimental sounding machine	13.50
Edwin Smith	Traveling expenses	68.63
H. S. Smith	do	17.31
Spedden Shipbuilding Co	Experimental sounding machine	4.82
John S. Stevenson	do	10.10
C. A. Thompson	Constructing experimental sounding machine.	131.83
The M. Lindsay Rubber Co	Sheet rubber	4.38
O. H. Tittmann	Traveling expenses	53.10
D. B. Wainwright	Traveling expenses, special duty, and wireless telegraphy.	197.20
Amount disbursed		2 520.95
Railroad accounts referred to Auditor for settlement		28.90
Expenditures		2 549.85
Appropriation		4 000.00
Less 10 per cent transferred to State surveys, etc	$400.00	
Expenditures	2 549.85	
		2 949.85
Unexpended balance		1 050.15

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

RECAPITULATION.

[Showing expenditures in gross, by subitems.]

Tides, etc	$4 380. 46
Offshore work, etc	8 401. 14
State surveys, etc	51 138. 35
Objects not named	2 520. 95
Amount disbursed	66 440. 90
Railroad accounts referred for settlement	527. 82
Expenditures	66 968. 72
Total amount appropriated for party expenses, 1902	69 100. 00
Total amount expended for party expenses, 1902	66 968. 72
Unexpended balance	2, 131. 28

CLASSIFICATION OF EXPENDITURES FOR PARTY EXPENSES, 1902.

On what account.	Amount.
Tidal operations	$4 380. 46
Coast Pilot	8 401. 14
Triangulation	17 247. 98
Magnetics	26 514. 44
Leveling	6 606. 53
Geographic positions	1 268. 32
Experiments in wireless telegraphy	664. 70
Experimental sounding machines	648. 07
Traveling expenses, transportation, etc	443. 53
Inspection service	793. 55
Total	66 968. 72

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

REPAIRS OF VESSELS, 1902.

To whom paid.	On what account.	Amount.
Atlantic Iron Works Co	Repairs steamer Blake	$345.55
J. B. Boutelle	Repairs steamer Eagre	2 757.56
R. L. Faris	Repairs steamer Blake	170.00
Geo. L. Flower	Repairs schooner Matchless	131.45
Gibson & Kirk	Repairs steamer Patterson	142.50
J. J. Gilbert	Repairs steamer Pathfinder	2 834.45
E. B. Latham	Repairs steamer Bache	1 283.38
Moran Bros. Co	Repairs steamer Patterson	25 000.00
Murray & Tregurtha Co	Launch for steamer Bache	1 645.00
New Bedford Boiler and Machine Co.	Repairs steamer Blake	21.19
New York Steam Fitting Co	Repairs schooner Eagre	498.00
Lewis Nixon	Repairs steamer Pathfinder	327.00
H. G. Ogden	Traveling expenses	298.10
J. F. Pratt	Repairs steamer Patterson	2 622.11
John Ross	Traveling expenses	32.55
Homer P. Ritter	Repairs steamer Taku	370.33
Spedden Shipbuilding Co	Repairs steamers Endeavor, Blake, Bache.	5 151.34
O. H. Tittmann	Traveling expenses	2.75
The James Reilly Repair and Supply Co.	Repairs steamer Hydrographer	80.00
F. F. Weld	do	374.11
P. A. Welker	Repairs steamers Blake and Bache	1 373.05
Ferdinand Westdahl	Repairs steamer McArthur	3 503.50
Wm. E. Woodall & Co	Repairs steamer Endeavor	2 549.66
Fred A. Young	do	667.63
Expenditures		52 181.21
Appropriations		54 600.00
Expenditures		52 181.21
Unexpended balance		2 418.79

CLASSIFICATION OF EXPENDITURES FOR REPAIRS OF VESSELS, 1902.

Name of vessel.	Amount.
Steamer Bache	$5 239.97
Steamer Blake	3 796.29
Schooner Eagre	3 255.56
Steamer Endeavor	4 170.54
Steamer Hydrographer	454.11
Steamer McArthur	3 503.50
Schooner Matchless	131.45
Steamer Pathfinder	3 161.45
Steamer Patterson	27 764.61
Steamer Taku	370.33
Traveling expenses of inspection officers	333.40
Total	52 181.21

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PUBLISHING OBSERVATIONS, 1902.

To whom paid.	On what account.	Amount.
R. D. Chase	Services	$1 000.00
Appropriation		1 000.00
Expenditures		1 000.00

GENERAL EXPENSES, 1902.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	$105.03
Theo. Altender & Sons	Instruments	100.44
American Hard Rubber Co	Photographic supplies	157.18
American Ice Co	Ice	271.28
American Journal of Science	Subscriptions	6.00
American Radiator Co	Repairs	39.39
R. P. Andrews & Co., Incorporated	Stationery, chart paper, etc	2 003.16
E. & H. T. Anthony & Co	Drawing supplies	2.27
Armour & Co	Contingencies	1.50
R. Carter Ballantyne	Stationery, drawing supplies, etc	310.49
Wm. Ballantyne & Sons	Stationery and contingencies	69.24
Barber & Ross	Miscellaneous and carpenter shop	23.02
Herman Baumgarten	Stationery	1.10
Bausch & Lomb Optical Co	Instruments and photographic supplies	168.75
Benedict & Burnham Manufacturing Co.	Instrument shop	10.74
C. L. Berger & Sons	Instruments	1 586.25
J. G. Biddle	....do	27.50
Mary E. Bladen	Washing	2.73
John Bliss & Co	Books, charts, etc	191.86
Blue Line Transfer Co	Transportation	20.79
Blum Bros	Miscellaneous, contingencies	54.66
Wm. Bond & Son	Instruments	160.00
R. R. Bowker	Subscriptions	5.00
W. Andrew Boyd	Books	30.00
John A. Brashear	Miscellaneous	7.80
Brentanos	Books	.20
Brown & Sharpe Manufacturing Co.	Instrument shop	12.80
Bureau Engraving and Printing	Printing supplies	1 207.42
M. P. Bush	Miscellaneous	14.40
D. E. Burton	Carpenter shop and miscellaneous	74.98
J. H. Bunnell & Co	Books	15.00
Butters & Anderson Co	Instruments	198.54
B. H. Camden	....do	84.00
A. Campbell & Co	Miscellaneous	5.00
Capital Traction Co	Office travel	38.25
S. C. Chandler	Subscriptions	5.00
John Chatillon & Sons	Instruments and contingencies	37.68
R. P. Clarke Co	Printing supplies and miscellaneous	509.94
Clendenin Bros	Copper	750.24
Richard C. Cooley	Repairs	10.00
Jas. Connor	Office horse	25.77
Geo. E. Corbett	Carpenter shop	1.40
John Herbert Corning	Miscellaneous	2.19
H. S. Crocker Co	Book	5.00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

GENERAL EXPENSES, 1892—Continued.

To whom paid.	On what account.	Amount.
Joseph L. Crupper	Miscellaneous and carpenter shop	$3. 30
Cunningham, Curtis & Welch	Chart paper and stationery	165. 00
Devoe & C. R. Raynolds Co	Miscellaneous	13. 60
Dulan & Co	Books	42. 91
W. W. Duffield	Miscellaneous	. 60
Dulin & Martin	.....do	. 30
M. Du Perow	Instrument shop and contingencies	24. 82
H. M. W. Edmonds	Books	6. 00
Chas. R. Edmondston	Miscellaneous	5. 65
Eimer & Amend	Instruments and contingencies	37. 14
Elliott Electric Blue Print Co	Drawing supplies	19. 38
E. Morrison Paper Co	Stationery	14. 10
Geo. T. Ennis & Co	Instrument shop	63. 99
John B. Espey	Miscellaneous and carpenter shop	226. 31
Wm. F. Evans	Extra labor	100. 00
E. Faber	Stationery	6. 90
Fauth & Co	Instruments	8. 50
Felt & Tarrant Manufacturing Co	.....do	125. 00
Geo. J. Fey	Instrument shop	18. 00
Z. D. Gilman	Photographic supplies, etc	182. 26
Grant Gear Works	Instrument shop	60. 00
Andrew B. Graham	Photolithographing	3 315. 74
Henry J. Green	Instruments	60. 00
Harvard University	Subscription	2. 00
Jeremiah Hawkins	Extra labor	501. 61
Clifford W. Hawkins	.....do	538. 71
Hellman Oil Co	Miscellaneous	4. 00
Mrs. A. Hellmuth	Washing	147. 57
G. H. Henderson	Extra labor	58. 06
J. Hillingas	Repairs	52. 50
H. W. Hingman, jr., & Co	Photo supplies, etc	120. 08
I. H. Hoover	Miscellaneous	26. 50
International Distributing and Trading Co.	.....do	2. 88
Jones & Laughlins, Limited	Engraving supplies	. 89
M. E. Kahler	Instruments	49. 90
S. Kann Sons & Co	Miscellaneous	64. 98
Thomas Keely	Contingencies	41. 20
Keuffel & Esser Co	Instruments	853. 20
G. P. Killian	Miscellaneous	2. 50
John King	Contingencies	. 50
Ammie I. Koernicke	.....do	10. 95
Richard L. Lamb	Stationery and contingencies	40. 73
Jas. B. Lambie	Instrument shop and miscellaneous	52. 98
R. F. Lang	Freight	5. 70
W. H. Larman	Repairs	125. 00
Lemcke & Buechner	Books, subscriptions, etc	111. 37
Library Bureau	Stationery and contingencies	164. 04
Melville Lindsay	Photo supplies	8. 58
W. H. Lowdermilk & Co	Books and subscriptions	67. 43
Lufkin Rule Co	Instruments	289. 80
Lutz & Co	Office wagon, etc	17. 90
Mackall Bros	Electric and photographic supplies	207. 35
E. W. Mackintosh	Stationery and drawing supplies	29. 00
Jas. McSutherland	Contingencies	15. 00
P. Mann & Co	Miscellaneous	3. 00
Marine Engineering, Incorporated	Books and subscriptions	7. 00
Matthiessen & Hegler Zinc Co	Zinc	171. 13

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

GENERAL EXPENSES, 1902—Continued.

To whom paid.	On what account.	Amount.
W. H. Mehler	Repairs	$53.00
A. A. Meredith	Extra labor	600.00
J. M. Meyers	Stationery	45.00
Francis Miller	Printing supplies, etc	46.85
John Mitchell, jr	Repairs, etc	8.84
Moore Bros	Stationery and typewriter repairs	5.00
F. J. Monrote	Instrument shop	49.25
W. B. Moses & Sons	Office furniture, etc	145.97
Multum In Parvo Binder Co	Contingencies	2.00
Munn & Co	Subscriptions	7.00
N. Murray	....do	7.50
Geo. F. Muth & Co	Miscellaneous and drawing supplies	321.58
National Sponge and Chamois Co	Contingencies	4.13
J. P. Nawrath	Printing supplies, etc	14.64
Neely Electric Co	Electrotyping plant	1 455.34
T. S. & J. D. Negus	Instruments	64.80
New York Steel and Copper Plate Co.	Copper plates	300.24
A. Ott	Instruments	51.21
V. L. Ourdan	Engraving supplies	12.00
John C. Parker	Stationery, subscriptions, etc	96.19
Parsons Paper Co	Stationery	5.40
Thos. Pearsall, jr	Contingencies	11.58
J. A. Pierpont	....do	113.28
Pouthers & Therode	Instruments	715.28
Postal Telegraph Cable Co	Telegrams	285.08
Postmaster, Washington, D. C	Post-office box	16.00
J. F. Pratt	Intrument shop	15.00
Prentiss Vise Co	Miscellaneous	15.00
Professional Photograph Publishing Co.	Subscription	1.00
Public Printer, Government Printing Office.	Printing supplies	1.25
E. J. Pullman	Photo supplies	452.99
G. R. Putnam	Photolithographing and suboffice expenses.	488.26
Queen & Co., Incorporated	Carpenter shop, etc	55.75
John C. Rau	Repairs	611.59
Josephine Reed	Extra labor	180.00
Hugh Reilly	Miscellaneous	6.45
Revenue-Cutter Service	Flags	7.95
E. S. Ritchie & Sons	Instruments and repairs	420.65
C. B. Robinson	Office horse	18.50
Aug. F. Rodgers	Suboffice expenses, etc	128.92
Rudolph, West & Co	Carpenter shop and miscellaneous	49.54
E. G. Schafer	Repairs	24.28
Fred A. Schmidt	Stationery, drawing supplies, etc	349.52
Bertha I. Schott	Books	3.50
John Sellers & Son	Engraving supplies	18.00
Seth Thomas Clock Co	Instruments	228.40
F. Sharp	Drawing and engraving supplies	11.60
B. F. Shaw	Office horse	384.55
S. S. Shedd Bros	Repairs	20.85
Geo. A. Shehan	Carpenter shop	658.07
W. Silas Sheetz	Engraving supplies	14.20
Shoemaker & Busch	Miscellaneous	29.99
Smithsonian Institution	Transportation of exchange	140.90
Thos. W. Smith	Carpenter shop	28.56

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

GENERAL EXPENSES, 1902—Continued.

To whom paid.	On what account.	Amount.
Chas. C. Smith	Stationery	$3.00
C. W. Smith	Office horse	150.00
Frank C. Snyder	Miscellaneous	5.00
Standard Oil Co	....do	5.37
Ovid St. Marie	Extra labor	5.56
C. F. Starke	Instrument shop	31.53
G. E. Stechert	Books, subscriptions, etc	306.97
Sutherland & Carr	Instrument shop and contingencies	27.10
Sussfeld, Larsch & Co	Instruments	384.80
A. P. Swoyer & Co	Instrument shop	378.00
M. A. Tappan & Co	Miscellaneous	9.09
Tengwall File and Ledger Co	Stationery, etc	70.38
The Beck Duplicator Co	Miscellaneous	6.00
The Chesapeake and Potomac Telephone Co.	Exchange, rental, etc	58.10
The Cumulative Index Co	Subscriptions	5.00
The Electric Storage Battery Co	Electrotyping plant	393.75
The Engineering Magazine	Book	5.00
The J. C. Ergood Co	Miscellaneous	26.91
The Evening Star and Newspaper Co	Advertising	5.04
The Fred Macey Co., Limited	Stationery	122.25
The Fuchs & Lang Manufacturing Co.	Printing supplies and zinc	4.44
The Geo. W. Knox Express Co	Transportation	27.90
The Grove Lime and Coal Co	Miscellaneous	5.95
The Hansen and Van Winkle Co	Instrument shop and miscellaneous	27.05
The Julius Lansburgh Furniture and Carpet Co.	Contingencies	10.50
The Inland Printer Co	Book	1.50
The McMillan Co	Books and subscriptions	11.85
The Marine Review Publishing Co	Book	8.00
The McDermott Carriage Co	Office wagon	2.40
The Maurice Joyce Engraving Co	Engraving	4.30
The M. Lindsay Rubber Co	Miscellaneous	2.00
The Newberry Library	Stationery and miscellaneous	112.50
The Red "C" Oil Co	Miscellaneous	16.12
The Scoville & Adams Co., of New York.	Photo supplies	20.44
The Shaw-Walker Co	Miscellaneous	5.53
The Smith Premier Typewriter Co	....do	27.70
The Strowger Automatic Telephone Exchange.	Rent of telephones	168.00
The University of Chicago Press	Subscriptions	4.00
The Washington Post Co	Advertising	6.30
The Wert Electric Co	Electrical supplies	130.00
Jas. F. Topham	Miscellaneous	10.35
Leo Uhlfelder	....do	4.50
United States Electric Lighting Co	Electricity	442.34
United States Express Co	Transportation	25.79
United States Marine-Hospital Service.	Miscellaneous	22.52
United States Naval Institute	Subscription	3.50
United States Typewriter Supply Co	Typewriter and repairs	91.96
T. W. Van Hoesen	Instrument shop	14.40
Valley Paper Co	Chart paper	1 404.32
Washington Gaslight Co	Gas	943.30
F. Weber & Co	Engraving supplies	4.80
Wellsbach Co	Miscellaneous	3.80

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

GENERAL EXPENSES, 1902—Continued.

To whom paid.	On what account.	Amount.
Western Union Telegraph Co	Telegrams	$330.77
Weston Electric Installation Co	Instruments	105.00
Louis Weule	....do	93.00
William Walters Sons	Office wagon	79.20
Conrad Witner	Books	13.29
Woodward & Lothrop	Office furniture, books, etc	424.15
Woodruff Manufacturing Co	Miscellaneous	163.60
Wyckoff, Seamans & Benedict	Typewriter and repairs	115.65
Yawman & Erbe Manufacturing Co.	Stationery	7.86
Wm. J. Zeh	Fuel	1 162.50
Carl Zeiss	Instruments	116.46
Jas. Zentmayer	Instrument shop	2.16
Chas. Zimmisch	Extra labor	3.75
Zucker & Levett & Loeb Co	Electrotyping supplies	168.66
Amount disbursed		33 803.33
Railroad accounts referred to Auditor		.65
Accounts settled by Auditor for stationery furnished by Treasury Department		542.47
Expenditures		34 346.85
Appropriation		34 500.00
Expenditures		34 346.85
Unexpended balance		153.15

CLASSIFICATION OF EXPENDITURES FOR GENERAL EXPENSES, 1902.

On what account.	Amount.
Instruments and repairs of same	$5 929.07
Instrument shop and carpenter shop	2 067.32
Books, maps, charts, and subscriptions	905.35
Chart paper	3 143.98
Copper plates and zinc	911.62
Engraving, printing, photolithographing, and electrotyping supplies	3 418.54
Photolithographing and printing from stone and copper	3 267.24
Stationery	1 535.37
Transportation of instruments and supplies	326.76
Office horse and wagon	673.67
Fuel	1 162.50
Gas	909.30
Electricity	292.94
Telegrams	616.19
Ice	271.28
Washing	150.30
Telephones	226.10
Extra labor	1 987.69
Traveling expenses (office)	38.25
Suboffice expenses in San Francisco and Manila	970.68
Office furniture	1 750.08
Electrotyping plant	2 472.43
Miscellaneous expenses and contingencies of all kinds	1 321.19
Total	34 346.85

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PAY, ETC., OF OFFICERS AND MEN, VESSELS, COAST SURVEY, 1902.

To whom paid.	On what account.	Amount.
H. J. Atwell	Pay	$140.32
Alexander Bain	do	331.29
Robert Boyd	do	117.92
J. B. Boutelle	Pay rolls, schooner Eagre	14 098.27
Gershom Bradford, 2d	Pay	187.50
E. F. Dickins	Pay rolls, steamer Gedney	812.05
Harry Ely	Pay	4.33
R. L. Faris	Pay rolls, steamer Blake	13 109.09
G. L. Flower	Pay rolls, schooner Matchless	9 962.10
H. F. Flynn	Pay of surgeons	298.87
O. B. French	Pay roll, steamer Blake	866.93
J. J. Gilbert	Pay rolls, steamer Pathfinder	36 229.90
C. L. Green	Pay rolls, steamer Bache	308.83
Thos. S. Hundley	Pay	79.76
J. Koiljord	do	15.00
Jas. A. McGregor	do	100.00
Fremont Morse	Pay of deck officer	300.00
John Nelson	Pay	156.63
J. F. Pratt	Pay rolls, steamer Patterson	19 712.04
G. R. Putnam	Pay of surgeon	625.00
H. W. Rhodes	Pay rolls, steamer Research	2 625.92
L. C. Ritchie	Pay	900.00
Aug. F. Rodgers	Pay of enlisted men	449.96
John Ross	Pay rolls, steamer Hydrographer	3 998.93
Wm. Sanger	Pay	173.87
Henry S. Smith	do	200.00
James Sullivan	do	115.00
W. I. Vinal	Pay rolls, steamer Bache	211.79
D. B. Wainwright	Pay rolls, steamer Blake	1 116.67
D. B. Wainwright, jr	Pay	6.45
Arthur L. Webb	do	87.10
F. F. Weld	Pay rolls, steamer Hydrographer	3 283.89
P. A. Welker	Pay rolls, steamers Blake and Bache	21 008.93
Ferd. Westdahl	Pay rolls, steamer McArthur	11 777.91
Fred A. Young	Pay rolls, steamer Endeavor	13 758.96
Amount disbursed		165 171.21
Account settled by Auditor for account of Lars Gunderson, deceased		43.55
Expenditures		165 214.76
Appropriation		182 745.00
Expenditures		165 214.76
Unexpended balance		17 530.24

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PAY, ETC., OF OFFICERS AND MEN, VESSELS, COAST SURVEY, 1901 AND 1902.

To whom paid.	On what account.	Amount.
Chas. F. Adae	Pay as watch officer	$805.00
Frank H. Ainsworth	....do	1 570.00
Wm. G. Appleton	....do	1 620.00
Wm. M. Atkinson	....do	1 475.00
H. F. Cauffman	....do	49.50
Byron J. Crowley	....do	1 500.00
E. S. Daniels	....do	110.00
John C. Dow	....do	375.00
John L. Dunn	....do	483.00
Whitney I. Eisler	....do	1 429.99
John G. Fels	....do	307.91
C. W. Fitzgerald	....do	1 560.00
Lawrence M. Furman	....do	1 500.00
Wm. F. Glover	....do	1 620.00
N. G. Grayson	....do	263.39
Cannon L. Green	....do	1 620.00
Thos. L. Jenkins	....do	131.29
Victor R. Lyle	....do	1 540.65
Chas. Lyman	....do	1 500.00
Joseph W. McGrath	....do	880.00
Jas. A. McGregor	....do	333.93
R. McD. Moser	....do	447.85
Chas. R. Palmer	....do	112.50
Wm. B. Proctor	....do	1 380.00
Howard W. Rees	....do	165.32
Henry S. Smith	....do	292.74
Chas. A. Thompson	....do	1 440.00
H. S. Throckmorton	....do	14.66
Expenditures		24 527.73
Appropriation		27 500.00
Expenditures		24 527.73
Unexpended balance		2 972.27

PARTY EXPENSES.

ATLANTIC COAST, ETC.

To whom paid.	On what account.	Amount.
Chas. F. Adae	Traveling expenses	$11.45
Adams Express Co	Transportation	28.69
American Steam Gauge and Valve Manufacturing Co.	Outfit, steamer Endeavor	10.50
D. Ballauf	Sounding machines and tubes	410.00
C. F. Bennett	Repairing launch	397.43
W. H. H. Bixler & Co	Supplies for steamer Blake	1 172.35
Blue Line Transfer Co	Transportation	22.56
J. B. Boutelle	Combined operations, schooner Eagre	3 932.33
Wm. Bowie	Hydrography	512.72
Andrew Braid	Topography	54.40
Brown Warehouse Co	Storage	30.00
F. H. Brundage	Topography	2.55

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

ATLANTIC COAST, ETC.—Continued.

To whom paid.	On what account.	Amount.
Bureau of Supplies and Accounts, Navy.	Coal and sounding wire for vessels	$1 878.00
E. F. Busick	Storage	20.95
P. B. Castles	Services	180.65
Clifton J. Claridge	Repairs to launch	28.09
W. C. Dibrell	Traveling expenses	46.30
J. W. Donn	Topography	2 821.41
C. Durm & Son	Storage and overhauling launch	25.65
Swepson Earle	Traveling expenses	4.80
W. B. Fairfield	Triangulation	5 187.45
R. L. Faris	Combined operations, steamer Blake	4 086.45
Geo. L. Flower	Combined operations, schooner Matchless	3 392.98
Stehman Forney	Topography	4 432.33
Forsberg & Murray	Repairing launch	199.00
Owen B. French	Triangulation	1 931.42
Gas Engine and Power Co. and C. L. Seabury & Co., Consolidated.	Repairing launches	131.65
F. D. Granger	Triangulation	790.10
H. C. Graves	Traveling expenses	1.55
C. L. Green	Hydrography, steamer Bache	135.66
Chas. E, Hansen	Services	734.00
James Syndicate, Limited	Sounding machines	400.41
Thos. L. Jenkins	Traveling expenses	1.75
S. M. Johnson & Son	Coal for steamer Hydrographer	47.85
J. B. Kendall	Instrument shade	2.00
Anton Kviljoid	Traveling expenses	21.15
E. B. Latham	Combined operations, steamer Bache	2 295.72
L. H. Miller Safe and Iron Works	Safe for steamer Hydrographer	20.00
Chas. Lyman	Traveling expenses	48.70
Maddrix & Somers	Repairing sounding machine	2.00
Marine Engine and Machine Co	Outfit for schooner Eagre	17.00
John E. McGrath	Triangulation	1 739.42
James A. McGregor	Traveling expenses	1.30
Merchant and Miners' Transportation Co.	Outfit for launch	275.00
R. McD. Moser	Traveling expenses	8.00
Moore Bros	Purchase of typewriter	53.00
A. T. Mosman	Triangulation	1 173.26
F. P. Murphy	Outfit, steamer Hydrographer	109.55
Murray & Tregurtha Co	Outfit for launch	67.47
National Coal Co	Coal for steamer Blake	315.00
National Vaccine Establishment	Medical supplies	6.25
John Nelson	Triangulation and topography	5 481.86
New York and Porto Rico Steamship Co.	Freight	8.79
New York Steam Fitting Co	Outfit, steamer Hydrographer	465.00
Norfolk and Washington Steamboat Co.	Transportation	1.61
H. G. Ogden	Traveling expenses, etc	679.84
Geo. Olsen	do	12.90
William E. Parker	do	3.95
Pennsylvania Railroad Co	Transportation	5.00
Joan Petterson	Traveling expenses	25.97
Paul Policar	Oil for vessels	3.00
Talbot Pulizzi	Traveling expenses	1.80

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

ATLANTIC COAST, ETC.—Continued.

To whom paid.	On what account.	Amount.
Revenue-Cutter Service	Flags and bunting	$200.52
Jose Vano Reyes	Traveling expenses	8.10
H. W. Rhodes	Topography	881.89
A. C. L. Roeth	Traveling expenses	11.40
John Ross	Hydrography, steamer Hydrographer	2 355.18
William Sanger	Traveling expenses	4.55
Edwin Smith	Triangulation	462.07
Vladimir Sournin	Services	434.57
Spedden Shipbuilding Co	Outfit, steamer Hydrographer	95.14
Standard Oil Co	Oil for steamer Blake	22.66
W. Stebbins & Sons	Repairs to launch Rudy	51.00
Stevenson & McGee	Cover for launch	142.50
The George W. Knox Express Co	Transportation	95.79
The Jas. Reilly Repair and Supply Co.	Outfit for steamer Hydrographer and launch.	2 305.93
The Nottingham & Wrenn Co	Coal and water for steamer Hydrographer.	67.28
The Smith Premier Typewriter Co	Typewriter for steamer Blake	80.00
The Townsend & Downey Ship Building and Repair Co.	Outfit for steamer Bache	19.72
C. A. Thompson	Traveling expenses	5.05
O. H. Tittmann	....do	25.30
John Turnbull & Co., jr	Supplies, steamer Blake	81.30
United States Express Co	Transportation	25.10
E. W. Vacher	Supplies for schooner Quick	18.65
W. Irving Vinal	Topography and triangulation	2 901.94
D. B. Wainwright	Combined operations, steamer Blake	1 547.16
Wallace & Gale	Outfit, steamer Hydrographer	147.69
Fred Walpert & Co	Supplies, steamer Blake	25.45
A. L. Webb	Traveling expenses	10.30
F. F. Weld	Topography	2 098.48
P. A. Welker	Combined operations, steamers Blake and Bache.	11 426.49
Western Union Telegraph Co	Telegrams	.43
Wm. E. Woodall & Co	Storage	120.00
Edwin F. White	Traveling expenses	3.22
J. William Yates, jr	....do	3.55
Fred A. Young	Hydrography, steamer Endeavor	3 692.97
Amount disbursed		75 299.35
Railroad accounts referred to Auditor for settlement		94.25
Accounts settled by Auditor for coal, sounding wire, medical and ordnance stores furnished by Navy and War Departments and Marine-Hospital Service.		1 588.17
Expenditures		76 981.77
Balance on hand, Report for 1901		64 120.94
Appropriation, sundry civil act, June 28, 1902		70 000.00
		134 120.94
Expenditures		76 981.77
Present unexpended balance		57 139.17

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

PACIFIC COAST.

To whom paid.	On what account.	Amount.
Adams Express Co	Transportation	$94.70
American Steam Gauge and Valve Co.	Supplies for steamer Gedney	2.50
American Steel and Wire Co	Sounding wire for steamer Patterson	187.50
S. Applegate	Services	100.00
John Bach	Salary and subsistence	97.20
Bailey Building Co	Rent	230.00
D. Ballauf	Sounding machines and tubes for vessels.	2 085.00
Barber & Co	Freight	2.36
John Bliss & Co	Sounding machines, etc	316.00
J. B. Boutelle	Account of steamer Pathfinder	6.35
C. H. Bowker	Traveling expenses	112.65
F. H. Brundage	....do	172.50
Bureau of Supplies and Accounts, Navy.	Coal and sounding wire for vessels	954.18
Wm. H. Burger	Traveling expenses	120.10
P. B. Castles	Services	143.85
Boyne Furniture Co., Limited	Office furniture	52.75
H. C. Denson	Combined operations	2 035.58
R. B. Derickson	....do	1 395.49
E. F. Dickins	Hydrography, steamer Gedney	4 700.09
Dunham, Carrigan & Hayden Co	Supplies for steamer Pathfinder	2 973.76
Wm. Eimbeck	Astronomical	112.50
H. F. Flynn	Combined operations	491.43
Harry L. Ford	Hydrography	475.45
O. B. French	Combined operations	857.20
E. R. Frisby	Services	145.00
J. J. Gilbert	Combined operations, steamer Pathfinder.	17 878.97
James Reilly Repair and Supply Co.	Supplies for steamer Pathfinder	10.00
James Syndicate, Limited	Sounding machines	533.90
E. B. Latham	Traveling expenses	46.25
O. M. Leland	....do	32.80
V. R. Lyle	....do	180.30
Marine Engine and Machine Co	Purchase of launch	1 118.35
J. E. McGrath	Geographical positions	624.15
David Moyer	Traveling expenses	42.00
Frank B. Meyer	....do	7.95
H. C. Mitchell	Geographical positions	1 120.85
C. E. Morford	Combined operations	557.48
Fremont Morse	Hydrography	1 916.63
J. J. Murphy	Traveling expenses	33.05
Murray & Tregurtha Co	Outfit for launches	141.89
National Vaccine Establishment	Medical supplies for steamers Patterson and McArthur.	6.20
T. S. & J. D. Negus	Outfit for steamer Pathfinder	181.50
Pacific Hardware and Steel Co	....do	257.56
Wm. E. Parker	Traveling expenses	111.25
J. F. Pratt	Combined operations, steamers Patterson and Gedney.	14 149.11
G. R. Putnam	Combined operations	5 474.79
Revenue-Cutter Service	Flags and bunting	249.38
José Vano Reyes	Traveling expenses	122.92
H. W. Rhodes	Hydrography	1 816.88
H. P. Ritter	Combined operations	7 043.59
Aug. F. Rodgers	....do	5 544.86
H. B. Roelker	Outfit for steamer Pathfinder	2 854.00
San Francisco Typewriter Exchange	Typewriter	94.50
Seattle Electric Co	Services	1.10

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

PACIFIC COAST—Continued.

To whom paid.	On what account.	Amount.
Earl B. Shaw	Traveling expenses	$49.41
Edwin Smith	Astronomical	117.50
The G. E. Bernard Co	Electric supplies	10.00
The Geo. W. Knox Express Co	Transportation	49.41
The Roberts Safety Water Tube Boiler Co.	Supplies for launch	25.04
United States Express Co	Transportation	39.42
Williams Welch	Services and traveling expenses	546.99
Ferdinand Westdahl	Combined operations, steamer McArthur	6 853.45
Amount disbursed		87 707.41
Railroad accounts referred to Auditor for settlement		2 132.23
Accounts settled by Auditor for coal, water, and sounding wire, and medical and ordnance stores furnished by Navy and War Departments and Marine-Hospital Service		750.23
Expenditures		90 589.87
Balance on hand, report for 1901		103 334.21
Appropriation, sundry civil act, June 28, 1902		107 500.00
		210 834.21
Expenditures		90 589.87
Present unexpended balance		120 244.34

SPECIAL SURVEYS.

To whom paid.	On what account.	Amount.
Blue Line Transfer Co	Transportation	$20.39
E. S. Randall Potomac River Line Co.	do	1.00
H. L. Marindin	Triangulation and hydrography	667.18
Moore Bros	Purchase of typewriter	36.50
O. H. Tittmann	Traveling expenses	49.65
C. H. Sinclair	N. W. Boundary	89.44
Geo. W. Knox Express Co	Transportation	1.19
United Warehouse Co	do	2.75
D. B. Wainwright	Traveling expenses	33.30
Amount disbursed		891.40
Railroad accounts referred to Auditor for settlement		10.11
Expenditures		901.51
Balance on hand, report for 1901		8 639.87
Appropriations, sundry civil act, June 28, 1902		13 400.00
		22 039.87
Expenditures		901.51
Present unexpended balance		21 138.36

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PARTY EXPENSES, 1902—Continued.

RECAPITULATION.

[Showing expenditures in gross by subitems.]

On what account.	Amount.
Atlantic coast, etc	$75 299.35
Pacific coast, etc	87 707.41
Special surveys	891.40
Amount disbursed	163 898.16
Railroad accounts referred to Auditor for settlement	2 236.59
Accounts settled by Auditor for coal, water, and sounding wire, and medical and ordnance stores furnished by Navy and War Departments and Marine-Hospital Service	2 338.40
Expenditures	168 473.15
Balance on hand, Report for 1901	176 095.02
Appropriations, sundry civil act, June 28, 1902	190 900.00
Total amount available	366 995.02
Expenditures	168 473.15
Present unexpended balance	198 521.87

CLASSIFICATION OF EXPENDITURES FOR PARTY EXPENSES.

Triangulation	$49 219.45
Topography	48 116.20
Hydrography	69 162.50
Astronomical	1 975.00
Total	168 473.15

STEAMER FOR COAST SURVEY.

To whom paid.	On what account.	Amount.
James Reilly Repair and Supply Co.	Final payment for steamer Hydrographer.	$500.00
Balance on hand, Report for 1901		500.00
Expended since, as above		500.00

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

STEAMER BACHE, COAST SURVEY.

To whom paid.	On what account.	Amount.
The Townsend & Downey Shipbuilding and Repair Co.	Rebuilding steamer Bache	$24 386.75
Balance on hand, Report for 1901		24 982.17
Expended since, as above		24 386.75
Present unexpended balance		595.42

GENERAL EXPENSES, 1900.

To whom paid.	On what account.	Amount.
R. R. Bowker	Book	$2.00
Louis P. Casella	Instruments	236.76
Lemcke & Buechner	Books	15.64
E. S. Ritchie & Sons	Miscellaneous	20.00
Expenditures		274.40
Balance on hand, Report for 1901		330.40
Expended since, as above		274.40
Present unexpended balance		56.00

PARTY EXPENSES, 1901.

STATE SURVEYS, ETC.

To whom paid.	Amount.
Railroad accounts referred to Auditor for settlement	$1.18
Balance on hand, Report for 1901	80.07
Expended since, as above	1.18
Present unexpended balance	78.89

RECAPITULATION.

[Showing expenditures in gross, by subitems.]

State surveys, etc	$1.18
Balance on hand, Report for 1901	5 413.11
Expended since, as above	1.18
Present unexpended balance	5 411.93

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

REPAIRS OF VESSELS, 1901.

To whom paid.	On what account.	Amount.
Murray & Tregurtha Co	Launches of steamer Pathfinder	$1 455.00
J. F. Pratt	Steamer Gedney	4 537.00
Spedden Shipbuilding Co	Steamer Blake	2 907.00
Expenditures		8 899.00
Balance on hand, Report for 1901		13 165.59
Expended since, as above		8 899.00
Present unexpended balance		4 266.59

CONTINGENT EXPENSES, OFFICE OF STANDARD WEIGHTS AND MEASURES, 1901.

To whom paid.	On what account.	Amount.
Franz Schmidt & Haensch	Instruments	$320.34
Kruss, A	Apparatus	23.06
Siemens & Halske	do	39.16
Wyckoff, Seamens & Benedict	Typewriter	82.00
Expenditures		464.56
Balance on hand, Report for 1901		1 038.28
Expended since, as above		464.56
Present unexpended balance		573.72

GENERAL EXPENSES, 1901.

To whom paid.	On what account.	Amount.
Cumulative Index Co	Subscription	$5.00
Lemcke & Buechner	Books	7.00
Stechert, G. E	Books	9.50
The George W. Knox Express Co	Transportation	3.21
Amount disbursed		24.71
Railroad accounts referred to auditor for settlement		5.52
Expenditures		30.23
Balance on hand, report for 1901		187.26
Expended since as above		30.23
Present unexpended balance		157.03

Statement of the expenditures of the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1902—Continued.

PAY, ETC., OF OFFICERS AND MEN, VESSELS, COAST SURVEY, 1901.

To whom paid.	On what account.	Amount.
J. J. Gilbert	Pay of enlisted men	$88.03
J. F. Pratt	Pay rolls, steamer Patterson	2 906.39
Expenditures		2 994.42
Balance on hand, report for 1901		15 853.38
Expended since as above		2 994.42
Present unexpended balance		12 858.96

GENERAL RECAPITULATION.

[Showing expenditures and balances for the fiscal year ended June 30, 1902, and for all other accounts included in this report].

Name of appropriation.	Appropriated.	Expended.	Balances.
Salaries, 1902, sundry civil act, Mar. 3, 1901:			
Pay of field officers	$127 260.00	$112 566.88	$14 693.12
Pay of office force	145 240.00	143 967.95	1 272.05
Party expenses, 1902, sundry civil act, Mar. 3, 1901	69 100.00	66 968.72	2 131.28
Repairs of vessels, 1902: Sundry civil act, Mar. 3, 1901 $29 600.00; Deficiency act, Feb. 14, 1902 25 000.00	54 600.00	52 181.21	2 418.79
Publishing observations, 1902, sundry civil act, Mar. 3, 1901	1 000.00	1 000.00	....
General expenses, 1902: Sundry civil act, Mar. 3, 1901 $32 000.00; Deficiency act, July 1, 1902 2 500.00	34 500.00	34 346.85	153.15
Pay, etc., of officers and men, vessels, Coast Survey, 1902, sundry civil act, Mar. 3, 1901	182 745.00	165 214.76	17 530.24
Pay, etc., of officers and men, vessels, Coast Survey, 1901 and 1902, sundry civil act, Mar. 3, 1901	27 500.00	24 527.73	2 972.27
Party expenses: Balance on hand, Report for 1901 $176 095.02; Appropriation, sundry civil act, June 28, 1902 190 900.00	366 995.02	168 473.15	198 521.87
Steamer for Coast Survey, balance on hand, Report for 1901	500.00	500.00	....
Steamer Bache, Coast Survey, balance on hand, Report for 1901	24 982.17	24 386.75	595.42
General expenses, 1900, balance on hand, Report for 1901	330.40	274.40	56.00
Party expenses, 1901, balance on hand, Report for 1901	5 413.11	1.18	8 411.93
Repairs of vessels, 1901, balance on hand, Report for 1901	13 165.59	8 899.00	4 266.59
Contingent expenses, office of Standard Weights and Measures, 1901, balance on hand, Report for 1901	1 038.28	464.56	573.72
General expenses, 1901, balance on hand, Report for 1901	187.26	30.23	157.03
Pay, etc., of officers and men, vessels, Coast Survey, 1901, balance on hand, Report for 1901	15 853.38	2 994.42	12 858.96
Total	1 070 410.21	806 797.79	263 612.42

VI. OFFICE OF EDITOR OF PUBLICATIONS.

ISAAC WINSTON, *Editor.*

C. F. Dewoody, *Stenographer and typewriter, Sept. 28 to Nov. 18.*

C. J. Hellerstedt, *Stenographer and typewriter, Nov. 19 to June 30.*

On July 1, 1901, the Annual Report for 1900 was running through the press, and nearly all the proof of this publication was read after that date. An index to the volume was prepared and the last revised proof was returned to the printer on October 24. Bound copies were received for distribution on April 1, 1902.

The fourteen leaflets prepared for distribution at the Buffalo Exposition were revised, and a new edition prepared for printing and sent to the printer on August 6. The Spanish translation of thirteen of the first edition of these leaflets was revised by M. Felipe Valle, Ingénieur-géographe, Directeur de l'Observatoire astronomique, Professor a l'Ecole militaire, Membre du Conseil supérieur du Cadastre, Tacubaya, Mexico, and the accuracy of the translation, which has elicited complimentary comment from a distinguished Spanish scientist, is due to his courteous kindness. The Spanish edition of the leaflets was published on July 24, 1901. An abstract of the work of the Survey during the fiscal year ending June 30, 1901, was prepared for the Annual Report of the Secretary of the Treasury.

The Annual Report covering the progress of the work for the fiscal year ending June 30, 1901, was compiled, prepared for printing and submitted to Congress ready to print on December 6, 1901. This included the work of editing Appendix No. 3.

The first proof of Special Publication No. 7, "The Oblique Arc of the United States and Osculating Spheroid," was received on January 2 and final proof of this publication was returned to the printer on February 27, 1902. Bound copies of the volume were received on June 25, 1902.

The first proof of your Annual Report for 1901 was received on February 25, 1902, an alphabetical index was prepared and the final proof was returned to the printer on March 25. Bound copies of the volume were received on June 13, 1902.

A list of geographic names in the Hawaiian Islands was edited and prepared for printing.

United States Coast Pilot, Part VI, Chesapeake Bay and Tributaries, prepared in the Office of the Inspector of Hydrography and Topography, was sent to the printer. The proof of this publication was read by the Coast Pilot party, but only a few unbound copies were received in advance, by the courtesy of the Public Printer, before the close of the fiscal year.

A volume of Tide Tables for 1903, prepared in the Tidal Division, was sent to the printer and nearly all the proof was read by the Tidal Division before the close of the fiscal year.

A new edition of the Catalogue of Charts, prepared in the Chart Division, was edited and printed, but no copies were received during the year.

A large volume, the United States Declination Tables, prepared in the Division of Terrestrial Magnetism, was edited and sent to the printer.

In addition to the above, the routine duties of Editor and numerous assignments to temporary duty were performed.

Previous to September 28, a typewriter was assigned to this office on two occasions for short periods. From November to July, about two-thirds of the time of the typewriter was occupied in compiling a list and catalogue of the publications of the Coast and Geodetic Survey, covering the period of its existence, under the direction of the Librarian, Mr. E. L. Burchard.

The publications of the Coast and Geodetic Survey during the fiscal year are given in the following list:

Report of the Superintendent Coast and Geodetic Survey showing the progress of the work from July 1, 1899, to June 30, 1900, with the following appendices published also as separates:

No. 3. Oblique Boundary Line between California and Nevada, by C. H. Sinclair, Assistant.

No. 4. Proportion and spacing of Roman Letters as ascertained from the best examples, by Williams Welch, Draftsman.

No. 5. The International Latitude Service at Gaithersburg, Md., and Ukiah, Cal., under the auspices of the International Geodetic Association, by Edwin Smith, Coast and Geodetic Survey, and Mr. F. Schlesinger, Special Observer.

No. 6. Description of Precise Levels Nos. 7 and 8, Coast and Geodetic Survey, 1900, by E. G. Fischer, Chief of Instrument Division, Coast and Geodetic Survey.

No. 7. Manual of Tides. Part IV A. Outlines of Tidal Theory, by Rollin A. Harris.

No. 8. The determination of the mean value of a micrometer screw, by Edwin Smith, Assistant.

Report of the Superintendent Coast and Geodetic Survey, showing the progress of the work from July 1, 1900, to June 30, 1901, with the following appendices published also as separates:

No. 3. On the measurement of nine base lines along the ninety-eighth meridian, by A. L. Baldwin, Computer and Chief of Party, with preface by J. F. Hayford, Assistant, etc.

No. 4. Extension of Tables for the computation of Geodetic Positions to the Equator, by John F. Hayford, Assistant, etc.

No. 5. Determination of relative value of Gravity in Europe and the United States in 1900, by G. R. Putnam, Assistant.

No. 6. Triangulation northward along the ninety-eighth meridian in Kansas and Nebraska, by John F. Hayford, Assistant, etc.

The Eastern Oblique Arc of the United States and Osculating Spheroid, by Charles A. Schott, Assistant. (Special publication No. 7.)

United States Coast Pilot, Pacific Coast, Alaska, Part I, from Dixon Entrance to Yakutat Bay, with inland passage from Juan de Fuca Strait to Dixon Entrance. Fourth edition.

Bulletin No. 40. Alaska Coast Pilot Notes on the Fox Island Passes, Unalaska Bay, Bering Sea, and Arctic Ocean as far as Point Barrow. Fourth edition, with additions and changes.

Notices to Mariners Nos. 273 to 285.

Fourteen leaflets (illustrated) describing the work of the Coast and Geodetic Survey. Second English edition.

Thirteen leaflets (illustrated) describing the work of the Coast and Geodetic Survey. Spanish edition.

NECROLOGY.

The loss to the Survey by death during the year was unusually heavy, as shown by the following list:

Mr. William A. Thompson, Engraver, died on July 22, 1901.

He was born September 18, 1838, at Washington, D. C., and entered the Coast Survey as an apprentice in his seventeenth year. He served eighteen months without compensation and was permanently appointed on July 1, 1856. His service was continuous until death ended his long and useful life. He was appointed Chief Engraver in 1897, and still held that position at the time of his death.

The numerous copperplates in the archives engraved by him show the excellence of his work and form an enduring monument to his patience and industry.

The announcement of the death of Assistant Schott, issued by the Superintendent, is republished below:

U. S. COAST AND GEODETIC SURVEY,
Washington, D. C., August 19, 1901.

The Superintendent announces with great regret the death of Charles Anthony Schott, Assistant in the Coast and Geodetic Survey. After being ill for four months, he passed quietly away at his home on July 31, 1901. This sad event has deprived the Survey of one of its oldest and most able members.

Mr. Schott was born at Mannheim, Baden, Germany, August 7, 1826, and graduated from the Polytechnic School at Carlsruhe with the degree of civil engineer in 1847. He came to the United States in 1848, and at once began his life work in the Computing Division of the Coast and Geodetic Survey. During the years 1850 to 1855 he acted as Chief of the Division during irregular periods, and from 1855 until the close of 1899 was continuously in full charge of that important part of the office.

In 1898 he attended, as the representative of the United States Coast and Geodetic Survey, the International Conference on Terrestrial Magnetism, held in Bristol, England. On February 4, 1899, at the White House, Mr. Schott was presented by the President of the United States with the Wilde prize, which had been conferred upon him by the Academy of Sciences of France in recognition of his researches in terrestrial magnetism. According to the terms accepted by the academy in founding the prize, it was to be given each year to the person from any nation whose discoveries in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics are judged by the academy to be most worthy of reward.

On January 1, 1900, Assistant Schott was relieved of the burden of the charge of the Computing Division, which he had carried with most remarkable success for nearly a half century. Thus freed from the daily round of exacting routine duties, and with two computers to help him, he was authorized to devote all his time to the problem of determining the size and figure of the earth from the geodetic measures made within the United States. During 1900 and the first half of 1901 his great work, "The Transcontinental Triangulation," was put into print, and the manuscript of his report on the "Eastern Oblique Arc of the United States" was made ready for the printer.

To few men has it been given as to Assistant Schott to have a long and useful life completely rounded out in its latter days by the receipt of well-deserved honors and by the satisfactory completion of great works.

At a meeting of the members of the Coast and Geodetic Survey held at the office on August 1, 1901, the following well-deserved tribute to Assistant Schott was unanimously adopted:

He was enthusiastic, faithful, and diligent in all duties he was called upon to perform, and through his learning and probity earned a reputation extending over two continents which is most worthy of emulation. Conscientious and expert in his specialties, geodesy and terrestial magnetism, his labors added immeasurably to the reputation of the Bureau and of his comrades who gathered the material he so ably discussed. The methods of computation now in use in the Bureau are an indelible record of his ability. His high ideals of duty and his tireless and persistent striving for them made him stand forth as a noble example of the best type of public official, and his uniform kindliness endeared him to those who knew him as a friend.

O. H. TITTMANN, *Superintendent.*

Mr. Charles Mahon, Draftsman, died on January 8, 1902. Mr. Mahon was a native of Pennsylvania and entered the Survey previous to 1850, serving first as hydrographic draftsman on board ship, and afterwards as topographic draftsman in the office. In 1850 he resigned the position of draftsman, but continued to make topographic drawings for the Survey under contract until 1853, when he went South and was employed in railroad business. He was chief engineer of the Charleston and Savannah Railroad previous to the civil war.

About 1875 he was employed in the Hydrographic Office of the Navy Department, and on October 12, 1885, he was again appointed draftsman in the Coast and Geodetic Survey and served in that capacity until he died.

Mr. Edward Henry Courtenay, Computer, died on June 3, 1902.

Mr. Courtenay was born April 11, 1842, in Rhode Island, and entered the Coast Survey January 2, 1862, in his nineteenth year.

He was immediately assigned to duty in the Computing Division of the Office, and his service was continuous until he died. For many years he was the senior computer in the Service.

A meeting of his associates in the Computing Division was held on the day after his death and the following resolution was adopted:

That in the death of our late associate, Edward Henry Courtenay, we have lost a co-worker whose courtesy, patient forbearance, and kindliness endeared him to all, and the Survey a member who has devoted his whole working life with undivided loyalty to its service. We can but feebly pay tribute to the memory of a fellow-worker whose splendid attainments are recognized by every member of the Survey. A member of the Computing Division during the years when its methods were being rapidly developed, he was of invaluable assistance with his unusual talent for systematic and careful work. For over forty years he gave able and devoted service, and has left in the archives of this Office many volumes of his computations and adjustments, work which for accuracy and completeness has no equal, and which will always be an enduring memorial to him.

APPENDIX No. 1.

REPORT 1902.

DETAILS OF FIELD OPERATIONS.

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EASTERN DIVISION.

MAGNETIC OBSERVATIONS.	DISTRICT OF COLUMBIA. KENTUCKY. MARYLAND. PENNSYLVANIA.	L. A. BAUER.

W. G. CADY, *Magnetic Observer.*	July 1 to May 3.
S. A. DEEL, *Magnetic Observer.*	Mar. 22 to June 30.
J. W. MILLER, *Magnetic Observer.*	July 1 to Dec. 16.
L. G. SCHULTZ, *Magnetic Observer.*	May 1 to June 30.
R. W. WALKER, *Magnetic Observer.*	July 1 to July 31.
W. F. WALLIS, *Magnetic Observer.*	July 1 to July 17.
W. WEINRICH, Jr., *Magnetic Observer.*	July 1 to July 31. Jan. 1 to Jan 24.

Magnetic observations in various localities in the Eastern Division were placed in charge of Assistant L. A. Bauer, and the observers named above were assigned to work under his direction as chief of party. Mr. W. G. Cady was continued in immediate charge of the magnetic observatory at Cheltenham, Md., until May 1, 1902, when he was relieved and the immediate charge of the observatory transferred to Mr. L. G. Schultz.

The Adie magnetograph was in operation continuously, giving photographic records of the three magnetic elements, and very few hourly values were lost. The necessary observations for scale value and torsion were made. Three Eschenhagen magnetographs were received at the observatory during the year at different times, as follows: No. 6 was examined and returned to the Office without being set up; No. 4 was in operation from August 21 to October 2 for tests and comparisons, and was then returned to the Office; No. 5 was in operation continuously after August 29, and is the standard set of variation instruments at the observatory. It recorded only the declination and horizontal intensity previous to April 22, when the instrument for measuring the vertical intensity was put in operation, but a satisfactory record of the vertical intensity could not be secured without an additional recording apparatus, which was not secured before the close of the fiscal year. The necessary scale values were determined, and the clockwork was so adjusted that a successful record can be obtained when the cylinders rotate once in two hours. The average daily range of temperature in the variometer rooms was not more than two or three tenths of a degree Centigrade. A sudden change of temperature outside produces a comparatively small change inside the variometer rooms and the effect is only shown after a considerable interval of time, sometimes after another change of the temperature on the outside from rising to falling or the contrary. Observations were made each week to determine the absolute value of the three magnetic elements. Meteorological observations were made daily in the manner prescribed by the United States Weather Bureau for "voluntary observers."

Mr. W. Weinrich, jr., July 1 to July 27, made observations to determine the magnetic elements, and established meridian lines for surveyors' use at the following places in *Kentucky*: Greenville, Morganfield, Owensboro, Paducah, Princeton, Russellville.

Mr. J. W. Miller, October 1 to November 26, made observations to determine the magnetic elements, and established meridian lines for surveyors' use at the following places in *Pennsylvania*: Bedford, Bellefonte, Carlisle, Clearfield, Ebensburg, Gettysburg, Greensburg, Harrisburg, Indiana, Lancaster, Lebanon, Lockhaven, Middleburg, Somerset, Uniontown, Washington, Waynesburg, Westchester, Williamsport, York.

HYDROGRAPHY.	MARYLAND.	J. B. BOUTELLE, Commanding.
RECONNAISSANCE.	NEW YORK.	Schooner *Eagre*.
TOPOGRAPHY.		
TRIANGULATION.		

New York—July 7 to November 24.

O. W. FERGUSON, *Assistant.*	July 29 to Nov. 24.
F. H. AINSWORTH, *First Watch Officer.*	Sept. 5 to Nov. 24.
W. B. PROCTOR, *Watch Officer.*	July 1 to Sept. 6.
J. E. SHEPHERD, *Surgeon.*	July 8 to Nov. 30.
B. E. TILTON, *Aid.*	Aug. 20 to Sept. 23.
J. H. ULLRICH, *Assistant Surgeon.*	
R. McD. MOSER, *Deck Officer, First Class.*	
A. C. L. ROETH, *Deck Officer, First Class.*	July 27 to Nov. 24.

SUMMARY OF RESULTS.

Hydrography:
- 30 square miles area covered by soundings.
- 262 miles lines sounded.
- 4 tide stations established.
- 2 current stations established.
- 3 hydrographic sheets completed.

Reconnaissance:
- 25 square miles area covered.
- 77 triangulation points selected.

Topography:
- 4 square miles area surveyed.
- 41 miles shore line of rivers surveyed.
- 2 miles shore line of creeks surveyed.
- 11 miles roads surveyed.
- 2 topographic sheets completed.

Triangulation:
- 25 square miles area covered.
- 31 stations occupied.
- 58 geographic positions determined.

Maryland—February 27 to June 30.

R. McD. MOSER, *First Watch Officer.*	
G. E. MARCHAND, *Surgeon.*	June 17 to June 30.
J. H. ULLRICH, *Surgeon.*	
THOMAS L. JENKINS, *Watch Officer.*	May 26 to June 6.
SWEPSON EARLE, *Deck Officer.*	Apr. 16 to June 30.

G. OLSEN, *Deck Officer.*	June 17 to June 30.
O. M. SPARROW, *Aid.*	June 10 to June 30.
H. W. MCALL, *Acting Deck Officer.*	Feb. 26 to Apr. 11.
F. N. PINNER, *Acting Deck Officer.*	May 14 to June 30.
J. W. YATES, JR., *Acting Deck Officer.*	May 17 to June 30.
L. S. PIQUETT, *Acting Deck Officer.*	June 7 to June 30.
C. E. SKEEN, *Acting Deck Officer.*	June 11 to June 30.

SUMMARY OF RESULTS.

Hydrography:
41 square miles area covered by sounding.
478 miles of lines sounded.
4 tide stations established.
1 hydrographic sheet completed.

The completion of the hydrographic survey in the vicinity of Shooters Island, New York, commenced during the previous fiscal year under the direction of Assistant Vinal, was assigned to Assistant J. B. Boutelle, commanding the schooner *Eagre*. The vessel reached New York on July 7, and field work began immediately. The survey was completed on July 20, and the vessel proceeded to Erie Basin for repairs to the steam launch *Inspector*, which were completed on August 9.

On that date the vessel proceeded to Ossining, N. Y., in order to continue the survey of the Hudson River in that vicinity. The survey began in the vicinity of Hook Mountain, at a point where the work of the previous season closed, and was extended to a point just above Anthonys Nose. The shore line was verified, and wherever changes had occurred a new survey was made. The triangulation was extended from Stony Point Light-House to Anthonys Nose, and the hydrography covered the river within these limits. The sounding lines were run and crossed at distances from 100 to 300 meters.

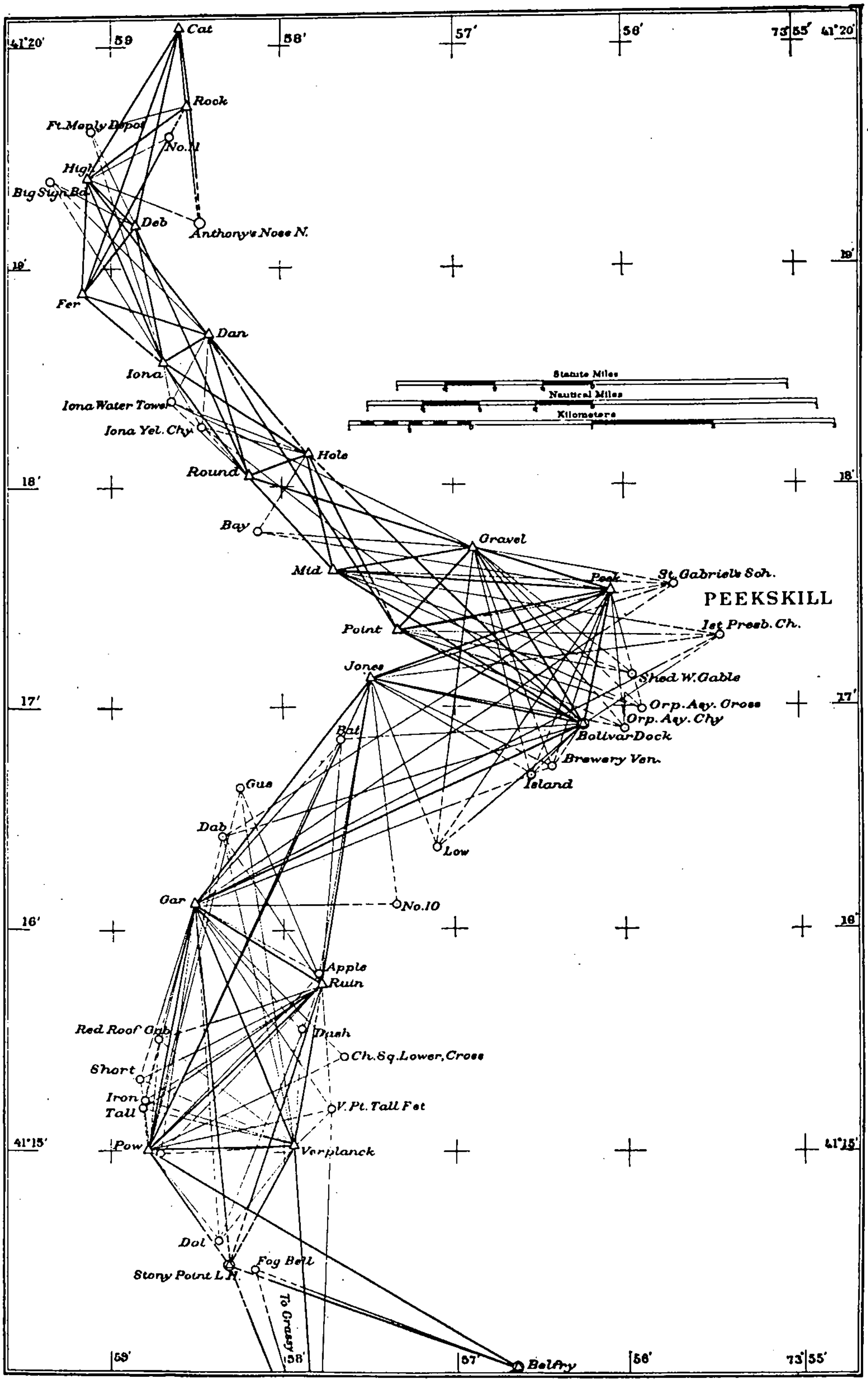
The work in this vicinity closed on November 24, and the vessel proceeded to New York for repairs. While the repairs were in progress, the position of the following light-houses, beacons, etc., was determined: Robbins Reef Light-House, West Bank Light-House, Great Beds Light-House, Governors Island Post Light, Waackaack Rear Beacon, Sandy Hook North Beacon, Sandy Hook South Beacon, Sandy Hook Fog Bell.

On February 27, 1902, the party on the *Eagre* began the hydrographic resurvey on the Tred Avon and Choptank rivers, in Chesapeake Bay, Maryland. Tide gauges were established at Oxford, Cambridge, Choptank River Light-House, and Sharps Island Light-House, and the signals needed in the work were erected. The hydrographic work was continued by the whole party until June 17, except for twenty days in May (7 to 27), when the vessel was at Baltimore for repairs.

On June 17 the vessel proceeded to New York, and was engaged in experiments in the use of wireless telegraphy under the direction of Assistant Wainwright for the remainder of the fiscal year.

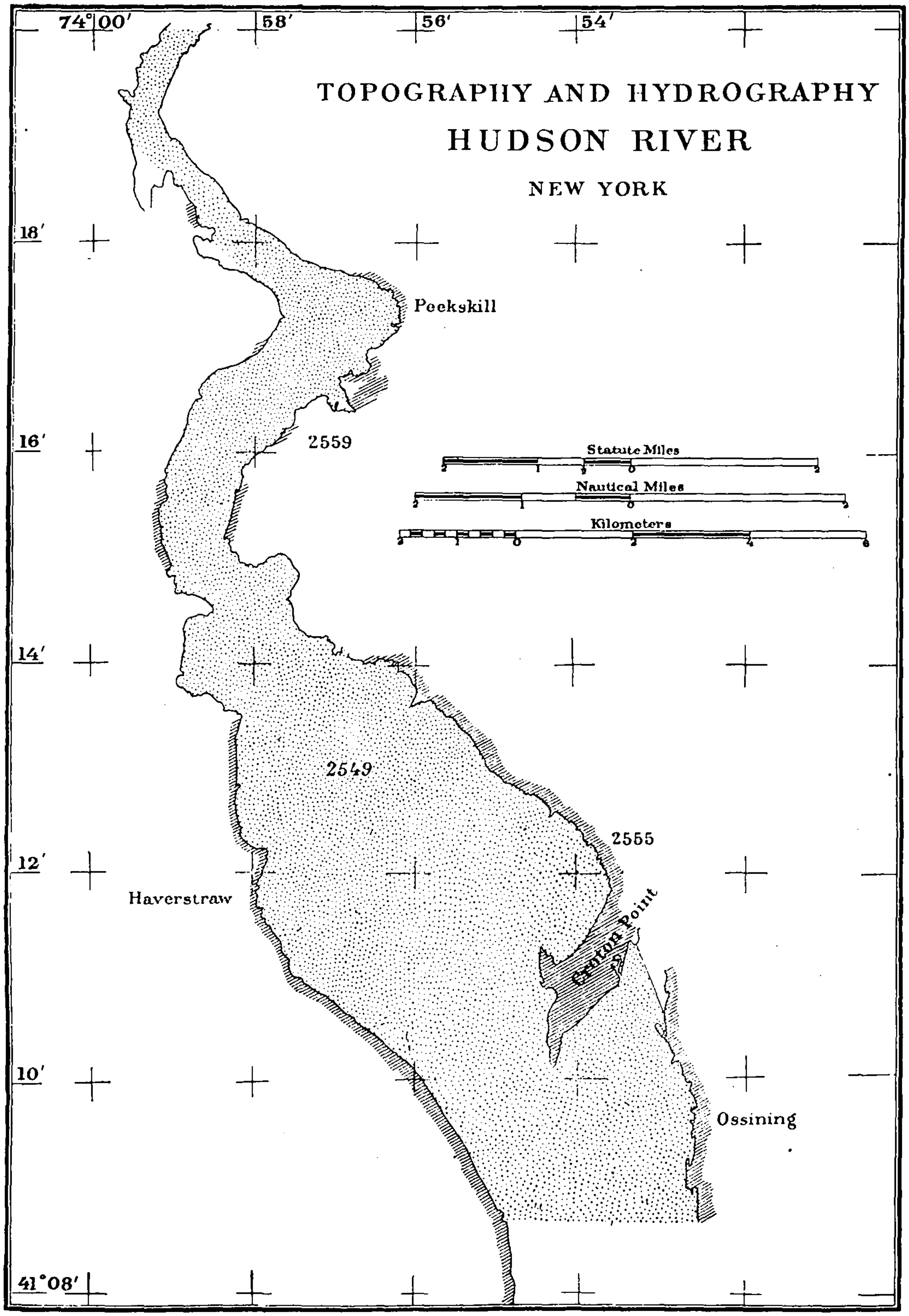
A party consisting of five officers and five seamen, with the steam launch *Inspector* and a whaleboat, was landed at Oxford and left to continue the work under charge of Watch Officer Moser, and the work was in progress on June 30. The statistics of the work are given above.

No. 1.

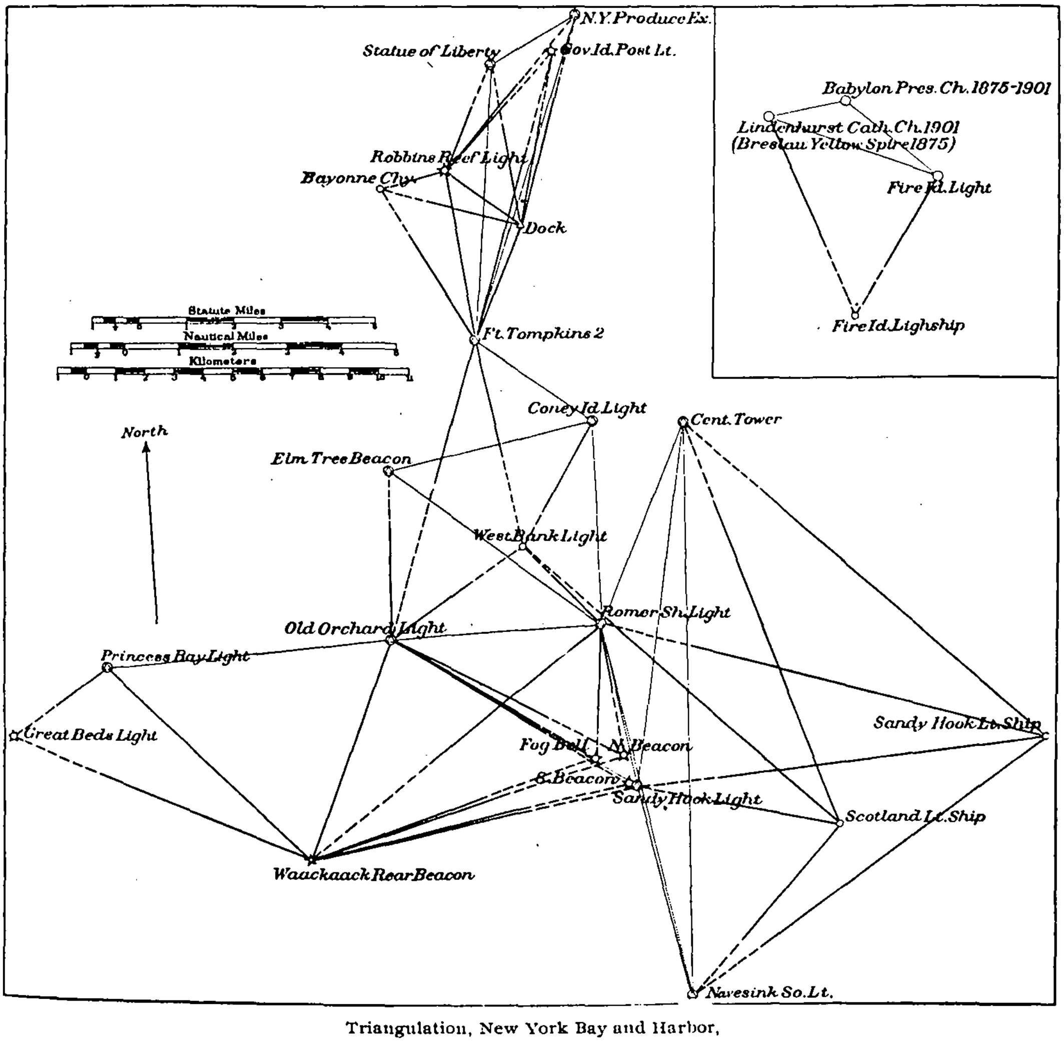


Triangulation, Hudson River, N. Y.

No. 2.

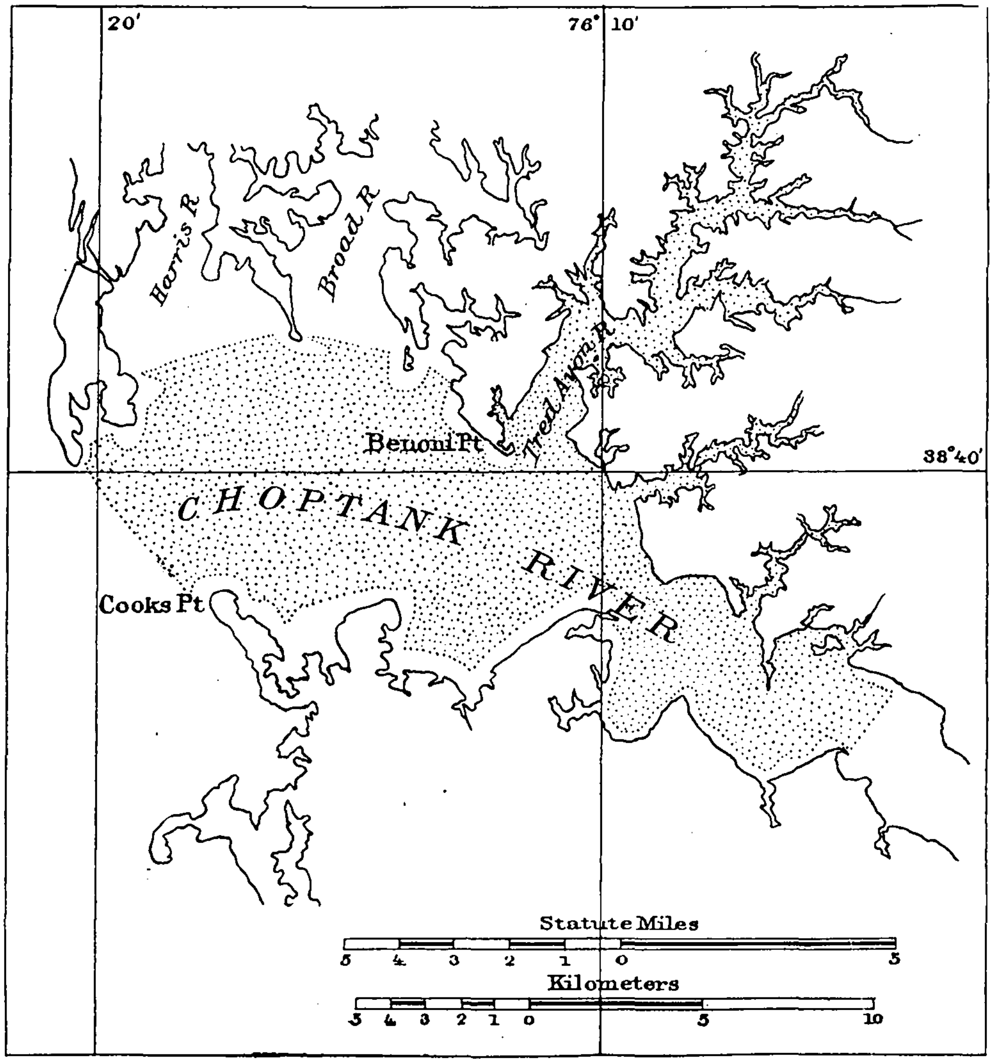

74° 00′
58′
56′
54′
TOPOGRAPHY AND HYDROGRAPHY
HUDSON RIVER
NEW YORK
18′
Peekskill
16′
2559
Statute Miles
Nautical Miles
Kilometers
14′
2549
2555
12′
Haverstraw
Croton Point
10′
Ossining
41° 08′

No. 3.



Triangulation, New York Bay and Harbor,

O. 4.



Hydrography, Choptank River, Chesapeake Bay.

HYDROGRAPHY. TOPOGRAPHY. — DISTRICT OF COLUMBIA. NEW JERSEY. NEW YORK. — WILLIAM BOWIE.

SUMMARY OF RESULTS.

Shooters Island, New York

Hydrography:
- 11 miles of lines sounded.
- 1 tide station occupied.
- 1 365 soundings made.

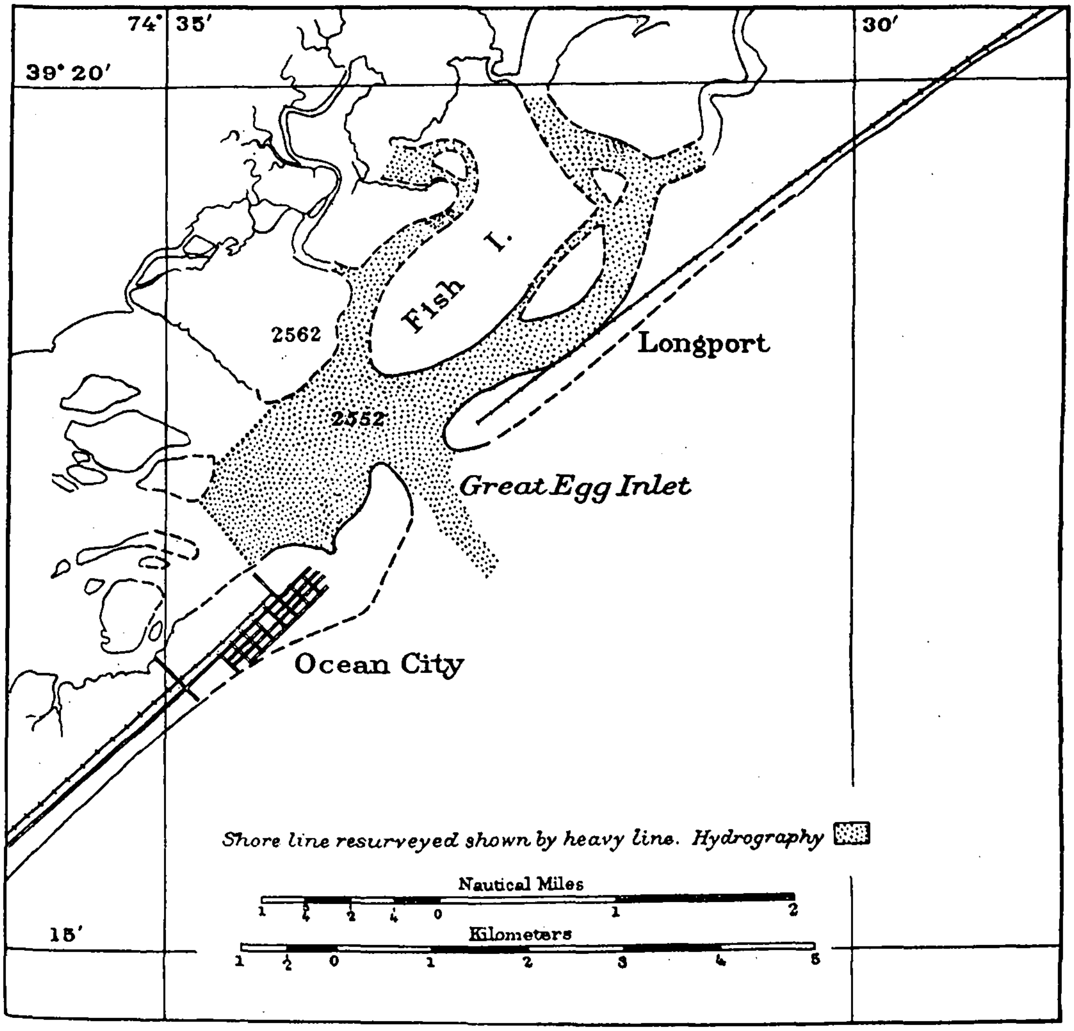
Great Egg Harbor, New Jersey.

Hydrography:
- 48 miles of line sounded.
- 2 804 soundings made.
- 2 tide stations established.
- 1 hydrographic sheet completed.

Topography:
- 6 miles of coast line surveyed.
- 1 topographic sheet completed.

Triangulation:
- 3 stations occupied.

No. 5.



Topography and Hydrography, Great Egg Inlet, N. J.

In response to a request from Mr. J. K. Taylor, Supervising Architect of the Treasury Department, for a topographic sketch of that portion of the old Naval Observatory

Reservation, on which it was proposed to erect a laboratory for the Marine-Hospital Service, Assistant Bowie was instructed to make the observations required to furnish the desired information. He made the necessary preparations and executed the field work, which included cross sections of the site of the building at intervals of ten feet. Four days, October 23 to 26, were occupied in the work and the elevations were all referred to the Datum Plane of the Topographic Survey of the District of Columbia. A sketch showing the details desired was prepared and forwarded to Mr. Taylor.

A special examination of the shore line and hydrography at the entrance of Great Egg Harbor, New Jersey, was ordered for the purpose of ascertaining the depth of water which could be carried through the channel from Atlantic City and across the harbor to Ocean City. This work was assigned to Assistant Bowie, and Deck Officer Gershom Bradford 2d was detailed to assist in the work. The party reached Ocean City on December 2 and the work was completed on December 21. Three triangulation stations were occupied with a plane table, and the position of a number of objects determined for use in the topographic and hydrographic work. These stations were also occupied with a theodolite and certain necessary angles measured. Tide gauges were established at Ocean City and at Longport. Continuous tide observations, day and night, were made at Ocean City for sixteen days, and day observations were made at Longport for seven days. Both tide gauges were referred to permanent bench marks. A portion of the shore line of Beach Thoroughfare and at the entrance was surveyed with a plane table, and a distance of 6 miles covered. The weather was unfavorable for hydrographic work on account of strong wind and freezing temperature frequently prevailing. The strong tides in Beach Thoroughfare prevented the adoption of a regular system of sounding lines normal to the shore, except at slack water, and a system of lines diagonal to the current was substituted. A jetty was under construction at Longport to protect the point of land to the north of the Inlet, and for the purpose of producing a channel across the large sand flat in front of Longport, and its position was determined. In his report on the work, Assistant Bowie expresses his appreciation of the valuable assistance rendered by Deck Officer Bradford and Quartermaster Emanuelson in the prosecution of the work.

A hydrographic examination in the vicinity of Shooters Island, New York, was undertaken for the purpose of verifying the soundings shown on the hydrographic sheet covering the region, and the work was assigned to Assistant Bowie. He proceeded to the locality, accompanied by Mr. William Sanger, captain's clerk, and made the necessary observations. A boat and such officers and men as were needed were assigned to the work by Assistant Welker, commanding the steamer *Bache*, who also detailed a man to make tide observations. The work was successfully completed in four days, January 22 to 25.

LEVELING. ALABAMA. MISSISSIPPI. NEW YORK. W. C. DIBRELL.

SUMMARY OF RESULTS, OCTOBER 20 TO DECEMBER 10.

Alabama and Mississippi.

88 kilometers double line.
64 kilometers single line.
20 bench marks established.

SUMMARY OF RESULTS, APRIL 15 TO JUNE 14.

New York.

215 kilometers of completed line.
90 bench marks established.

The adjustment of the precise leveling work in the United States, executed to date, indicated a serious discrepancy in a closed figure, including the line from Decatur, Ala., to Corinth, Miss., and it was decided to revise the elevations along this line.

These elevations were determined under the direction of the Corps of Engineers, U. S. Army, in connection with the improvement of the Tennessee River.

Aid Dibrell was instructed to make the revision by rerunning the line beginning at Decatur and carrying a single line of levels over the route along the Southern Railway. Alternate sections, approximately equal, were leveled in opposite directions and the elevation of all permanent bench marks, which were recovered, was verified as stated. When the work reached Tuscumbia it was found necessary to level back to Decatur, which completed a double line between these points, run in the usual manner in both directions. A single line was leveled between Tuscumbia and Corinth, and 19 kilometers of the distance was releveled on account of a change indicated in the elevations of two old bench marks, which it was necessary to verify. In leveling between Burnsville and Iuka, Miss., the discrepancy indicated by the adjustment of the figure was discovered and verified, and the line closed at Corinth in a satisfactory manner. The party reached Decatur, Ala., on October 20 and was disbanded at Corinth, Miss., on December 10. Velocipede cars were not used on this work, and considerable time was lost in walking to and from work.

In order to revise the elevations previously established along the Hudson River between Dobbs Ferry and Rensselaer (Greenbush), N. Y., Aid Dibrell organized a leveling party at Dobbs Ferry and began field work on April 15 by establishing three new bench marks at that place. One of the old bench marks previously established was found undisturbed and in good condition and it was used as a base for the leveling work. The route follows the New York Central and Hudson River Railroad to Rensselaer, N. Y. The usual method of running the levels in both directions was used on this work. The elevation of numerous bench marks previously established along the route was determined, and at Poughkeepsie, Hudson, and Troy the line was connected with the bench marks used by the city engineers. The elevations of two bench marks established by the United States Geological Survey at Poughkeepsie, and of nine bench marks established by the Deep Waterways Commission at Hudson, Stockport, Stuyvesant, Stuyvesant Light-House (one between Stuyvesant and Castleton), Castleton, Rensselaer, and Troy were also determined. The line was connected with eighteen railroad bench marks. Two unusual conditions were found on this line, very slight changes of elevation prevailed and a large body of water was nearly always present on one side of the line. The traffic was heavy and the numerous trains prevented the use of velocipede cars as the means of transportation, which resulted in much loss of time and made the work unusually laborious. The work was completed on June 14.

TOPOGRAPHY.
TRIANGULATION.

MARYLAND.

J. W. DONN.

SUMMARY OF RESULTS, JULY 1 TO NOVEMBER 30.

Topography:
74 square miles area surveyed.
232 miles of shore line surveyed.
150 miles of road surveyed.
2 topographic sheets completed.
Triangulation:
12 square miles of area covered.
71 stations occupied.
72 geographic positions determined.

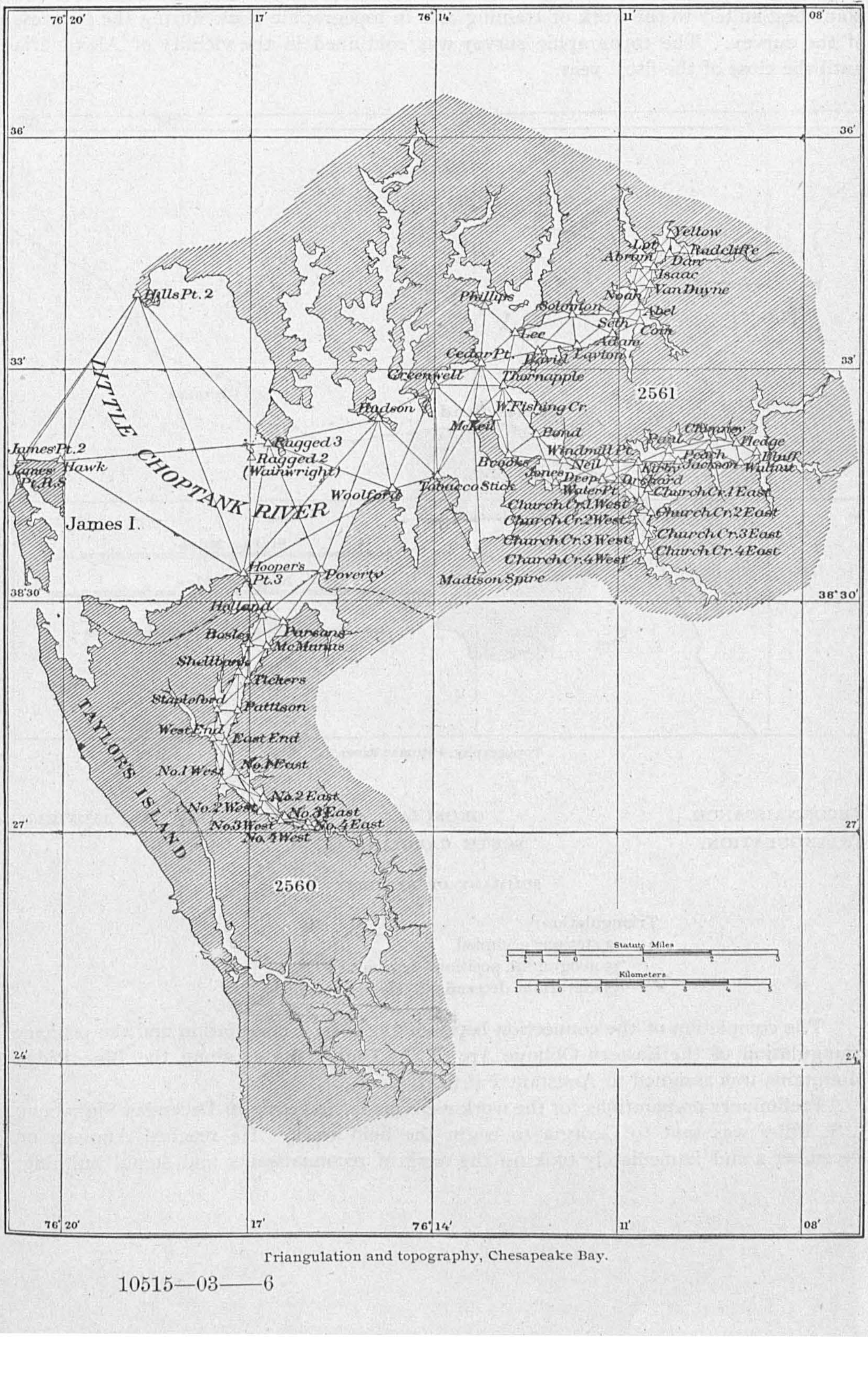
MAY 22 TO JULY 30.

Topography:
1 000 acres of area surveyed.
2 miles of shore line surveyed.
3 miles of road surveyed.
5 miles of trolley roads surveyed.

The topographic survey of the Little Choptank River was in progress on July 1, 1901, by a party under charge of Extra Observer J. W. Donn. During the month of July the triangulation of the lower portion of the river and southward along the line of Slaughter Creek was continued, and a survey was made of the shore line of James Island, the upper end of Taylors Island, and the river from Hills Point and Oyster Bay to Ragged Point and Tobacco Stick Bay. The work was also extended southward to the Honga Bridge, and the topography on the east side of Slaughter Creek from the bridge at Honga crossing to that at Taylors Island was completed. The old survey of 1843–1848 was examined and partially revised. The shore and marginal work of the bay from Meekins Neck to Oyster Bay Inlet was also completed. The necessity for a survey of Slaughter Creek from the Little Choptank to the Honga was recognized and an attempt was made to extend the triangulation over the region, but it was found to be impracticable to make observations across the wide expanse of marsh. The shores of the creek were so unstable along more than half its length that it was decided to close the triangulation when half the distance had been covered, and to extend the work by a plane table traverse to Honga Bridge. The triangulation was extended up the Little Choptank to a point within a mile of the head, and up Fishing and Church creeks about the same distance. In surveying the shore line careful provision was made to facilitate the hydrographic work, and many plane-table points were marked and described, and other objects back from the shore determined. The work closed on November 30.

In April Mr. Donn was directed to take up the topographic survey of the Potomac River between Indianhead, Md., and Georgetown, D. C. On June 1 a special survey of the Naval Reservation at Indianhead was begun, and this work was completed on the 18th. José Vano Reyes, aid, joined the party on the 3d and remained until the 7th. The members of the party had no experience in executing large scale work, but they gave close attention to their duties and good progress was made. Contours at intervals of 5 feet were determined over all open ground, including the route of the trolley lines which extend from the Potomac River to Mattawoman Creek connecting the factories

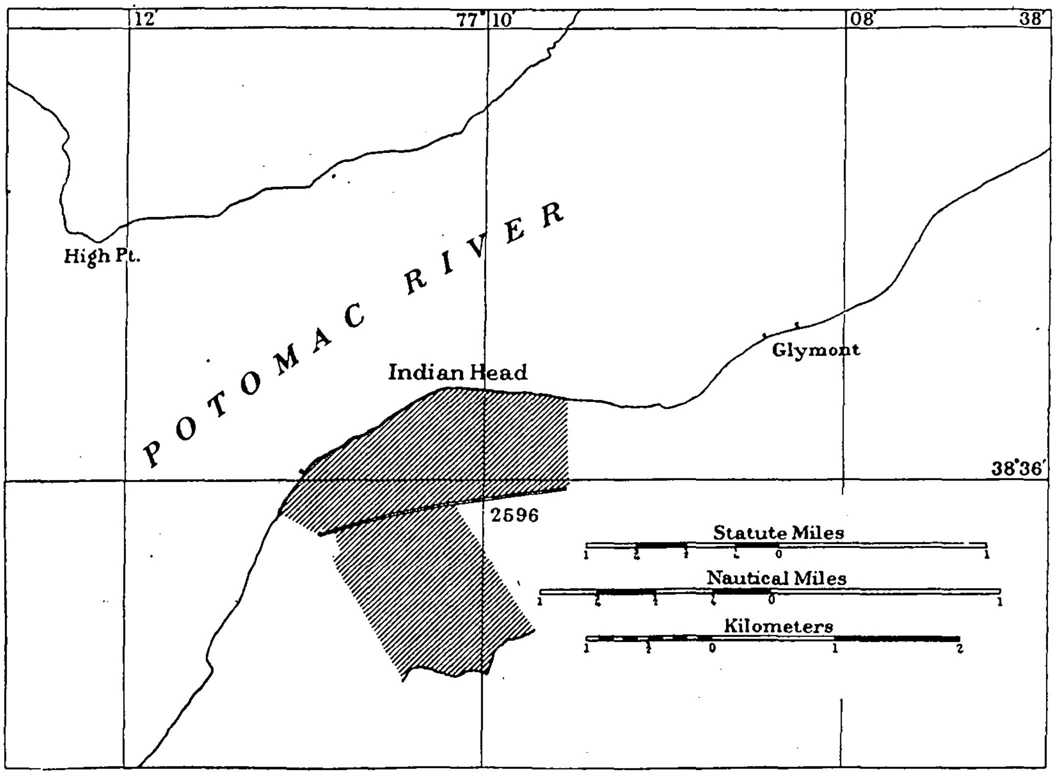
No. 6.



Triangulation and topography, Chesapeake Bay.

and other buildings. After completing this work the party moved to Alexandria as the point best suited to the work of training aids in topographic work during the progress of the survey. The topographic survey was continued in the vicinity of Alexandria until the close of the fiscal year.

No. 7.



Topography, Potomac River.

RECONNAISSANCE. GEORGIA. W. B. FAIRFIELD.
TRIANGULATION. SOUTH CAROLINA.

SUMMARY OF RESULTS.

Triangulation:
- 12 stations occupied.
- 35 geographic positions determined.
- 35 elevations determined trigonometrically.

The completion of the connection between the coast triangulation and the primary triangulation of the Eastern Oblique Arc of the United States along the Blue Ridge Mountains was assigned to Assistant Fairfield.

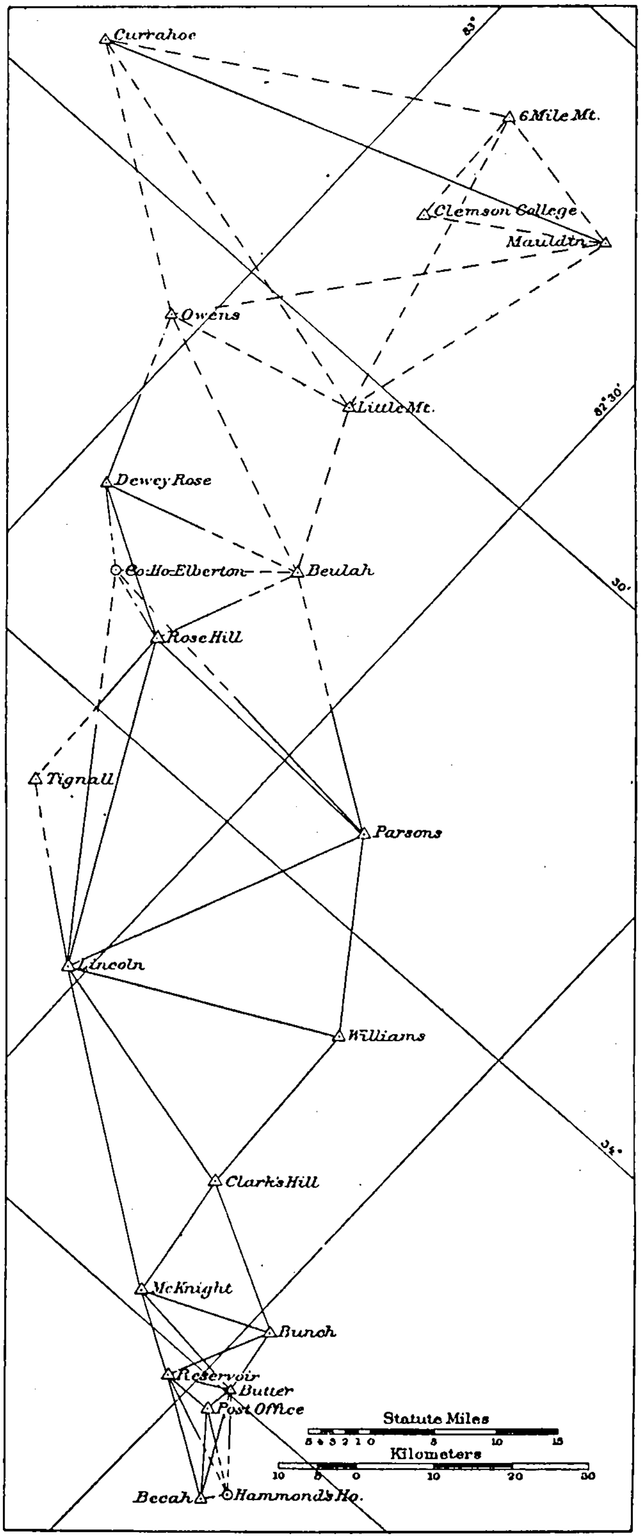
Preliminary preparations for the work were made, and early in December Signalman J. S. Bilby was sent to Georgia to begin the field work. He reached Augusta on December 4 and immediately took up the work of reconnaissance and signal building.

Assistant Fairfield reached Augusta on December 18 and took personal charge of the operations in the field. During January and February the reconnaissance was completed, and twelve observing tripods and scaffolds, ranging in height from 30 to 75 feet, with an average height of 58, were erected. The connection between the end of the direct measurement from the coast inland, completed during the previous fiscal year, and the astronomic station at Augusta was made, and the stations were all marked in a substantial manner.

From January 26 to February 3 the station at Clarks Hill, S. C., was occupied for the purpose of testing acetylene lamps under the direction of the Inspector of Geodetic Work. These lamps had been prepared for use as objects to observe upon in measuring angles at night, and they served the purpose in a satisfactory manner.

Signalman Bilby was detached from the party on February 14. On March 10 the observations began at Beech Island Station, and the measurement of angles was continued until the close of the fiscal year, and as rapid progress made as the atmospheric conditions permitted. At the four stations in the first quadrilateral, Beech Island, Butler Reservoir and Post-Office, the observations were made during the day, and poles were used as objects to observe upon, all these lines being short, but at all other stations acetylene lamps were used and the angles were measured at night. Unfavorable weather prevailed until

No. 8.



Triangulation, Georgia and South Carolina.

the middle of May, and the progress of the work was greatly delayed by haze and smoke, especially in observing over long lines. The smoke resulted from burning brush, etc., on land cleared by farmers for agricultural purposes.

Thomas Nelson Page, jr., joined the party as recorder in January, but unfortunately became ill soon afterwards, and died at the hospital in Augusta on January 30. Mr. Page was an intelligent and capable man, and his death was a loss to the party. The work was in progress at the close of the fiscal year.

HYDROGRAPHY.	MARYLAND.	G. L. FLOWER, Commanding
TOPOGRAPHY.	VIRGINIA.	Schooner *Matchless*.
TRIANGULATION.		

WM. B. PROCTOR, *Watch Officer*.	Sept. 10 to June 30.
C. F. ADAE, *Watch Officer*.	
SWEPSON EARLE, *Deck Officer*.	Jan. 13 to Apr. 15.
H. I. MCCREA, *Deck Officer*.	Aug. 19 to Nov. 8.
E. H. HARRIS, *Deck Officer*.	Feb. 16 to Mar. 14.
E. J. MCINTYRE, *Deck Officer*.	Apr. 16 to June 30.
E. V. MILLER, *Captain's Clerk*.	

SUMMARY OF RESULTS.

Hydrography:
- 1 398 miles (nautical) lines sounded.
- 9 tide stations established.

Topography:
- 70 square miles area covered.
- 175 miles of shore line surveyed.
- 64 miles of shore line of creeks surveyed.
- 84 miles of roads surveyed.

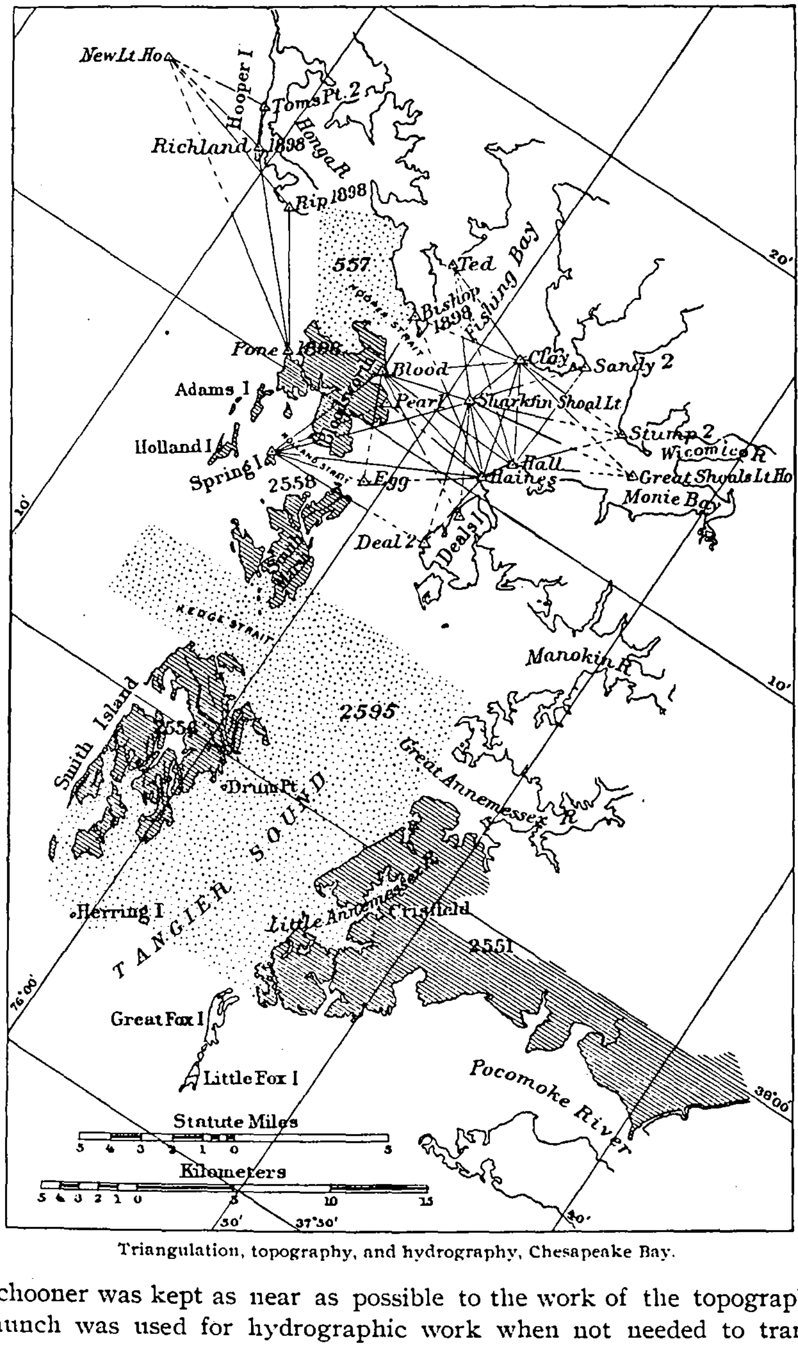
Triangulation:
- 11 stations occupied.
- 11 geographic positions determined.

The resurvey of certain portions of Chesapeake Bay was assigned to Assistant Flower. He made the necessary preparations and sailed from Baltimore on August 19 for Tangier Sound. The second watch officer, Mr. C. F. Adae, was unfit for duty on account of sickness and was left at Baltimore. He reported for duty on September 19. The wind was unfavorable and the lack of officers on board made it necessary to anchor the vessel at night. The party reached Deal Island on August 22 and field operations began the next day. Some old triangulation points were recovered and some new ones established. Several stations selected by Assistant Vinal were occupied. There was no launch attached to the vessel at this time and the shoal water prevented the close approach of the schooner to the working ground, and time was lost in using row boats. This work continued until August 30.

On September 2 the schooner was anchored in Hooper Strait and the topographic work began. The first topographic sheet included Bloodsworth Island, South Marsh, Holland Island, and several of the adjacent islands. On September 6 steam launch No. 22 arrived for the use of the party, but the large quantity of water needed daily for use in the launch greatly curtailed its usefulness. Water could only be obtained on

Deal Island, where it was necessary to pump it from the wells and carry it by hand to the shore, and this wasted a great deal of time.

No. 9.



Triangulation, topography, and hydrography, Chesapeake Bay.

The schooner was kept as near as possible to the work of the topographic party, and the launch was used for hydrographic work when not needed to transport the topographic party to and from work.

The first topographic sheet was finished on October 11, and the party moved to Crisfield and began topographic work on Smiths Island and hydrographic work in the Little Annemessex River. After completing the topographic work within reach of Crisfield, Assistant Flower took the topographic party to Smiths Island and lived on shore until the survey was completed. The hydrographic work in the Little Annemessex River was completed and work was then begun in Kedge Strait. The unfavorable weather, the floating ice, and freezing weather seriously delayed the progress of the work during the winter months.

Watch Officer Thompson reported on board on November 16 for the purpose of testing his sounding machine, and the launch was placed at his disposal whenever he needed it until December 19, when he went to Baltimore to make changes and repairs and to make further tests in the vicinity. He returned to the schooner on March 21, and the sounding machine received several tests before May 31, when the last test was made. After this date Mr. Thompson aided in the work of the party and rendered valuable assistance.

The party remained in the field continuously during the winter, and the hydrography of Kedge Strait was completed. The weather was severe and there was a great deal of ice and strong wind almost every day, which greatly delayed the progress of the work. The interior topography, extending from the Big Annemessex River to the Pocomoke River, was begun on February 20 and completed on May 8.

Hydrographic work in Tangier Sound was continued and was in progress at the close of the fiscal year.

TOPOGRAPHY. MARYLAND. S. FORNEY.

SUMMARY OF RESULTS.

Topography:
- 204 square miles area covered.
- 150 miles of shore line surveyed.
- 136 miles of shore line of creeks surveyed.
- 247 miles of roads surveyed.
- 6 topographic sheets completed.

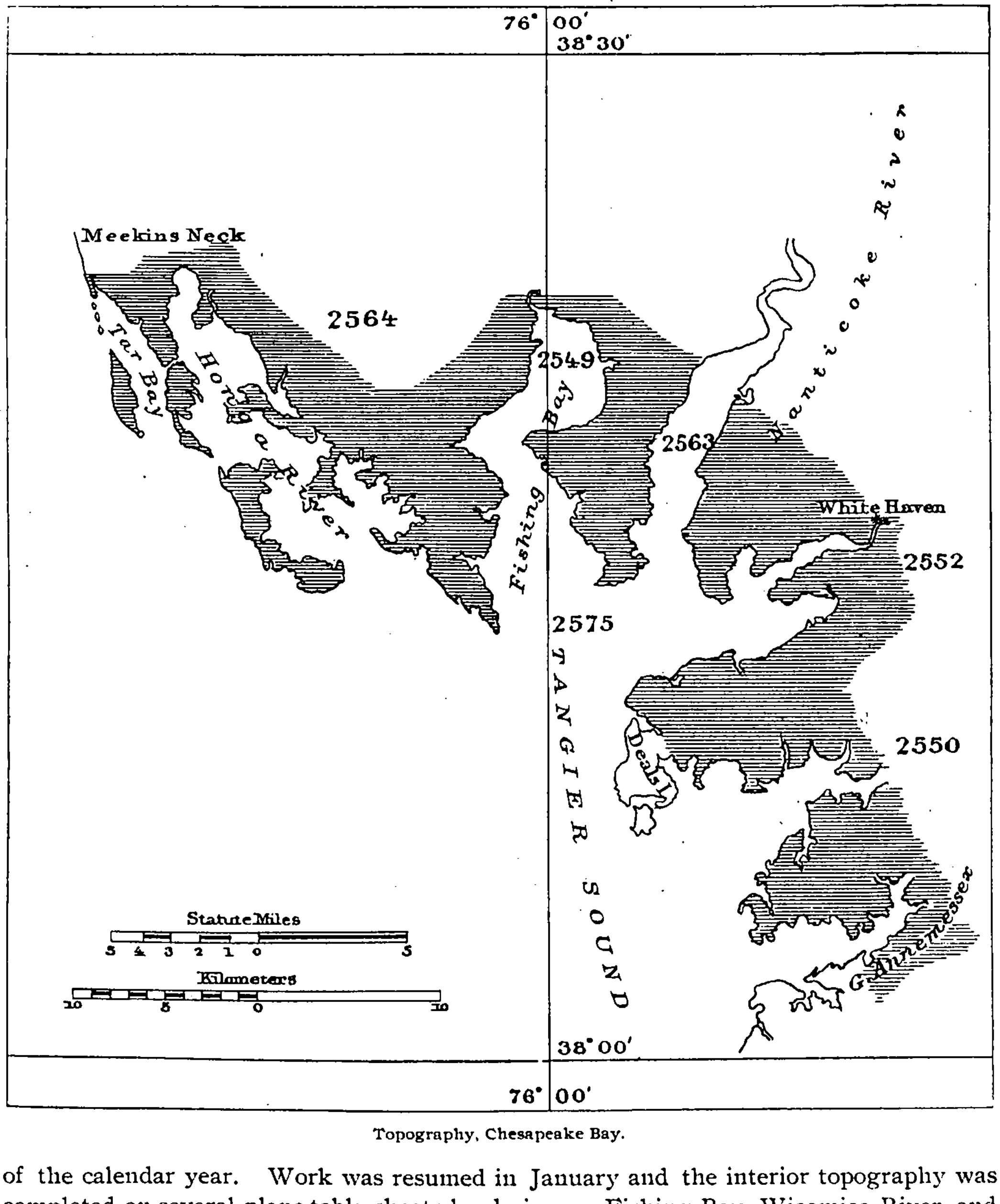
The topographic resurvey of a certain portion of Chesapeake Bay was assigned to Assistant Forney. He organized a party and proceeded to Wingates Point, Maryland, and immediately began the resurvey of the shore line and interior topography, from Bishops Head to Meekins Neck, including Hooper Strait, Fox Creek, Honga River, and Tar Bay.

Previous to November 15 the weather was favorable for the work, but progress was seriously retarded by the absence of suitable means of transportation until October 19, when a small naphtha launch was hired for the work. Previous to that date a sail boat had been used, and much time was lost on account of unfavorable winds.

The field work in the locality named above was completed by November 15. Many of the topographic features remain unchanged since the survey made in 1848, while in some places considerable changes have taken place. The party then proceeded to Tyaskin, Md., and reached there on November 21.

The resurvey of the shore line of the Nanticoke River above its mouth was immediately taken up, and in spite of cold and unfavorable weather this work was completed to the limit of the plane table sheet by December 11, and progress was made on the interior topography until December 23, when the work was suspended for the remainder

No. 10



Topography, Chesapeake Bay.

of the calendar year. Work was resumed in January and the interior topography was completed on several plane table sheets bordering on Fishing Bay, Wicomico River, and Deal Island. The party then proceeded to Upper Fairmount, Md., and on June 28 completed the interior topography on a plane table sheet covering this vicinity.

HYDROGRAPHY. GEORGIA. O. B. FRENCH.
MAGNETIC OBSERVATIONS. MASSACHUSETTS.
TRIANGULATION. SOUTH CAROLINA.

SUMMARY OF RESULTS.

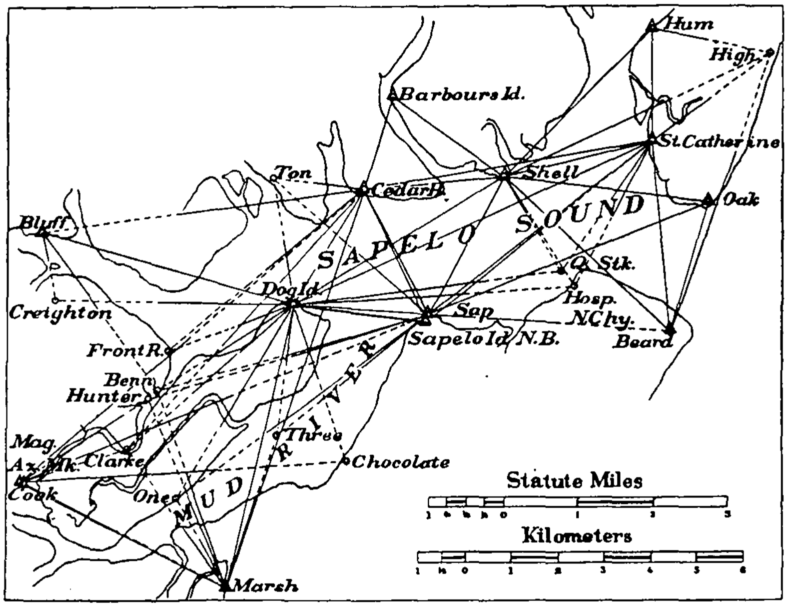
Georgia and South Carolina

Magnetic observations:
- 5 stations occupied.

Triangulation:
- 100 square miles area covered.
- 48 stations occupied.
- 121 geographic positions determined.
- 151 old stations visited.
- 60 old stations recovered and re-marked.

The continuation of the hydrographic examination of Nantucket Sound was assigned to the party on the steamer *Blake*, and on July 13 Assistant French temporarily relieved Assistant Welker of the command of the vessel at Baltimore and sailed the following day for the working ground.

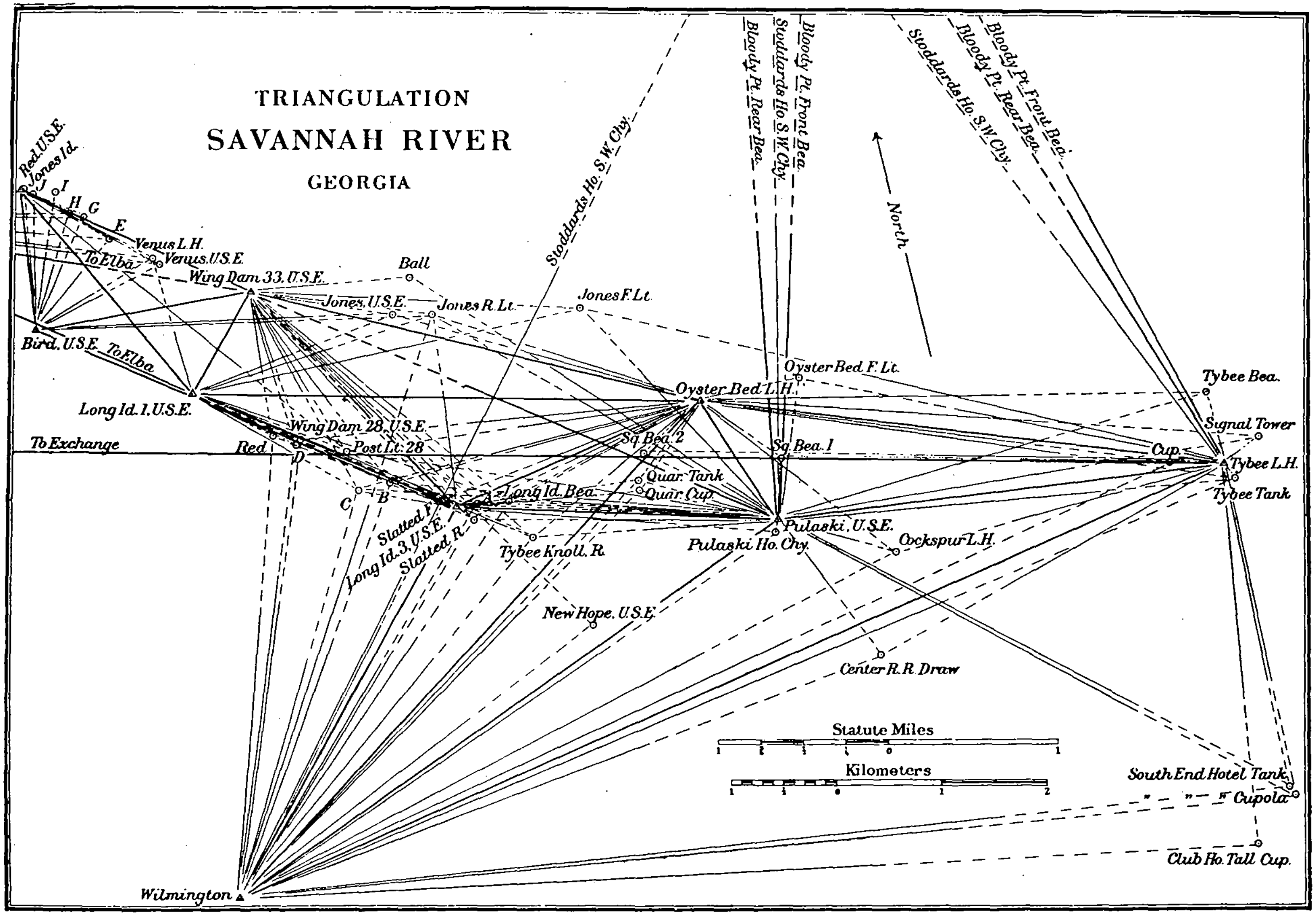
No. 11.



Triangulation, Sapelo Sound, Georgia.

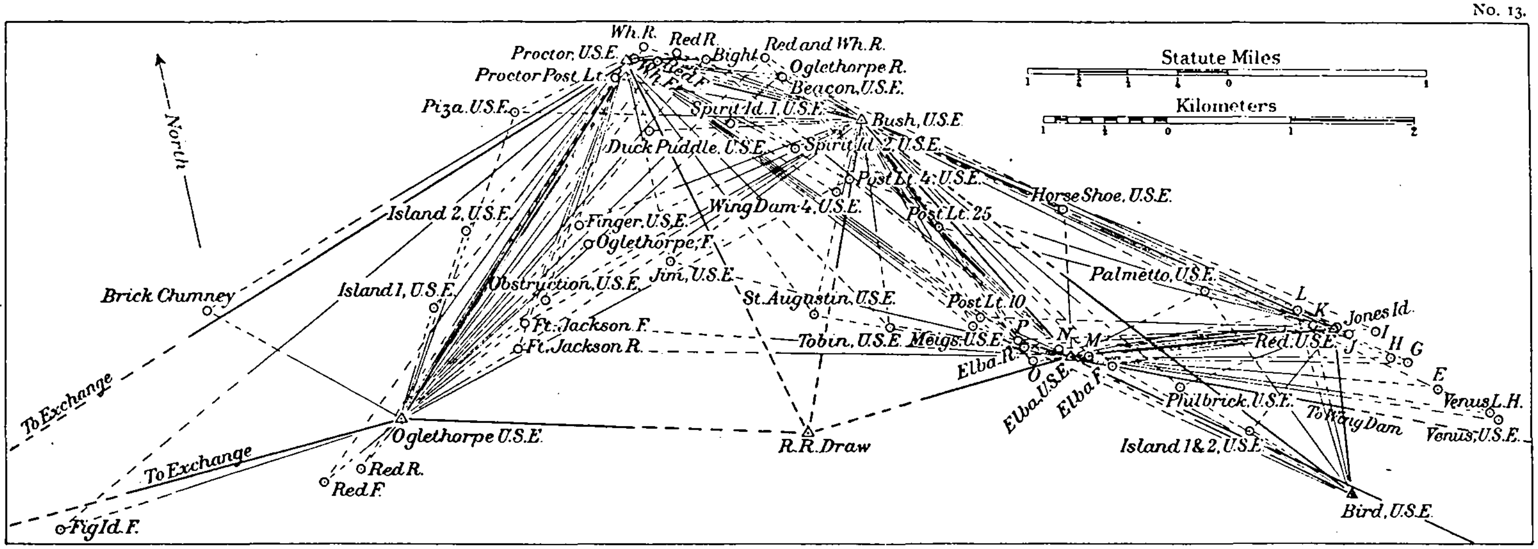
The *Blake* reached her destination on the 17th, and immediately took up the hydrographic examination of the various shoals in or near the principal channels in Nantucket Sound and the eastern approaches. A tide gauge was set up on Nantucket Island, south of the Nantucket Light-House, and referred to the bench mark at the light-house. Soundings were made whenever the weather and other conditions permitted, and lines were run east and west covering the main channel entrance to the sound, with a few cross lines. On August 10 Assistant Welker resumed command of

No. 12.



Triangulation, Savannah River, Georgia.

No. 13.



Triangulation, Savannah River, Georgia.

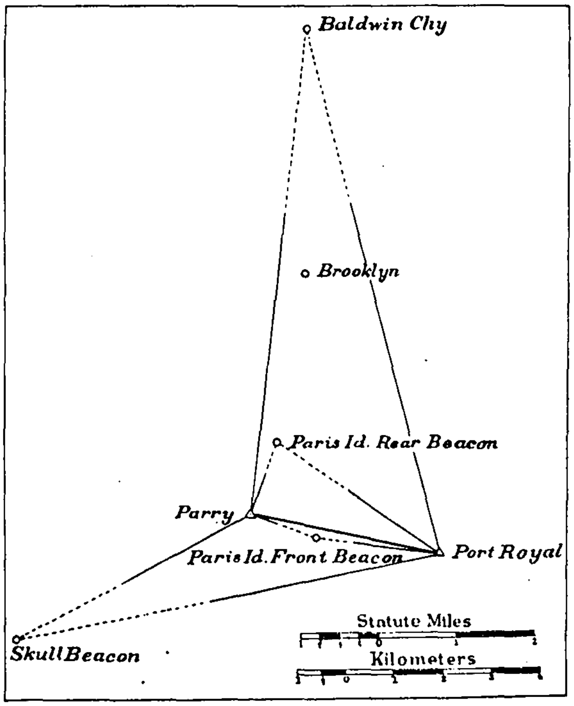
the *Blake*, relieving Assistant French from further duty on the vessel, and the details of the continuation of the work can be found under his name.

The extension of the triangulation in Sapelo Sound, Georgia, and the recovery and re-marking of triangulation points to the northward, including the determination of the geographic positions of the light-houses and beacons when not known, was assigned to Assistant French. After making the necessary preparation he proceeded to Sapelo Sound, Georgia, and began field work on December 29.

Several of the old triangulation stations were recovered to form a base for the new work in establishing positions to be used in the hydrographic survey of the sound, and observations were made at 14 stations and 20 new geographic positions were determined. The work in this locality was finished on February 2, and Assistant French took up the work along the coast to the northward. A small sloop was hired and used as quarters and to transport the party from place to place as the work progressed. South of the Savannah River nearly all of the stations which had been marked with underground marks were recovered.

Some of the stations of the triangulation along the Savannah River, established by the U. S. Army Engineers between Savannah and Tybee Light-House, were occupied and observations made to determine their positions and the positions of the numerous beacons and light-houses in this vicinity. In the vicinity of Port Royal Sound all the stations, of which descriptions were furnished, were recovered, and the positions of three beacons were determined.

No. 14.



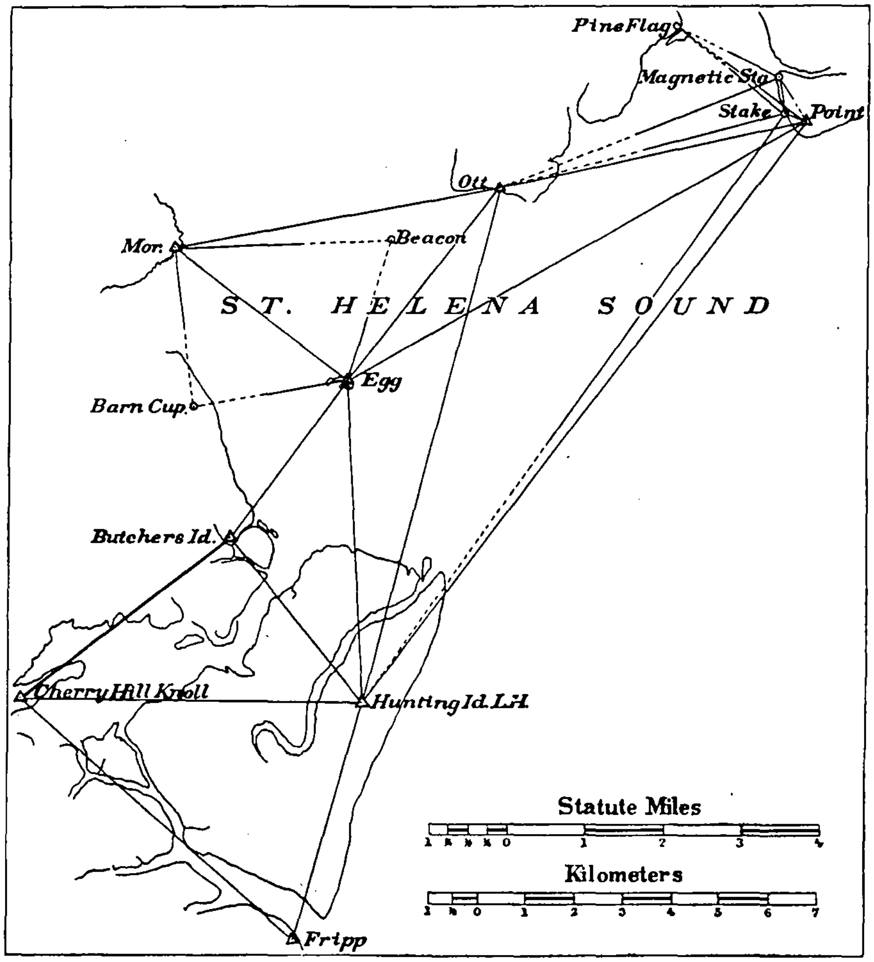
Triangulation, vicinity of Port Royal, S. C.

At St. Helena Sound more triangulation was necessary to furnish positions for use in the proposed hydrographic examination. None of the old station on the shores of the sound could be found, but three old stations near by to the southwest were recovered and the new stations were established without much difficulty. Between St. Helena Sound and Charleston very few of the old stations were found, but fortunately all the primary stations except two were recovered.

The ends and four of the mile stones of the Edisto Base Line were recovered. The large monument at the east end had been overturned and the underground mark dug up, but three of the reference stones were found apparently undisturbed and the monument was replaced in position on a cement foundation.

Most of the old stations in the vicinity of Charleston and to the northward as far as Bulls Bay, for which descriptions were furnished, were recovered. A few stations, recently established near the entrance to Charleston Harbor, were not visited. At Bulls Bay three stations were occupied for the purpose of determining the positions of Cape Romain Light-House and Bull Bay Light-House.

No. 15.

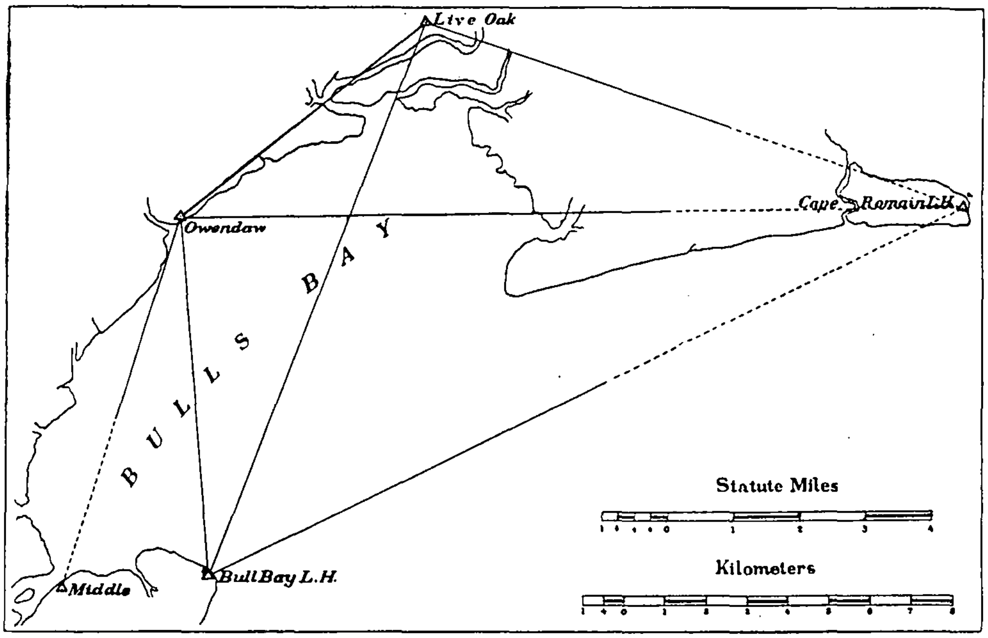


Triangulation, St. Helena Sound, South Carolina.

All of the old stations recovered along the coast between Sapelo Sound and Bulls Bay, with a few exceptions, were re-marked. Observations were made to determine the magnetic elements at the following stations: Cedar Point, Sapelo Sound; Woods, Beaufort River, near Port Royal; Bay Point, St. Helena Sound; Breach Inlet, near Charleston; Live Oak, near Bulls Bay.

The work closed on May 10, 1902.

No. 16.



Triangulation, Bulls Bay, South Carolina.

RECONNAISSANCE. MARYLAND. J. E. MCGRATH.
TRIANGULATION. VIRGINIA.

SUMMARY OF RESULTS.

Reconnaissance:
- 345 square miles area covered.
- 68 triangulation stations selected.

Triangulation:
- 335 square miles area covered.
- 61 stations occupied.
- 258 geographic positions determined.

The triangulation of the Potomac River was assigned to Assistant McGrath, and he was directed to extend the triangulation of the river inland from its mouth, basing the work upon a line of the Chesapeake Bay triangulation, and determining all the points necessary for the topographic and hydrographic survey of the river, and for the extension of surveys up all the tributary streams of importance.

Only three stations in the former triangulation of the river were recovered—Point Lookout Light-House, Piney Point Light-House, and Blakistone Island Light-House. The banks on both sides of the Lower Potomac River are alluvial in character and are constantly subject to erosion. The sharp bends and numerous trees in existence more than thirty-five years ago forced the location of the stations near the water line, and as a result the old stations have nearly all been destroyed. The location of these old points on the charts of the river furnished to the party greatly facilitated the work of reconnaissance.

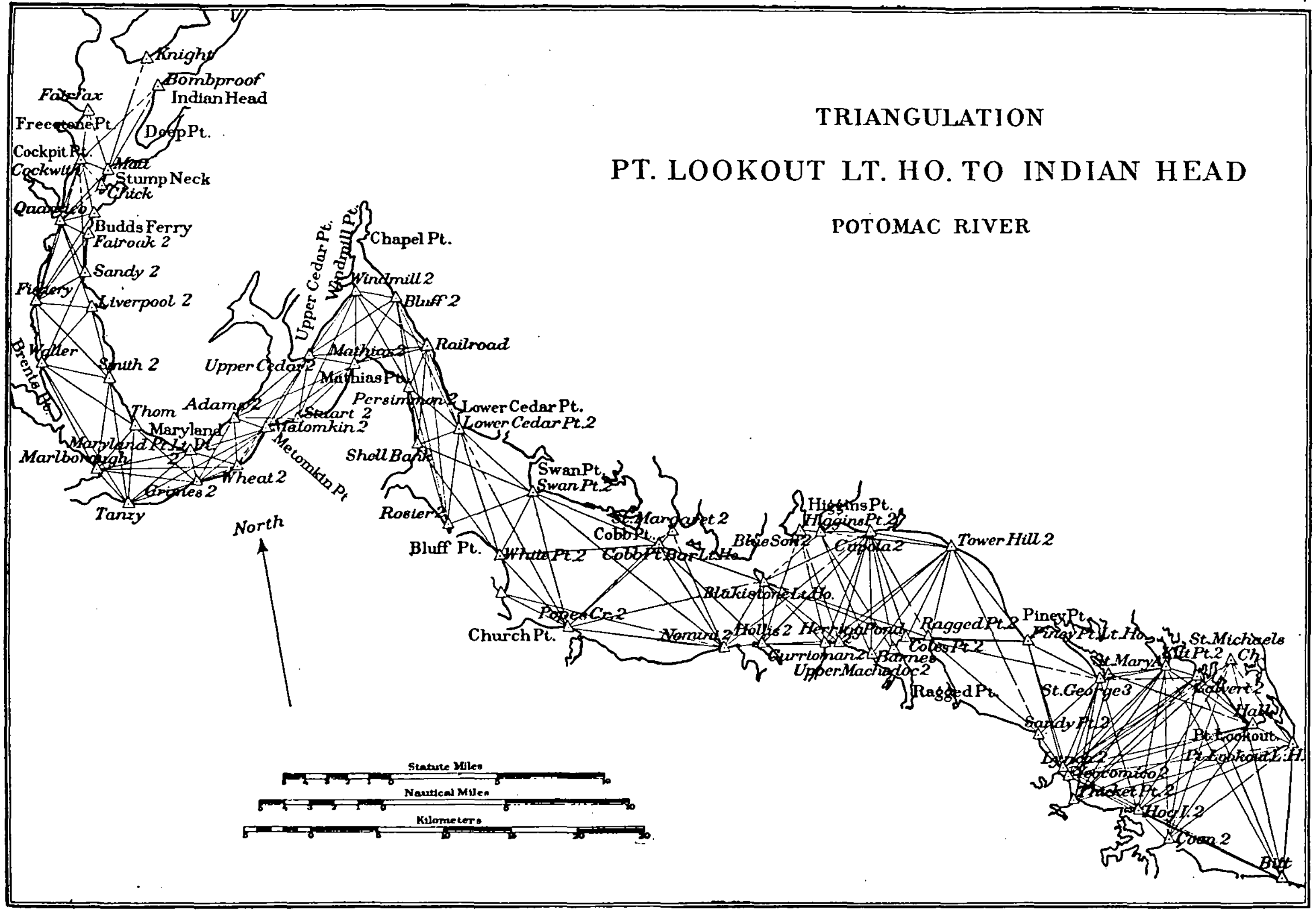
Assistant McGrath and party reached St. Georges Island on August 8, and a reconnaissance was started from the line, Point Lookout Light-House to Bitt, and extended up the river. A search was made for the stations of the old work, but only three were recovered, as stated. The station Bitt, of the Chesapeake Bay triangulation, was established in recent years. A steam launch was used by the party as the only practicable means of transportation in the region along the river. It was difficult to secure quarters for the party, and long trips in the launch to and from work were frequently necessary.

The weather was in general very favorable for the work, and very little time was lost on account of bad weather, previous to November 1, but after that date there was a gale of wind from the northwest nearly all the time for several weeks, which greatly delayed the progress of the work. About December 1 ice began to form in the creeks and along the banks of the river and occasioned much delay in the work, becoming impassable with the launch in many places toward the close of the month.

A large quantity of fresh water was needed for use in the launch, and this was at times supplied with difficulty and delay. In spite of these obstacles constant progress was made until the work closed on December 31, and the party was disbanded on January 1.

Assistant McGrath's report commends the conduct of all the members of his party, and makes special mention of the valuable assistance rendered by Thomas Nelson Page, jr., James E. Marsh, and Henry Becker, whose devotion to duty greatly facilitated the progress of the work and rendered possible the result accomplished.

No. 17.


TRIANGULATION
PT. LOOKOUT LT. HO. TO INDIAN HEAD
POTOMAC RIVER
North
Statute Miles
Nautical Miles
Kilometers
Knight
Bombproof
Indian Head
Fairfax
Freestone Pt.
Deep Pt.
Cockpit Pt.
Stump Neck
Chick
Budds Ferry
Fairoak 2
Sandy 2
Liverpool 2
Smith 2
Thom
Maryland
Marlborough
Tanzy
Wheat 2
Upper Cedar 2
Upper Cedar Pt.
Windmill Pt.
Chapel Pt.
Windmill 2
Bluff 2
Railroad
Mathias Pt.
Lower Cedar Pt.
Lower Cedar Pt. 2
Shell Bank
Roster 2
Bluff Pt.
Swan Pt.
Swan Pt. 2
St. Margaret 2
Cobb Pt.
Church Pt.
Blakistone Lt. Ho.
Higgins Pt.
Tower Hill 2
Ragged Pt. 2
Piney Pt.
Piney Pt. Lt. Ho.
Ragged Pt.
St. George 3
St. Michaels Ch.
Sandy Pt. 2
Calvert 2
Pt. Lookout.
Pt. Lookout L.H.
Hog I. 2
Coan 2
Bitt

RECONNAISSANCE. TRIANGULATION. VIRGINIA. A. T. MOSMAN.

SUMMARY OF RESULTS.

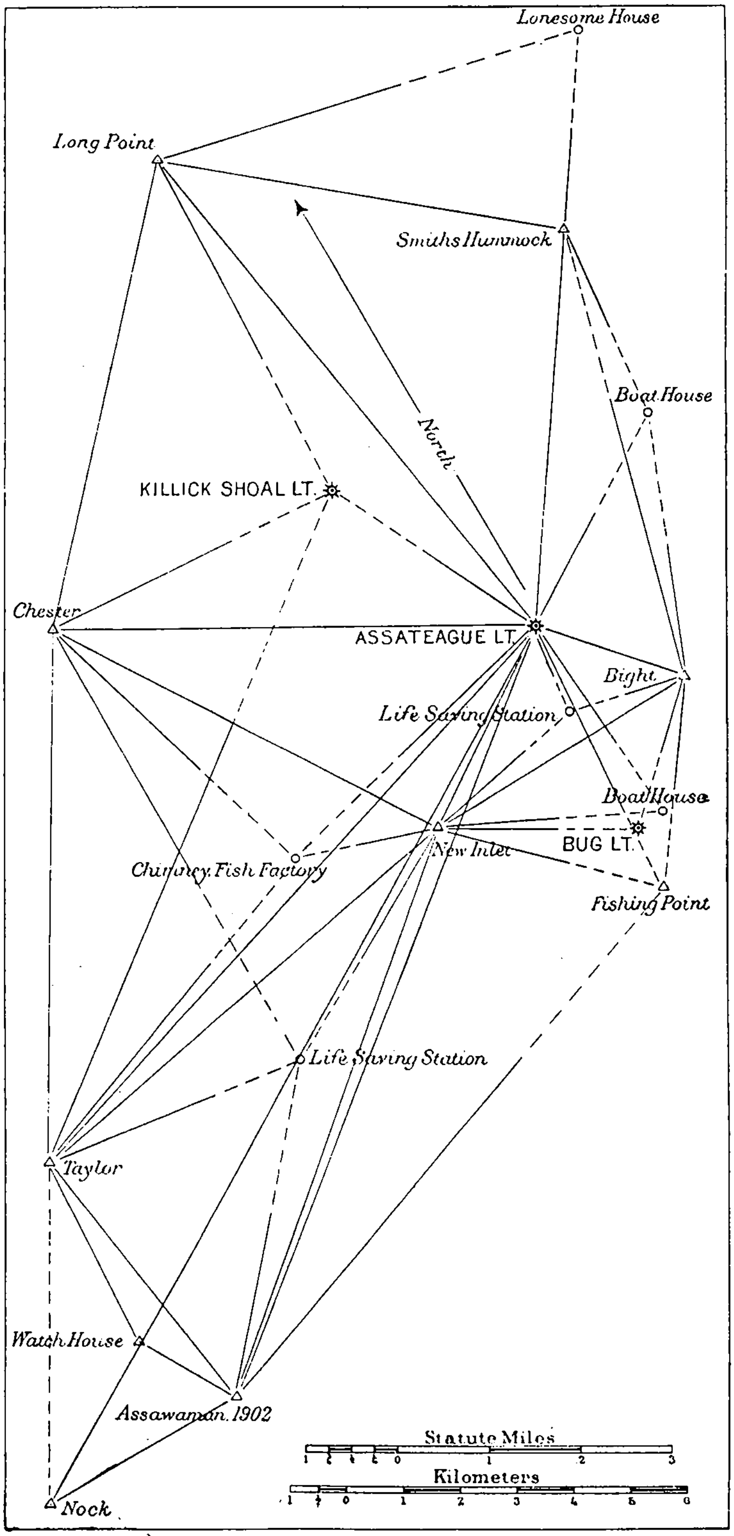
Reconnaissance:
- 90 square miles area covered.
- 15 stations selected.

Triangulation:
- 90 square miles area covered.
- 10 stations occupied.
- 18 geographic positions determined.

A resurvey in the vicinity of Chincoteague Island being necessary, the recovery of old triangulation stations and the establishment of new ones for this purpose was assigned to Assistant Mosman. He sent Foreman E. E. Torrey to the island on May 16 to make all necessary preliminary arrangements, and on May 25 proceeded to the island and took charge of the operations in the field. Two old triangulation points, Nock and Taylor, were recovered. From the line between them, used as a base, the triangulation was extended 15 miles to the northeast and 10 miles to the east, to Fishing Point.

The observations began on June 5 and were continued during the remainder of the fiscal year. The geographic positions of the life-saving station at Assateague and at Wallops, and of Assateague Light-House, Killick Shoal Light-House, and Bug Light-House were determined during the progress of the work. The necessity of traveling long distances, to erect signals and to occupy stations, in a sailboat, and the fact that observations could only be made very early in the morning and very late in the afternoon, caused considerable delay in the progress of the work. The work was in progress at the close of the fiscal year.

No. 18.



Triangulation, entrance Chincoteague Inlet, Va.

TOPOGRAPHY. NEW HAMPSHIRE. JOHN NELSON.

SUMMARY OF RESULTS.

Topography:
- 15 square miles area covered.
- 3 miles shore line creeks and ponds surveyed.
- 84 miles roads surveyed.

The continuation of the topographic survey in the vicinity of Portsmouth, N. H., was assigned to Assistant Nelson. He reached Portsmouth on August 12 and began the field work without unnecessary delay. The work on the Portsmouth Harbor sheet was slow and tedious on account of the peculiar topographic features of the surrounding country, and the dense growth of timber covering the region surveyed. A large area of wooded marsh was developed during the progress of the work. The roads and trails in the locality are very crooked and narrow, and much time was spent in determining their position, as they were necessarily used in fixing the boundaries and outlines of the wooded marshes. Some of the prominent points are from 80 to 100 feet high. These were covered with a dense growth of pines and a great deal of cutting was necessary in order to develop the contours. An unsuccessful effort was made to place the city of Portsmouth on the topographic sheet by reducing the plan found on published maps, but this proved to be impracticable, and a complete topographic survey was made of the city.

The work on the Portsmouth Harbor sheet, extending from the entrance to the Piscataqua River bridge was completed on October 31 and the field work of the party closed on that date.

MAGNETIC OBSERVATIONS. VIRGINIA. E. D. PRESTON.

Stations occupied.

BEDFORD CITY.	OLDTOWN.
FINCASTLE.	PEARISBURG.
HILLSVILLE.	PULASKI.
NEW CASTLE.	

The extension of the magnetic survey in Virginia was assigned to Assistant Preston, and he began field operations at Bedford City on June 5. The determination of the magnetic elements began on June 6, and observations were made at the stations above named. At Hillsville a meridian line for surveyors' use was established. The work was in progress at the close of the fiscal year.

COAST PILOT. | MAINE. MARYLAND. VIRGINIA. | JOHN ROSS, Commanding, Steamer *Hydrographer*.

November 13 to January 17.

H. C. GRAVES, *Nautical Expert.*	
H. W. PEERCE, *Chief Engineer.*	Nov. 23 to Jan. 17.
HARRY ELY, *Acting Chief Engineer.*	Nov. 13 to Nov. 30.
H. S. SMITH, *Deck Officer, First Class.*	Nov. 13 to Nov. 30.
TALBOT PULLIZI, *Writer.*	

June 1 to 30.

H. C. GRAVES, *Nautical Expert.*
C. L. GREEN, *First Watch Officer.*
H. W. PEERCE, *Chief Engineer.*
J. W. OGDEN, *Acting Captain's Clerk.*

The published edition of United States Coast Pilot, Atlantic Coast, Part VI, having been exhausted, Nautical Expert John Ross was placed in command of the steamer *Hydrographer* and instructed to collect the information necessary to bring a new edition up to date.

The work began in Baltimore Harbor on November 13. The party left Baltimore on November 15 and inspected the mouth of the Susquehanna River and Curtis Bay. On November 20 the party again started from Baltimore and inspected the following places: Swan Point Bar, Elk River to Town Point, Sassafras River to Betterton, Chester River to Queenstown, and thence to Annapolis. On November 22 the party inspected Eastern Bay up to St. Michaels, and then returned to Baltimore for coal and water. On the 27th the vessel left Baltimore and proceeded to Washington to examine the Potomac River. The following places were then visited in the order stated: Great Wicomico River, York River, Norfolk, James River, and Cape Charles City.

On January 7 Assistant Edwin Smith went on board the vessel at Norfolk and was transported to the following places for the purpose of determining the magnetic declination for use on the charts, viz: Old Point Comfort, entrance of York River and of Rappahannock River, Tangier Sound and Hooper Strait, returning to Baltimore on January 15. At the places visited, and during the passage of the vessel from place to place, notes were made of all changes which affected the coast pilot volume above referred to, and sufficient information was collected, by personal inspection of certain localities, and by inquiry from ship masters, pilots, officers in charge of improvements, and others, for the publication of a revised edition of the Coast Pilot, Volume No. VI. The weather was unfavorable a great portion of the time, and as many localities were visited with the vessel as the late season, prevailing winds, and ice permitted. The work closed at Baltimore on January 17.

The revision of the coast pilot volume covering the coast of Maine being necessary, the collection of information for this purpose was assigned to John Ross, nautical expert, and on May 27 he took command of the steamer *Hydrographer* at Washington, D. C. He proceeded to Eastport, Me., via New York and Boston, and began the collection of coast pilot information at that place on June 25. This work was in progress at the close of the fiscal year.

MAGNETIC WORK. RECONNAISSANCE. TRIANGULATION. — MARYLAND. VIRGINIA. — EDWIN SMITH.

SUMMARY OF RESULTS, JULY 1 TO 24.

Triangulation:
- 40 square miles area covered.
- 8 stations occupied.
- 22 geographic positions determined.

SUMMARY OF RESULTS, APRIL 1 TO 30.

Reconnaissance:
- 50 square miles area covered.

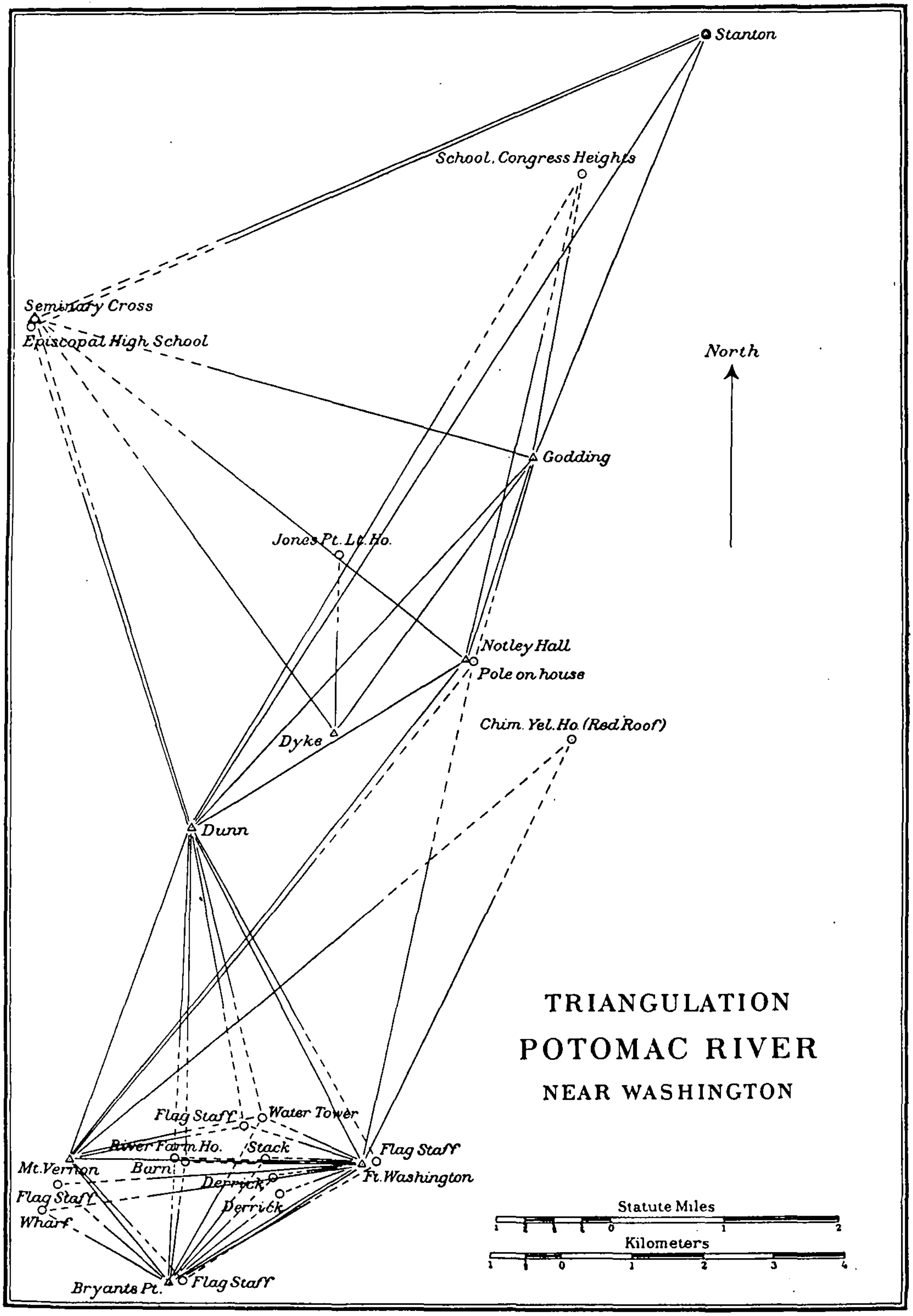
Triangulation:
- 50 square miles area covered.
- 22 stations occupied.
- 77 geographic positions determined.

The triangulation along the Potomac River below Washington, D. C., was in progress at the close of the previous fiscal year, under charge of Assistant Smith. He occupied the following stations in the order named, viz: Bryants Point, Mount Vernon, Fort Washington, Dunn, Notley Hall, Dyke, Godding, and Stanton. The condition of the weather was not favorable for rapid progress, and considerable delay resulted from the difficulty of securing transportation between the stations. The work closed on July 24.

Magnetic observations being necessary for the correction of the compasses on the charts of the Potomac River, Assistant Smith proceeded to Norfolk, Va., and went on board the steamer *Hydrographer*, John Ross, nautical expert, commanding, on January 6. The vessel transported Assistant Smith to the localities selected, and the magnetic declination was determined at Old Point Comfort, at a point on the shore of York River, on the shore of Rappahannock River, and at Hoopers Island, in Chesapeake Bay. Assistant Smith left the vessel at Baltimore on January 15.

The continuation of the triangulation along the Potomac River was also assigned to Assistant Smith, and on April 1 active field operations began. The work was completed from the point where Assistant McGrath suspended work during the previous season, in the vicinity of Gunston, to a junction with the work of Assistant Smith below Alexandria, completed in the first part of the fiscal year, as mentioned above. This work extended along the river from Cockpit Point to Fort Washington, and it was completed on April 30. On June 13 Assistant Smith proceeded to Long Island, N. Y., to take part in testing the Marconi system of wireless telegraphy for use in the telegraphic determination of longitudes. He continued on this work until June 30, when he was detached while the test was still in progress.

No. 19.


Stanton
School, Congress Heights
Seminary Cross
Episcopal High School
North
Godding
Jones Pt. Lt. Ho.
Notley Hall
Pole on house
Chim. Yel. Ho. (Red Roof)
Dyke
Dunn
TRIANGULATION
POTOMAC RIVER
NEAR WASHINGTON
Flag Staff
Water Tower
River Farm Ho.
Stack
Flag Staff
Mt. Vernon
Barn
Ft. Washington
Derrick
Flag Staff
Derrick
Wharf
Bryants Pt.
Flag Staff
Statute Miles
Kilometers

ASTRONOMIC OBSERVATIONS.	MASSACHUSETTS.	EDWIN SMITH.
RECONNAISSANCE.	OHIO.	W. B. FAIRFIELD.
TRIANGULATION.	WISCONSIN.	

SUMMARY OF RESULTS.

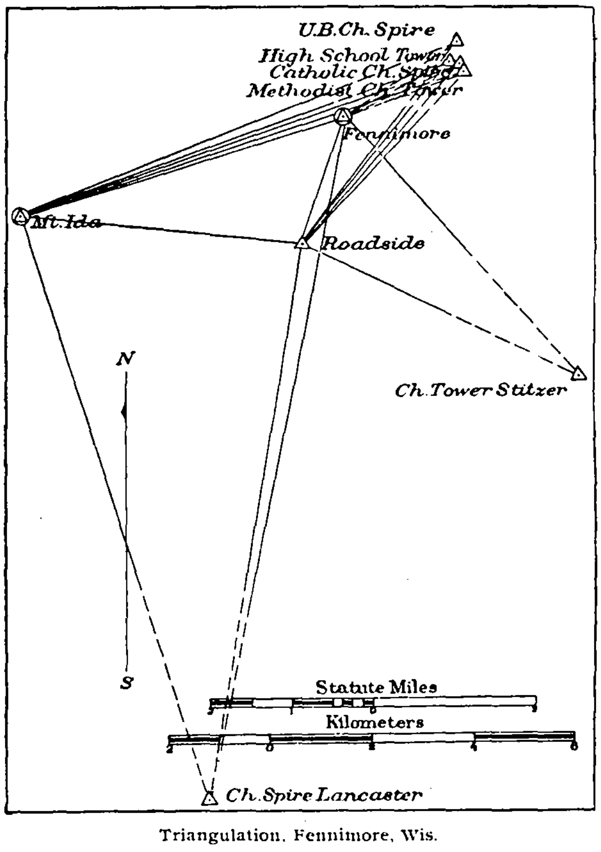
Astronomic observations:
- 2 longitude stations determined.
- 1 latitude station determined.

Reconnaissance:
- 114 square miles area covered.
- 7 stations selected.

Triangulation:
- 114 square miles area covered.
- 8 stations occupied.
- 16 geographic positions determined.

The determination of the longitude of Provincetown, Mass., and of Fenimore, Wis., and the connection of the stations occupied with the triangulation in the vicinity was assigned to Assistants Smith and Fairfield as chiefs of cooperating parties. They were also instructed to connect the longitude station at Cleveland, Ohio, with the triangulation of the United States Lake Survey. Assistant Smith reached Cambridge, Mass., on August 8 and found that the station occupied for longitude observations in 1872 had been destroyed. Prof. E. C. Pickering placed the facilities of the Harvard College observatory at his disposal, and the instrument was mounted on the west transit pier, which had been occupied by the Coast and Geodetic Survey observer in 1869. The station of 1872 was connected with this pier. Assistant Fairfield reached Provincetown, Mass., on August 9, erected a pier and temporary observatory, and was ready for observations on August 14. Unfavorable weather prevented observations until August 26. Observations were made and signals were exchanged on three nights, and then the observers changed stations and repeated the observations. The latitude of Provincetown was determined by Assistant Smith, and

No. 20.



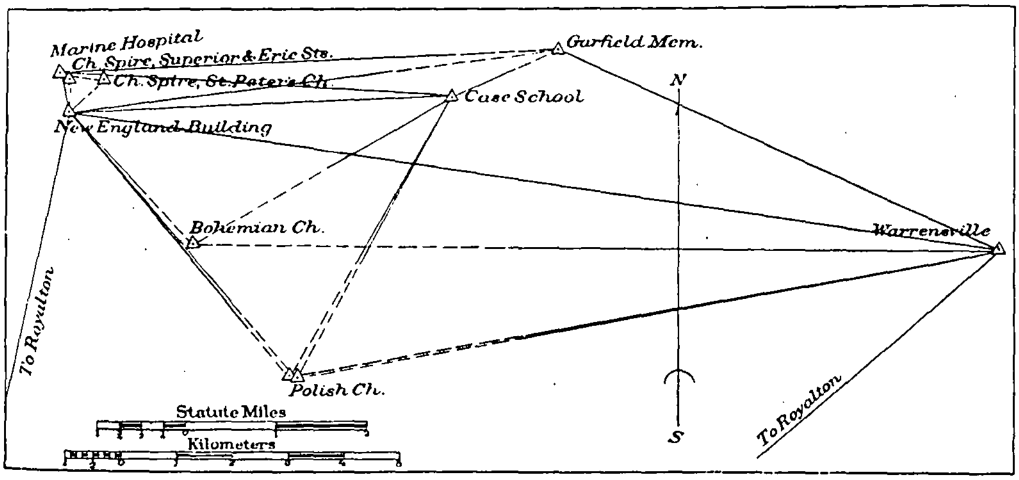
Triangulation, Fennimore, Wis.

the Provincetown station was connected with the triangulation by Assistant Fairfield. The work in this locality was completed and the parties started west on September 9.

Assistant Smith reached Omaha, Nebr., on the 12th, and found it impracticable to occupy the old station on account of obstruction of view by the growth of trees and the erection of a building since the station was established. A new station was established and connected with the old station, and all necessary preparations for work completed.

Assistant Fairfield reached Fenimore, Wis., on September 12 and recovered the triangulation stations Mount Ida and Fenimore, with which to connect the longitude station, when determined. A longitude station was then selected with this object in view, the necessary preparations were made, and everything was ready for work on September 21. Unfavorable weather again delayed the observations, both before and after the exchange of positions by the observers, and the observations were not completed until October 14.

No 21



Triangulation, Cleveland, Ohio.

Assistant Smith connected the station at Fenimore with the triangulation by occupying Mount Ida, Fenimore, and a new auxiliary station. The work was completed on the 16th, and he proceeded to Cleveland, Ohio, arriving on the 18th. Assistant Fairfield reached Cleveland on October 19. Signalman J. S. Bilby arrived in Cleveland on September 30, under instructions from Assistant Smith, and had already made the necessary preparations for the connection of the longitude station with the triangulation of the United States Lake Survey by recovering two lake survey stations and erecting observing tripods and scaffolds before the observers arrived. Assistant Fairfield occupied a station on the New England Building, located in the center of the city, and after being delayed for days on account of smoke, completed the necessary observations on November 3 and closed his connection with the work on November 4. Assistant Smith continued the work until December 10, when sufficient observations had been secured to complete the connection, and the work closed.

Assistant Smith reports the great interest taken in the work by Dr. C. S. Howe, of the Case School of Applied Science, and the valuable assistance rendered by him and the students under his charge in showing a heliotrope from the Case School for the use of the observers.

TIDE OBSERVATIONS.

DISTRICT OF COLUMBIA.
FLORIDA.
NEW YORK.
PENNSYLVANIA.

Automatic tide gauges were kept in operation throughout the year at the following places: Washington, D. C., various members of tidal division, observers; Fernandina, Fla., B. W. Weeks, observer; Fort Hamilton, N. Y., J. G. Spaulding, observer; Philadelphia, Pa., F. A. Kummel, observer.

TOPOGRAPHY.
TRIANGULATION.

MARYLAND.

W. I. VINAL.

SUMMARY OF RESULTS, AUGUST 13 TO DECEMBER 20.

Topography:
- 12 square miles area covered.
- 82 miles general coast line surveyed.
- 29 miles shore line of creeks, etc., surveyed.
- 8 miles of roads surveyed.
- 1 topographic sheet completed.

Triangulation:
- 87 square miles area covered.
- 17 stations occupied.
- 30 geographic positions determined.

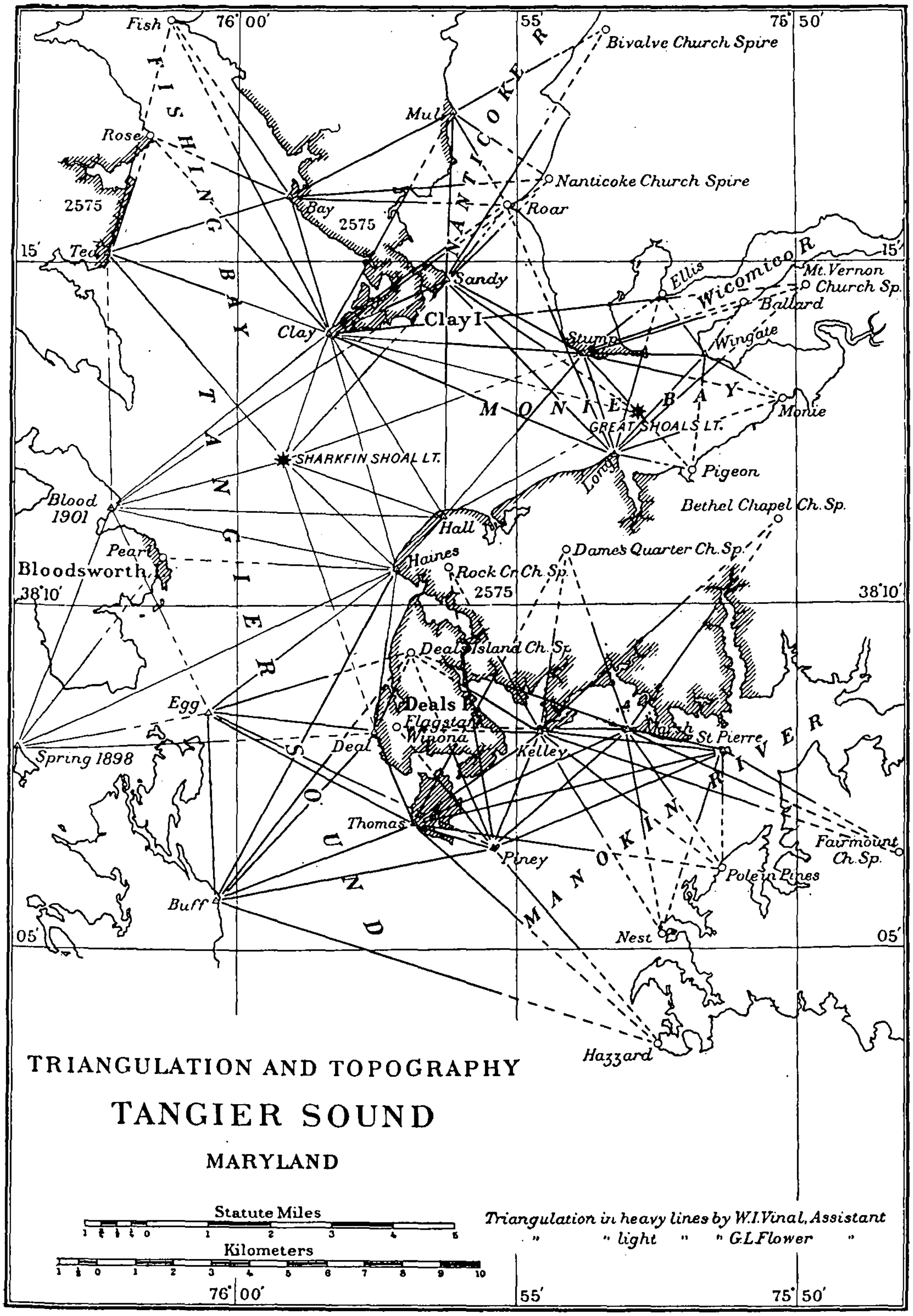
SUMMARY OF RESULTS, MAY 24 TO JUNE 30.

Topography:
- 3 square miles area surveyed.
- 24 miles of shore line of rivers and creeks surveyed.
- 8 miles of roads surveyed.
- 3 topographic sheets in progress.

A portion of the resurvey of Chesapeake Bay was assigned to Assistant Vinal, and he began work in the vicinity of Deals Island on August 13. A naphtha launch was furnished to him and was used as the means of transportation until September 2, when it was turned over to Assistant Weld and a larger steam launch received from him in exchange. This steam launch was not in good condition, and considerable delay in the work resulted from the necessity of making repairs from time to time. Triangulation was done in the northern portion of Tangier Sound, in Fishing and Monie bays, and in the Nanticoke and Manokin rivers. The topography covered portions of the shore line of this same region, as stated in the summary of results given above. Geographic positions were furnished to Assistants Forney and Weld. The work closed and the party was disbanded on December 20.

In May, topographic work on the Potomac River was assigned to Assistant Vinal, who made all necessary preparations and arrived at Colonial Beach, Va., on May 21. The plane-table work began on May 24 and was continued until the close of the fiscal year, whenever the weather conditions permitted. A naphtha launch was used by the party as the means of transportation. The statistics of the work accomplished are given above. The work was in progress on June 30.

No. 22.



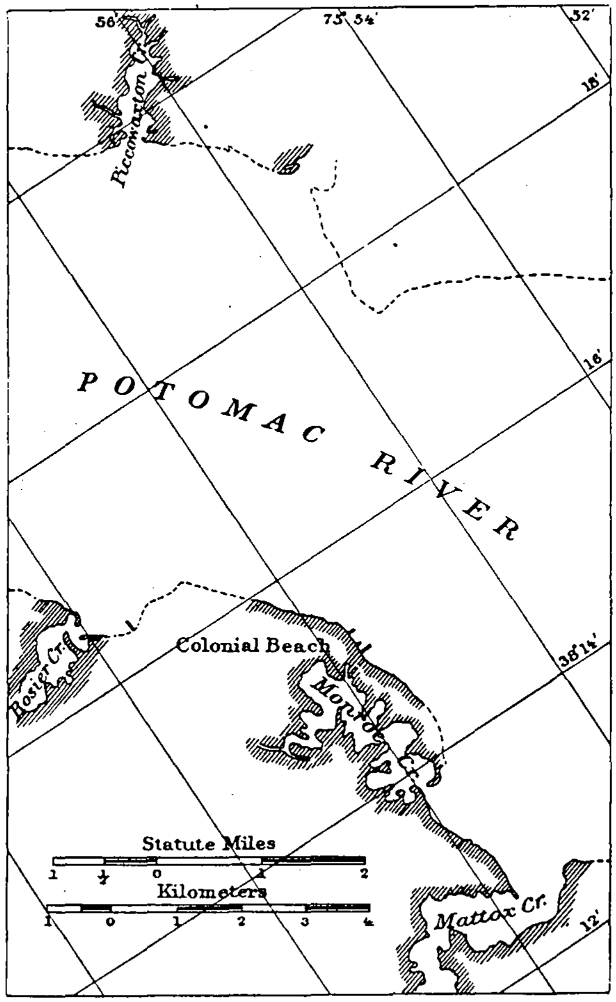
TRIANGULATION AND TOPOGRAPHY

TANGIER SOUND

MARYLAND

Triangulation in heavy lines by W. I. Vinal, Assistant
" " light " " G. L. Flower "

No. 23.



Topography, Potomac River.

EXPERIMENTAL OBSERVATIONS. MASSACHUSETTS. D. B. WAINWRIGHT.
WIRELESS TELEGRAPHY. NEW YORK.

The investigation of the Marconi system of wireless telegraphy with reference to its possible adoption for use in determining the difference of longitude, by the telegraphic method, between places where no wire connection existed, was assigned to Assistant Wainwright.

The New York Herald had established and was operating a wireless telegraph station at Siasconset, Nantucket Island, Mass., in connection with a wireless telegraph outfit placed by the Herald on the Nantucket light-ship, 50 miles offshore, for the purpose of receiving messages from steamships equipped with similar apparatus and passing close enough to the light-ship to communicate through it with the shore in this way. All the facilities thus afforded were courteously placed at Assistant Wainwright's disposal by the manager of the New York Herald, and the thanks of the Coast and Geodetic Survey are due to that corporation for their liberality, which rendered it possible to make this interesting investigation at this time. All necessary preparations were made and Assistant Wainwright reached Siasconset on October 4.

The experiments at the shore station consisted in simulating the essential conditions of a field telegraph station used in telegraphic longitude work and in obtaining a record of the customary time signals. For this purpose the chronograph was mounted in the operating room, together with the break-circuit chronometer. The programme included, first, the sending of a message to the light-ship notifying the operator when to send time signals; second, the time signals from the light-ship, consisting of a signal commencing in an even minute and repeated every five seconds for two minutes; third, a message from the light-ship giving the correction of the chronometer; fourth, a test to show the lag of the armature in circuit. All the foregoing sets of signals were recorded on the chronograph. The chronometer was out of the circuit when verbal messages were sent or received, as it would interfere with the clearness of the code signals. While the time signals were being received the chronometer was in circuit, and the record conforms to the customary field astronomical station record.

In order to obtain on the chronograph the signals sent to the light-vessel, a specially designed make-and-break key was substituted for the Marconi key and connected with the chronograph circuit. When receiving signals from the light-vessel the chronograph-chronometer circuit was connected with the Marconi tape recorder, a pony relay being interposed so that when the signals of the light-vessel functioned the coherer, and its local circuits were closed, the chronograph-chronometer circuit would be broken and the pen deflected on the chronograph sheet. In arranging the apparatus for longitude work, the pony relay and also the tape recorder would be dispensed with, and the chronograph circuit directly connected with the polarized relay adjoining the coherer. The lag of the armatures, or the time consumed by them in moving between contacts, was determined by cutting out the resistance and condenser in circuit with the chronometer, thus allowing a spark to be made by the contact wheel at each break, the result being that the contact wheel in breaking would cause one deflection of the chronograph pen, and the spark, by functioning the coherer, cause another break through the pony relay and another and later deflection of the pen. The space between the two deflections would indicate the armature lag.

Covering the period of the experimental work on Nantucket, time observations were made with a sextant and artificial horizon, and the data obtained for computing a difference of longitude which, though rough, is probably the first determination by wireless telegraph. The experiments were successfully concluded on October 20. While on Nantucket Island, Assistant Wainwright determined the positions of the two beacon lights on the ends of the Nantucket Harbor jettys.

In April Assistant Wainwright proceeded to Barren Island, Chesapeake Bay, in response to a request from the Navy Department, for the purpose of relocating the water beacons marking the speed trial course off that island, which had been carried away by ice during the previous winter. The steamer *Endeavor*, Assistant F. A. Young, commanding, was placed at Assistant Wainwright's disposal for this work. The shore beacons were repaired and whitewashed and the water beacons were reconstructed by the contractors under Assistant Wainwright's direction. He also verified some topographic details in Honga River. This work was successfully completed on April 20.

From April 24 to 29 Assistant Wainwright was again in the field witnessing the trial of the Fessenden wireless telegraph apparatus in operation in the vicinity of Roanoke Island, North Carolina.

In June (15 to 30) additional tests of the Marconi wireless telegraph apparatus were made under the direction of Assistant Wainwright. These tests were made possible by the liberality of the Marconi Wireless Telegraph Company of America, which furnished an operator and apparatus for the cost of its installation and operation on board the United States Coast and Geodetic Survey schooner *Eagre*. The tests were made between the Marconi wireless telegraph station at Sagaponack, on the eastern end of Long Island, New York, and the *Eagre* at various distances. The plan was to have the *Eagre* establish easy connection with the station on shore and then proceed away from the station to determine how far this particular form of apparatus was available for signaling, as used in telegraphic longitude work. On the first trial in the latter part of June the apparatus was installed on the *Eagre* without any alteration in her standing rigging, which consists entirely of wire rope set up with turnbuckles. This gave a continuous length of wire rope from each topmast of almost 125 feet. As was partly anticipated, short distances only could be used for the purpose intended and the results of this test mainly consisted in familiarizing several officers of the Survey with the working of the apparatus and in indicating more effective arrangements in future tests. This work was in progress at the close of the fiscal year.

MAGNETIC OBSERVATIONS. VIRGINIA. W. F. WALLIS.

Stations occupied.

AMELIA.	GOOCHLAND.	RUSTBURG.
AMHERST.	LOUISA.	SMITHVILLE.
BEDFORD CITY.	LOVINGSTON.	STUART.
BUCKINGHAM.	MARTINSVILLE.	WEST APPOMATTOX.
CHARLES CITY.	NEW KENT.	CHARLOTTESVILLE.
CHATHAM.	NOTTOWAY.	LYNCHBURG.
CUMBERLAND.	PALMYRA.	PETERSBURG.
DINWIDDIE.	POWHATAN.	RICHMOND.
FARMVILLE.	ROCKY MOUNT.	

The continuation of the magnetic survey of Virginia was assigned to Magnetic Observer W. F. Wallis. He was engaged on the work from August 16 to November 27, and the stations named above were occupied.

Observations to determine the elements of the earth's magnetism were made at each station, and a meridian line, permanently marked with stone posts, was established at all the new stations and at one old station, Petersburg.

RECONNAISSANCE.
TOPOGRAPHY.
TRIANGULATION.

MARYLAND.

F. F. WELD.

SUMMARY OF RESULTS.

Reconnaissance:
- 10 square miles area covered.
- 8 triangulation points selected.

Topography:
- 15 square miles area covered.
- 222 miles of shore line surveyed.
- 65 miles shore line of creeks surveyed.
- 36 miles roads surveyed.
- 4 topographic sheets completed.

Triangulation:
- 10 square miles area covered.
- 10 stations occupied.
- 9 geographic positions determined.

A portion of the work involved in the resurvey of Chesapeake Bay was assigned to Aid F. F. Weld. He arrived at Oxford, Md., on July 19 and verified some of the work on the topographic sheet covering the locality, completing it on August 13. He then went to Baltimore to obtain a steam launch which had been placed at his disposal, and proceeded to Crisfield, Md., arriving there on August 21. It was found to be impracticable to use the steam launch in Pocomoke Sound on account of shoal water, and the difficulties in the way of keeping the launch supplied with fuel and fresh water for the boiler.

A sailboat was hired and a small scheme of triangulation was carried up to the head of Pocomoke Sound, starting from the line Apes to Messongo. A naphtha launch of light draft was then procured in exchange for the steam launch, which greatly facilitated the work. The topographic work in the vicinity of Crisfield began on August 28, and was limited to a survey of the main shore line and such interior topography as could be reached from the shore. Creeks leading to landings or used as thoroughfares were surveyed and the others were examined. Light boats with flat

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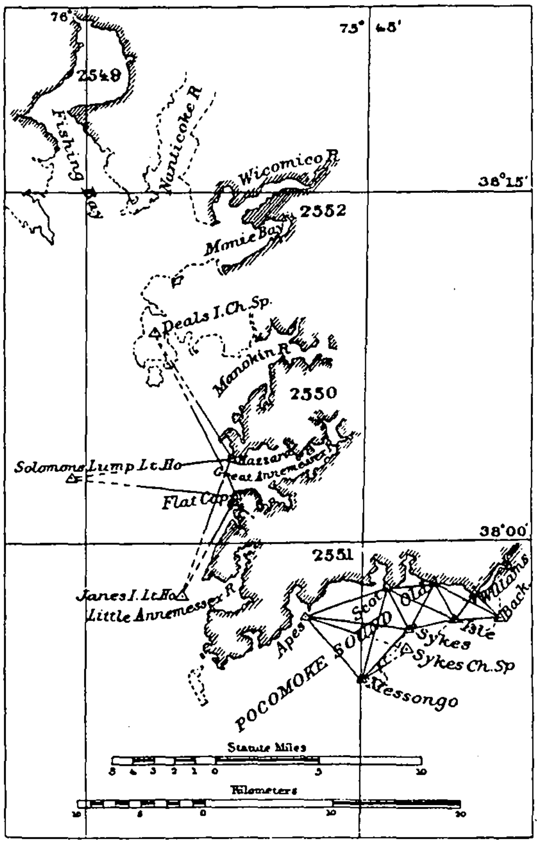

Triangulation and topography, Chesapeake Bay.

bottoms were hired for the use of the rodmen in passing from point to point along the marsh shore line, as it was found to be impassable on foot on account of the mud and numerous creeks to be crossed. The rodmen soon became expert in the use of the paddle and made excellent progress between stations.

It was necessary for the party to live in the towns, and for this reason the work was completed as far as possible from Crisfield before moving the party to another town. A wagon and team was used to transport the party to and from Apes Hole Creek and Jenkins Creek. The launch was anchored in these creeks, and consequently the party was able to do work in Pocomoke Sound and in Great Annemessex and Manokin rivers before moving from Crisfield on November 4. After completing this work the party moved to Ellicotts Island on Fishing Bay, and a survey was made of the bay, joining the work of Assistant Vinal at Station Rose and based upon data furnished by him. While the party was at Ellicotts Island some work was done around Bishops Head to join the work of Assistant Vinal to that of Assistant Forney, and a survey was made of the settlement of Ellicotts Island. On November 16 the party moved to White Haven on the Wicomico River and a survey was made of Ellis and Monie bays and the Wicomico River, including the town of White Haven and the settlement of Mount Vernon. This work was all based upon triangulation executed by Assistant Vinal. On December 4, before completing this work, it became necessary to transfer the party to Deals Island in order to connect the work previously executed there with the work of Assistant Vinal. This connection was completed and the work closed on December 7.

HYDROGRAPHY. TOPOGRAPHY.	GEORGIA. SOUTH CAROLINA.	F. F. WELD, Commanding, Steamer *Hydrographer*.

F. H. AINSWORTH, *First Watch Officer*.
H. W. PEERCE, *Chief Engineer*.
W. E. PARKER, *Aid*.
W. K. WEST, *Deck Officer*.

SUMMARY OF RESULTS.

Sapelo Sound.

Hydrography:
347 miles lines sounded.
2 current stations occupied.
Topography:
11 miles shore line surveyed.

St. Helena Sound.

Hydrography:
104 miles lines sounded.

The hydrographic survey of Sapelo Sound, Georgia, and of St. Helena Sound, South Carolina, was assigned to Assistant Weld, commanding the steamer *Hydrographer*. He sailed from Baltimore for Savannah on February 11, via Norfolk. All necessary preparations were made and the work in Sapelo Sound began on February 24. On the bar and in the entrance to the sound lines were sounded from 50 to 200 meters apart, and outside of this area the lines were sounded from 300 to 600 meters apart. The sounding work began on March 4 and progressed as rapidly as the weather conditions permitted. When the conditions were not favorable for outside work, the work in the sound was done. The inside work included the development of the anchorage at the national quarantine station and of the sound as far as Dog Hammock, with a few additional lines of soundings made to afford a comparison with previous work. Eleven miles of shore line was also surveyed in connection with this work. The shore line near the entrance has changed considerably, both points having been washed off. Tide observations were made at the quarantine station in the harbor, which is 8 or 10 miles inside the bar. Current observations were made at two stations, one on the bar and one at the entrance. The work in Sapelo Sound was completed on April 11 and the vessel proceeded to Savannah for repairs.

The hydrographic examination of the entrance to St. Helena Sound began on May 7 and was completed on the 14th. A gas-pipe signal was established on a shoal, bare at low water, just south of the main channel on line between Hunting Island Light-House and Bay Point, and about midway between them, and such signals as were necessary were erected at the triangulation points previously established. All the available time was used in developing the hydrography of the main channel and bar. Lines were sounded from 100 to 200 meters apart, and tide observations were made at a station in Big Bay Creek. The tide gauge was referred to bench marks established for reference. The vessel was needed for other duty and the examination was concluded on May 14 and the vessel sailed the same day for Washington via Charleston.

Assistant Weld reports the zealous cooperation and hearty support accorded him by the officers attached to the vessel.

HYDROGRAPHY. MASSACHUSETTS. NEW YORK. P. A. WELKER, Commanding, steamer *Blake*.

J. L. DUNN, *First Watch Officer*. July 20 to Sept. 3.
C. L. GREEN, *First Watch Officer*. Sept. 17 to Oct. 8.
J. A. MCGREGOR, *Deck Officer, First Class*.
GEO. OLSEN, *Deck Officer, First Class*.
L. M. HOPKINS, *Chief Engineer*.
G. E. MARCHAND, *Assistant Surgeon*.

SUMMARY OF RESULTS.

623 miles of lines sounded.
7 tide stations occupied.
4 hydrographic sheets completed.

The hydrographic examination of Nantucket Shoals began on July 20, 1901, under the direction of Assistant French, temporarily commanding the steamer *Blake*, in the vicinity of Great Point. No triangulation or signal building was necessary, as a sufficient number of prominent objects, whose position had been determined, were available. The progress of the work was as rapid as the condition of the weather permitted. On August 8 Assistant French turned over the work and the command of the vessel to Assistant Welker.

On August 8, the North Atlantic Squadron arrived at the anchorage under Great

Point, and Assistant Welker reported to Admiral Higginson, in command of the fleet, and offered the services of the vessel and party for such duty as he desired in making a survey of the main channel across Nantucket Shoals. He requested an examination of the channel to determine whether it was practicable to take the fleet through this channel, and his request was immediately complied with. Special attention was paid to the examination of that portion of the channel between the channel buoy northeast of Great Point and the Great Round Shoal Light Ship. Special buoys had been

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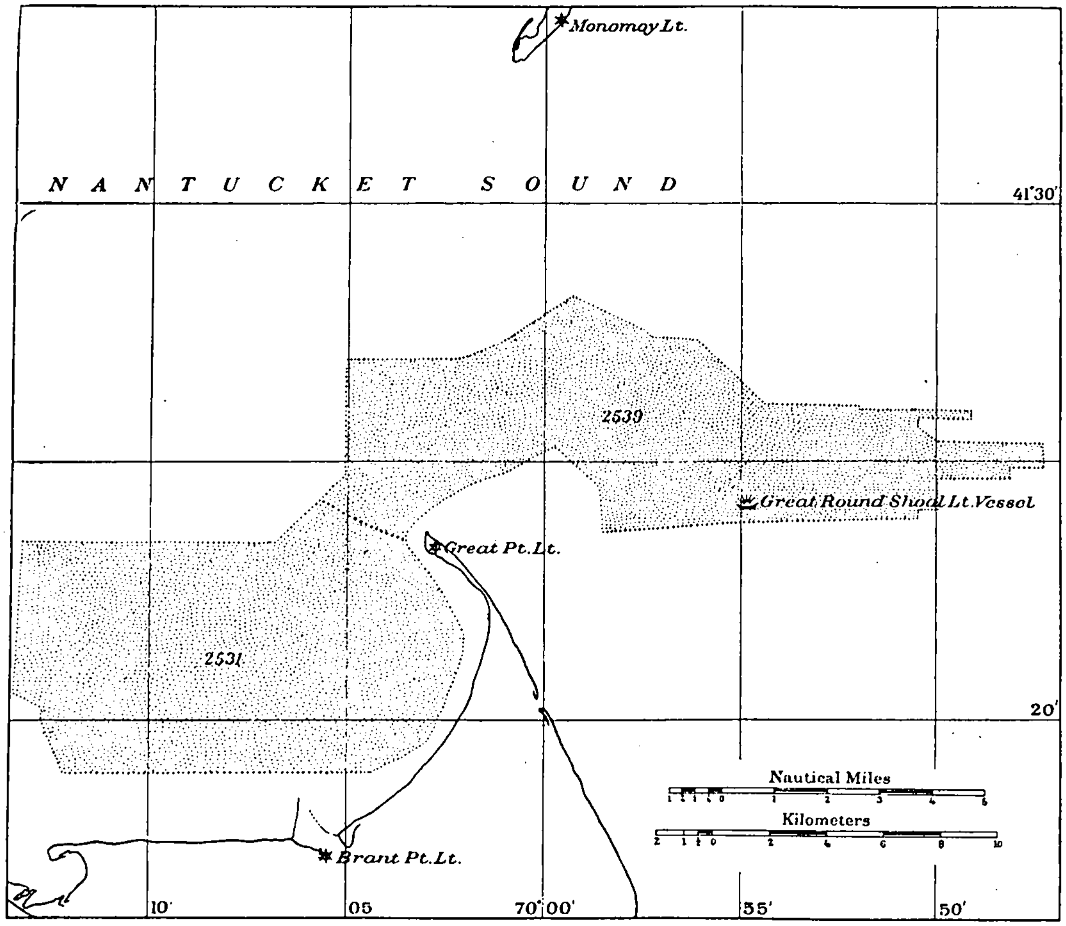


Hydrography, Nantucket Sound, Mass.

placed by the light-house tender *Mayflower* to mark the deepest water, as shown on the charts, and a system of lines approximately parallel to the direction of the line marked by buoys was sounded, and also lines approximately north and south and east and west. A copy of the hydrographic sheet on which this work was plotted was furnished to Admiral Higginson on August 21, and soon afterwards the fleet passed through the channel.

On August 17, while the party was engaged in sounding, a schooner showing signals of distress was noticed. The work was suspended and the vessels proceeded to the relief of the schooner *Mabel Jordan* of Thomaston, Me., which was aground on the western edge of the 17-foot shoal, about 7½ miles northeast of Nantucket Light-House. The schooner was hauled off the shoal into deep water and furnished with directions for continuing her passage. A crew from the Caskata Life Saving Station, searching for the schooner, was afterwards picked up in a dense fog and towed into the anchorage.

An examination was made in the vicinity of Horse Shoe Shoal Buoy No. 12, where the U. S. S. *Massachusetts* had grounded a few days before. The hydrographic work between Great Point and Orion Shoal was resumed and completed.

A reported shoal spot in the vicinity of Quicks Hole was found and its position determined. Several other shoal spots on the chart were discovered in this locality and their positions determined. The shoal spots were all found in soft bottom and evidently resulted from a deposit of silt carried from the upper bay through the strong current of Quicks Hole. The buoys in Robinsons Hole were located by using a plane table, and a supplemental survey was made. An examination was made of the western end of L'Hommedieu Shoal and the buoys that mark it were located.

Eustis Rock and the buoy marking it in Pocasset Harbor, Buzzards Bay, were located. A reported rock in the vicinity of Plum Island, Long Island Sound, was found and located. A reported rock between Hen Island and Scotch Caps was also found and located. A careful search was made for a rock reported to be outside the Hen and Chickens Reef, and the locality was thoroughly sounded and examined with a drag without finding any rock not on the chart. Inquiry at the Larchmont Yacht Club developed the fact that the report was the result of a vessel running upon the charted reef and being erroneously located.

The work closed on September 25 and the *Blake* proceeded to Baltimore by way of New York.

HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

FLORIDA.

P. A. WELKER, Commanding, steamer *Bache*.

E. B. LATHAM, *Assistant*. (April 14 to May 5 and June 24 to June 30.)
C. L. GREEN, *Watch Officer*. June 9 to 30.
M. F. FLANNERY, *Chief Engineer*.
H. S. SMITH, *Watch Officer*.
T. L. JENKINS, *Watch Officer*.
J. E. SHEPHERD, *Surgeon*.
A. C. L. ROETH, *Deck Officer*.
WM. SANGER, *Captain's Clerk*.
F. REISENBERG, *Deck Officer*.

SUMMARY OF RESULTS.

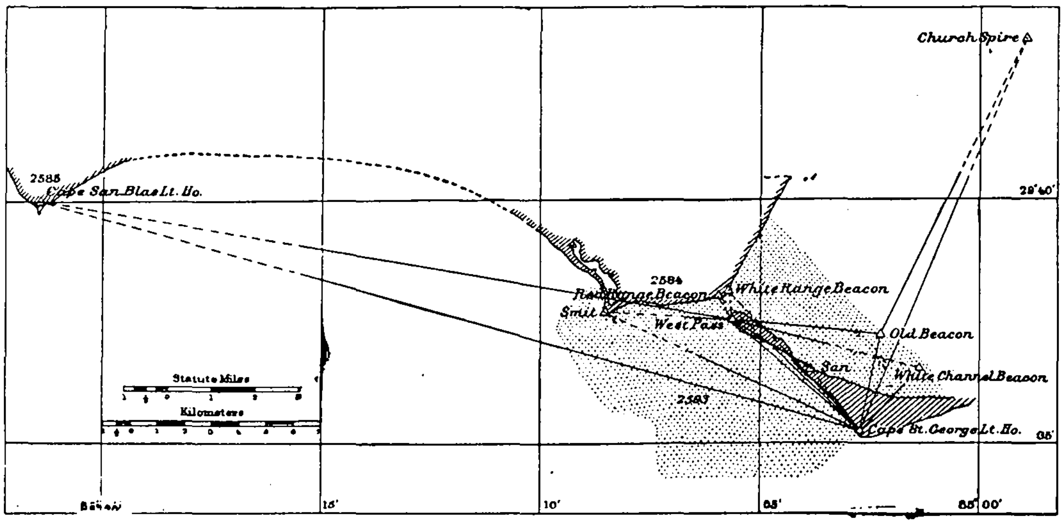
Hydrography:
30 square miles area covered by sounding.
405 miles lines sounded.
3 tide stations established.
1 current station occupied.
3 hydrographic sheets completed.

Topography:
- 48 miles of shore line surveyed.
- 3 topographic sheets completed.

Triangulation:
- 4 stations occupied.
- 8 geographic positions determined.

The resurvey of portions of the coast of Florida was assigned to Assistant P. A. Welker, commanding the steamer *Bache*. This vessel had recently been constructed and sailed from Baltimore on April 14, after making all necessary preparations for the season's work. The vessel reached Key West on April 20 and arrived at Apalachicola Bay on the 25th. The erection of signals for the survey of West Pass began immediately. Two old triangulation points, Cape St. George Light-House and West Pass, were recovered, and the work was based upon the known position of these two points.

No. 26.



Triangulation, topography and hydrography, Apalachicola Bay, Fla.

The position of Cape San Blas Light-House was determined by making the necessary observations at the stations named above. Great changes in the shore line were noted and it was necessary to resurvey it from a point 3 miles northwest of the entrance to West Pass to a point 2 miles east of Cape St. George Light-House. The point of land on the northwestern shore of the entrance has made out to sea about one-half mile and a large lagoon has been formed inside the present shore line. Sand Pass has been closed except at unusually high tides.

A party was placed under the direction of Assistant Latham by the commanding officer and a survey of the shore line in the vicinity of Cape San Blas Light-House was made. The work in the vicinity of West Pass, Apalachicola Bay, was completed on May 19, and on the following day the vessel proceeded to St. Andrews Bay for the purpose of continuing work in that locality. An examination of the bar and channel showed that the depth of water was not great enough for the ship to enter. A party was landed on May 23 in charge of Assistant Latham and the vessel proceeded to

Pensacola for coal and other supplies. The old triangulation stations in this vicinity could not be found and a detached topographic survey of the shore line of the entrance was completed on May 31 by Assistant Latham.

On June 2 a hydrographic party under the direction of Acting Watch Officer Sanger was landed and the ship proceeded to Pensacola and examined the dredged channel in the entrance to the harbor.

On June 9 the *Bache* left Pensacola for St. Andrews Bay, where the hydrographic party came on board, and then proceeded to Key West, arriving there on June 11. Stormy weather delayed the departure of the vessel until the 15th, on which date she sailed for Baltimore, arriving there on June 19.

HYDROGRAPHY.	MARYLAND.	F. A. YOUNG, Commanding,
TRIANGULATION.	VIRGINIA.	Steamer *Endeavor*.

C. L. GREEN, *First Watch Officer*.	July 16 to Aug. 19 and Oct. 11 to Nov. 10.
M. F. FLANNERY, *Chief Engineer*.	July 1 to Nov. 27.
H. G. LOCKE, *Chief Engineer*.	Nov. 19 to June 30.
J. A. MCGREGOR, *Watch Officer*.	Feb. 3 to June 30.
A. C. L. ROETH, *Deck Officer*.	July 1 to July 19.
J. A. MCGREGOR, *Deck Officer*.	Dec. 7 to Jan. 13.
WM. SANGER, *Captain's Clerk*.	July 7 to Jan. 13.
G. BRADFORD 2d, *Deck Officer*.	July 1 to Feb. 6.
R. J. NEELY, *Acting Deck Officer*.	Apr. 16 to June 30.
W. K. WEST, *Acting Deck Officer*.	May 26 to June 30.

SUMMARY OF RESULTS JULY 1 TO NOVEMBER 26.

Hydrography:
598 miles lines sounded.
3 tide stations established.
7 tide stations occupied.
2 hydrographic sheets completed.

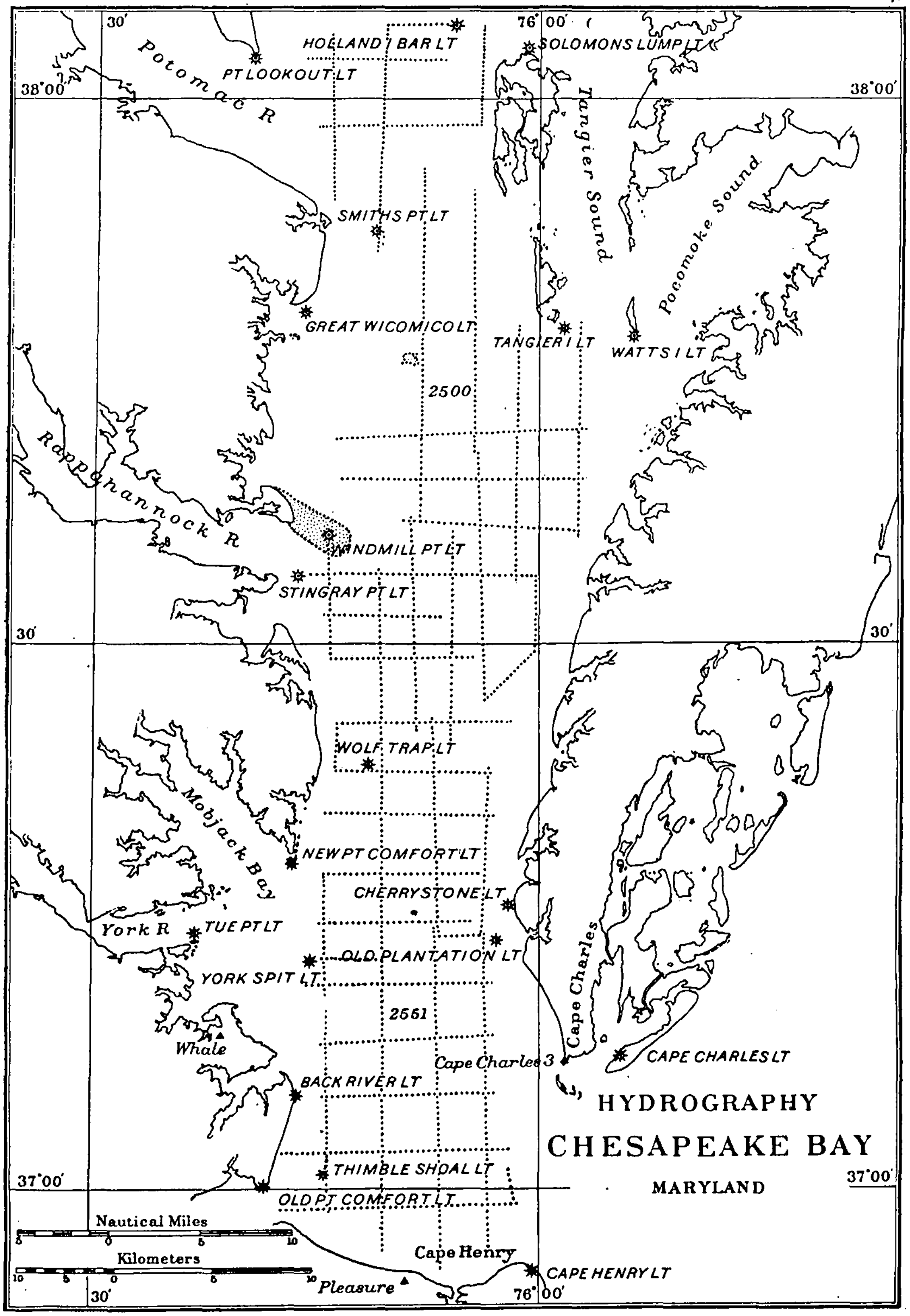
SUMMARY OF RESULTS MARCH 22 TO JUNE 30.

Triangulation:
16 triangulation stations occupied.
16 geographic positions determined.
Hydrography:
407 miles lines sounded.
1 tide station occupied.

The hydrographic examination of Chesapeake Bay from Holland Island Bar to the south shore was in progress at the beginning of the fiscal year under the direction of Assistant Young, commanding the steamer *Endeavor*. The erection of signals was continued until July 10, when in crossing the bay in stormy weather the lower blowpipe of the ship was broken, causing a leak, making it necessary to proceed to Baltimore for repairs. On July 23 the work was resumed and a survey was made of Rappahannock Spit.

In the general hydrographic examination, lines 3 miles apart were sounded north and south and east and west, covering the portion of the bay under examination and extending as far inshore as it was safe to go with the ship. On November 22 the vessel started to Baltimore and stopped on the way to sound two lines across the bay near Great Wicomico River, and also to an examination of a shoal below Smiths Point.

No. 27.



HYDROGRAPHY
CHESAPEAKE BAY
MARYLAND

The vessel reached Baltimore on November 26 and the field work for the season closed.

On March 17, 1902, the *Endeavor* left Baltimore to take up hydrographic work in the Potomac River, with launch No. 23 in tow, and proceeded to Crisfield, Md., where the launch was delivered to the commanding officer of the schooner *Matchless*. On the way to Crisfield the *Endeavor* was forced to anchor in the Patuxent River off Solomons Island for several days by a strong northwest gale and did not reach Crisfield until the 21st. On March 22 the *Endeavor* reached Rockpoint, Md., and began work on Kettle Bottom Shoals in the Potomac River. The work assigned to the party extended from Lower Cedar Point Light-House to a point 4 miles below Blakistone Island. The triangulation in this vicinity had been recently completed and the signals were still standing. It was necessary to remodel these signals for use in the hydrographic work and to establish many additional ones and determine their geographic position. A tide staff was established at Colonial Beach, Va., and high and low water observed for nearly two months. The range of the tide at this point is very much affected by wind. Tide observations were made here previously, but the bench marks to which they were referred had been destroyed and it was necessary to determine a plane of reference to which the soundings could be reduced. Many of the lumps forming the Kettle Bottom Shoals are in the position shown on the charts, but many changes were also developed and changes in the adjacent shore line noted. The *Endeavor* was absent from the field of work April 3 to 21 on special work, under direction of Assistant Wainwright, and the work was continued from that date until the close of the fiscal year, when it was still in progress.

MIDDLE DIVISION.

MAGNETIC OBSERVATIONS.	KANSAS. OKLAHOMA. TEXAS.	L. A. BAUER.

W. C. BAUER, *Magnetic Observer.*	At stated intervals.
S. A. DEEL, *Magnetic Observer.*	July 1 to Mar. 19.
W. B. KEELING, *Aid.*	June 4 to June 30.
J. M. KUEHNE, *Magnetic Observer.*	Aug. 1 to Sept. 30.
L. B. SMITH, *Aid.*	June 6 to June 30.

Magnetic observations in various localities in the Middle Division were placed in charge of Assistant L. A. Bauer and the observers named above were assigned to work under his direction as chief of party.

Mr. W. C. Bauer was continued in immediate charge of the work at the magnetic observatory at Baldwin, Kans. He had other professional duties which occupied most of his time and could only give about five days each month to the observatory work. The necessary assistance to perform the regular routine work was furnished to him and he supervised the work by personal attention for short periods whenever it was required. In September it became necessary to dismount the instruments and build a more stable foundation. This was successfully accomplished and the instruments remounted on September 28. After that date the record was well made and without interruption.

Mr. J. M. Kuehne, August 14 to September 30, made observations to determine the magnetic elements and established meridian lines for surveyors' use at the following places: In *Kansas* at Olathe; in *Oklahoma* at Perry; in *Texas* at Cuero, Edna, Gonzales, Hallettsville, Lindenau, and Victoria.

TRIANGULATION.	INDIAN TERRITORY. OKLAHOMA. TEXAS.	WM. BOWIE.

SUMMARY OF RESULTS.

4554 square miles area covered.
28 stations occupied.

The extension of the triangulation along the ninety-eighth meridian was placed in charge of Assistant Bowie, and Assistant O. W. Ferguson was assigned to assist him in the work.

Preliminary arrangements were begun by correspondence in February by Signalman J. S. Bilby, and on March 1 he started to Texas to complete the arrangements for the delivery of the outfit and lumber for the observing tripods and scaffolds. The camp outfit previously used by the parties engaged on this triangulation was shipped to Bowie, Tex., the point selected from which to extend the triangulation northward. The officers and outfit reached Bowie on March 10, and three parties were organized without unnecessary delay.

A building party was placed under the direction of Signalman Bilby and the erection of signals began immediately and was continued without interruption until the end of the fiscal year, by which time signals had been completed at all the triangulation points between the Bowie Base in Texas and the Anthony Base in Kansas. Forty observing tripods and scaffolds, with an aggregate height of 1 905 feet, were built by this party before June 30, a most creditable record for all concerned, and especially for Signalman Bilby.

Two observing parties were also organized, one under charge of Assistant Bowie, and the other under charge of Assistant Ferguson, as observers, and five light keepers were instructed in their duties. The general plan of operations was to have two observing parties at work continuously, using both heliotropes and lights and to have the building party erect the signals before they were needed by the observing parties. The following instructions in detail were issued for the guidance of the observers:

1. In making the measurements of horizontal directions you will measure each direction in the primary scheme sixteen times, a direct and reverse reading being considered one measurement, and sixteen positions of the circle are to be used, corresponding approximately to the following readings upon the initial signal:

	°	′	″		°	′	″
No. 1	0	00	40	No. 9	128	00	40
No. 2	15	01	50	No. 10	143	01	50
No. 3	30	03	10	No. 11	158	03	10
No. 4	45	04	20	No. 12	173	04	20
No. 5	64	00	40	No. 13	192	00	40
No. 6	79	01	50	No. 14	207	01	50
No. 7	94	03	10	No. 15	222	03	10
No. 8	109	04	20	No. 16	237	04	20

When a broken series is observed the missing signals are to be observed later in connection with the chosen initial, or with some other one, and only one, of the stations already observed in that series.

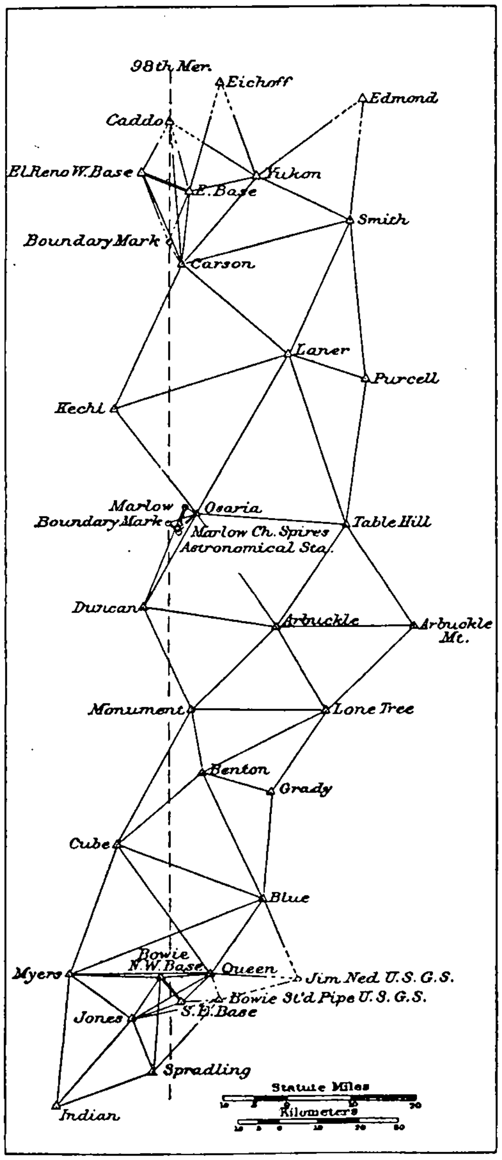
2. In selecting the conditions under which to observe primary directions, you should proceed upon the assumption that the maximum speed consistent with the requirement that the closing error of a single triangle in the primary scheme shall seldom exceed three seconds, and that the average closing error shall be but little greater than one second, is what is desired rather than a greater accuracy than that indicated.

Under this arrangement each observing party showed a heliotrope by day and a light at night to the other observing party, and each light keeper showed a heliotrope and a light to both the observing parties during the hours of work. Marks were left at each signal by which the light keepers could mount their heliotropes and lights properly, and they were controlled by the observers by means of a code of signals.

Each observing party consisted of the observer and three men until May 1, when an additional man was added to the party under charge of Assistant Bowie. Each of these parties was furnished with a covered spring wagon and two horses, and freight teams were hired in moving from station to station as the work progressed.

At the end of the fiscal year 26 primary and 2 secondary stations had been occupied and completed, and the geographic position of 6 secondary points had been determined, which included a connection with the United States Geological Survey triangulation in

No. 28.



Triangulation, Indian Territory, Oklahoma, and Texas.

the vicinity of Bowie, Tex., and in the Indian Territory; a connection with the Coast and Geodetic Survey longitude station at Marlow, Ind. T.; and a connection with 2 monuments of the Oklahoma-Indian Territory boundary line, one near Marlow and the other near Minco, Ind. T. The work was in progress at the close of the fiscal year.

LEVELING. INDIAN TERRITORY. OKLAHOMA. TEXAS. W. H. BURGER.

SUMMARY OF RESULTS.

540 kilometers of line completed.
89 bench marks established.

The extension of the standard levels of the survey from Bowie, Tex., northward in the vicinity of the ninety-eighth meridian was assigned to W. H. Burger, aid, Coast and Geodetic Survey. He reached Bowie, Tex., on April 1, and immediately organized a party consisting of Leland Wadsworth, jr., recorder, two rodmen, and two hands. The route followed was along the Chicago, Rock Island, and Pacific Railway to Medford, Okla., and thence along the Atchison, Topeka and Santa Fe Railway to a point 5 miles south of Wakita, Okla., where the work ended on June 30.

A branch line 18 kilometers long was run from Bowie to Bellevue, Tex., to determine the elevation of Bowie Northwest Base, and 32 kilometers of other branch lines were run to determine the elevation of triangulation points and boundary monuments. The elevations of numerous bench marks previously established by the United States Geological Survey were determined, and also the elevations of several triangulation stations and of a number of the posts marking the Indian Territory-Oklahoma boundary.

The usual method of running levels over the line in both directions was used. Strong and steady winds prevailed during the whole season, and a protection for the instrument against the wind was almost always necessary. This delayed the work, and additional delay was caused by the necessity of often traveling in the velocipede cars against the wind. The instrument was found to be remarkably stable when used in strong wind. Temporary bench marks were established at comparatively short intervals to afford a comparison of the results obtained by each of the two lines, and the elevations of numerous permanent bench marks were determined. The work was in progress at the close of the fiscal year.

LEVELING. NEBRASKA. WYOMING. W. C. DIBRELL.

SUMMARY OF RESULTS, WYOMING, JULY 24 TO OCTOBER 15.

246 kilometers completed line.
23 bench marks established.

SUMMARY OF RESULTS, NEBRASKA, JUNE 19 TO 30.

31 kilometers completed line.
5 bench marks established.

The extension of the standard levels in Wyoming was assigned to W. C. Dibrell, aid, Coast and Geodetic Survey. He reached Cheyenne, Wyo., on July 24, organized a party, and made all necessary preliminary arrangements The leveling outfit was stored at Rockcreek, Wyo., when the work closed at that place in 1899, and it was delayed in transit to Cheyenne, so that the observations were delayed until August 1. The route selected was along the Colorado and Southern Railway to Orin Junction, Wyo., and the work for the season closed at that place on October 15.

The party consisted of a recorder, two rodmen, and two hands, and the usual method was followed in executing the work. Velocipede cars were used to transport the party to and from work, and between stations during the progress of the work. A canvas-covered frame was used to protect the instrument from wind when necessary, and very little loss of time resulted from strong wind. The line began on two permanent bench marks at Cheyenne and ended on three permanent bench marks established at Orin Junction. Twenty-three permanent bench marks were established during the season, and temporary bench marks were established at short intervals to afford frequent comparisons between the forward and backward lines.

The extension of the standard levels in Nebraska was resumed in June by Aid Dibrell, who reached Chadron on June 19. The necessary arrangements were made, a party was organized, and the field work began on the 24th. The line began on the bench marks previously established at that place and was continued to the westward over the Fremont, Elkhorn and Missouri Valley Railway. The line was completed to a point 31 kilometers distant on June 30, the end of the fiscal year.

TRIANGULATION. NEBRASKA. SOUTH DAKOTA. F. D. GRANGER.

SUMMARY OF RESULTS.

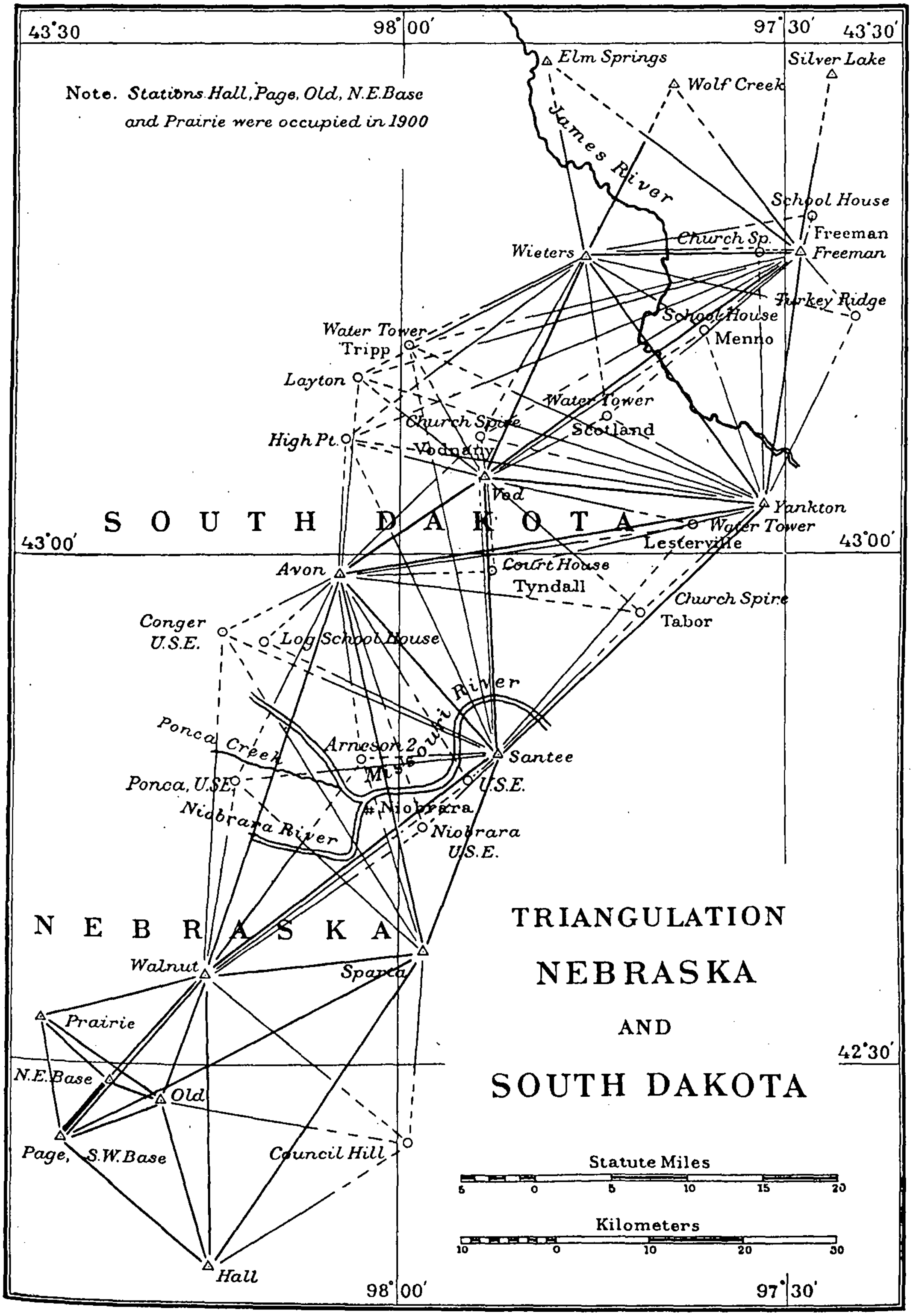
Triangulation:
- 1 280 square miles area covered.
- 8 stations occupied.
- 30 geographic positions determined.
- 19 elevations determined trigonometrically.

On July 1 the triangulation along the ninety-eighth meridian was in progress in Nebraska under charge of Assistant F. D. Granger, who was at work at Station Walnut, one of the points in the Page base net. The observations at this station were completed on July 5, and the following stations were then occupied in the order named: Sparta and Santee in Nebraska, and Avon, Vod, Yankton, Weiters, and Freeman in South Dakota. The atmospheric condition was very unfavorable for observations on signal poles, and it is probable that the use of heliotropes would be more economical when the work is continued.

All the laborers in this region had continuous employment, and at times it was found to be impossible to secure necessary assistance in building the observing tripods and scaffolds. In compliance with instructions Assistant Granger connected his work with the triangulation along the Missouri River, executed under the direction of the Missouri River Commission, and four of the stations, Conger, Ponca, Niobrara, and one (name not known), of the Missouri River triangulation stations were recovered and observed upon for the purpose of comparing the latitude, longitude, and azimuth as developed in these independent triangulations.

Assistant Granger reports the able assistance rendered in the work by Mr. E. E. Torry and Mr. D. A. Lewis, who were employed in his party. On October 28 the work closed and the party was disbanded.

No. 29.



TRIANGULATION
NEBRASKA
AND
SOUTH DAKOTA

MAGNETIC OBSERVATIONS. TEXAS. F. M. LITTLE.

Stations occupied.

ALBANY.	GARDEN CITY.	PALO PINTO.
ANSON.	GRAHAM.	ROBERT LEE.
ASPERMONT.	GUTHRIE.	ROBY.
BENJAMIN.	HASKELL.	SAN ANGELO.
BIG SPRINGS.	JACKSBORO.	SEYMOUR.
BRECKENRIDGE.	JUNCTION.	SHERWOOD.
CLAIREMONT.	MENARDVILLE.	SNYDER.
COLORADO.	MINERAL WELLS.	SONORA.
DICKENS.	OZONA.	STERLING CITY.
ELDORADO.		

Magnetic observations were in progress in Texas at the beginning of the fiscal year, with Assistant Little as observer. During the season the determination of the magnetic elements was made at the stations named above. These places were not accessible by means of railroad transportation, and a wagon and team was used in moving from place to place. In addition to the magnetic observations, a meridian line was established and permanently marked by suitable stones. Article 4101 of the revised statutes of Texas, 1895, requires each county surveyor to establish a meridian line at the county seat and mark the same at the expense of the county. The county surveyor furnished suitable stones and had them placed in position upon request, and thus greatly facilitated the work. Observations were continued until October 17, when the work for the season closed at Seymour.

RECONNAISSANCE.
TRIANGULATION. KANSAS. A. T. MOSMAN.

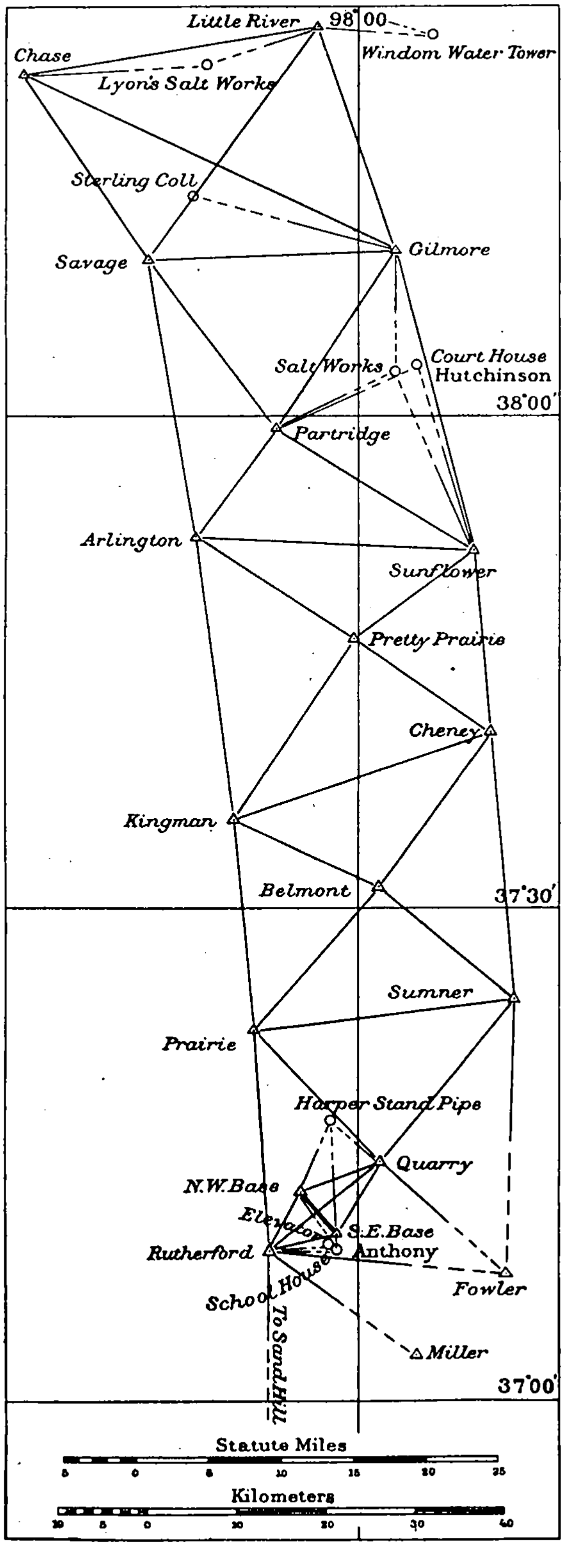
SUMMARY OF RESULTS.

Reconnaissance (revised):
- 1 500 square miles area covered.
  - 16 triangulation stations relocated.

Triangulation:
- 1 150 square miles area covered.
  - 13 stations occupied.
  - 27 geographic positions determined.
  - 21 elevations determined trigonometrically.

The triangulation along the ninety-eighth meridian in Kansas was in progress at the beginning of the fiscal year, with Assistant Mosman assigned to the charge of the work. During the season seventeen observing tripods and scaffolds were built, with an average height of 45 feet, for use in the work, and observations were completed at the following stations, in the order named: Partridge, Arlington, Sunflower, Pretty Prairie, Kingman, Cheney, Belmont, Prairie, Sumner, Quarry, Rutherford, Northwest Base, Southeast Base. The first observations were made at Partridge on July 1 and the observations at Southeast Base were completed on September 22. The party outfit was stored at Anthony, Kans., on September 24, and the party disbanded. Assistant Mosman expresses his appreciation of the service rendered by Signalman Jasper S. Bilby, and Foreman Arthur W. Lewis, and states that "too much praise can not be given them for their zeal, energy, and industry."

No. 30.



Triangulation, Kansas.

MAGNETIC OBSERVATIONS. NEW MEXICO. TEXAS. E. D. PRESTON.

Stations occupied.

NEW MEXICO.

ALAMAGORDA.*	KENNA.	PENASCO (UPPER).
CAMPBELL.	LINCOLN.	PORTALES.
CAPITAN.	MCMILLAN.	ROSWELL.*
CARLSBAD.*	MESCALERO.*	STEGMAN.
CARRIZOZO.	PECACHO.	TULAROSA.
HAGERMAN.	PENASCO (LOWER).	WHITE OAKS.
HOPE.		

TEXAS.

ALPINE.*	EAGLE PASS.*	MARFA.
AUSTIN.	GUADALUPE.	PEARSELL.*
BRACKETTVILLE.*	HONDA.*	PECOS CITY.
CARRIZO SPRINGS.*	KENT.	UVALDE.*
COTULLA.	MARATHON.	VALENTINE.
DEL RIO.*		

The extension of the magnetic survey in New Mexico and Texas was assigned to Assistant Preston and he proceeded to Austin, Texas, and arrived there on October 15. At Austin a series of observations were made for the purpose of comparing the magnetic instruments with those at the University of Texas. The determination of the magnetic elements was then taken up and observations were made of the stations named above, and meridian lines were established for surveyors' use at the stations marked with a star. The work was delayed by strong wind at times and the difficulties of transportation away from railroads, but steady progress was made until the work closed on April 15. It was necessary to reach many of the stations in an open wagon over extremely rough roads, and in one instance the distance to be traveled was 45 miles.

LEVELING. NEBRASKA. G. E. SELBY.

SUMMARY OF RESULTS.

430 kilometers completed line.
42 permanent bench marks established.

The work of extending the standard levels west from Page, Nebr., was assigned to Aid Geo. E. Selby. He arrived in O'Neill, Nebr., on July 12, accompanied by O. E. Carr, aid, and organized a party for the work. The route followed the Great Northern Railway from Page to O'Neill, and the Fremont, Elkhorn and Missouri Valley Railway from O'Neill to Chadron. The line was leveled twice, once in each direction, and temporary bench marks were established at intervals of about one mile to afford a comparison of the elevations resulting from each line of levels.

Aid Carr made the observations from July 12 to September 25, and great credit is due him for the rapid progress of the work during this period. His connection with the party terminated on September 26. The work was continued until November 25, when the work closed at Chadron, Nebr., and the party was disbanded. Three permanent bench marks were established in the vicinity of Chadron to secure a reliable elevation from which to extend the line. Mr. G. C. Baldwin served as rodman from July 12 to September 11, and his service was entirely satisfactory.

WESTERN DIVISION.

COAST PILOT. — CALIFORNIA. OREGON. WASHINGTON. — H. L. FORD.

The collection of information necessary for a new edition of the United States Coast Pilot, covering the coast of California, Oregon, and Washington, was assigned to Nautical Expert Ford, as stated in the report for the previous fiscal year, and he was actively engaged in this work on July 1. During July San Francisco was used as headquarters, and various trips were made to the ports and waters north of that place, using such transportation as the vessels engaged in coastwise traffic afforded. This was the only available means of transportation for the work and had to be used, but it was far from being as expeditious and satisfactory as a vessel specially assigned to the work. All the important points easily reached from San Francisco were visited and all necessary information collected.

After some delay on account of the sailors' strike in San Francisco, Mr. Ford went to Portland, Oreg., by rail, and reached there on September 12. The Columbia River and many points on the adjacent coast were visited, with Portland as headquarters, and necessary information covering this region was collected. On October 31 Mr. Ford proceeded to Seattle, Wash., and extended his work over the Puget Sound region, visiting such points as were necessary. After some delay, due to unfavorable weather, in addition to that caused by the necessity of using ordinary means of travel, the work in this region was completed by February 3, and on that date Mr. Ford proceeded by sea to San Francisco and extended his work so as to cover San Francisco Bay and the adjacent waters. All necessary work was completed and the work in the field closed on March 1.

HYDROGRAPHY.
RECONNAISSANCE.
TOPOGRAPHY.
TRIANGULATION. — CALIFORNIA. OREGON. WASHINGTON. — FREMONT MORSE.

SUMMARY OF RESULTS.

Oregon and Washington, July 1 to October 17.

Hydrography:
- 10 square miles area covered.
- 206 miles lines sounded.
- 3 tide stations established.
- 2 hydrographic sheets completed.

Reconnaissance:
- 13 square miles area covered.
- 4 triangulation points selected.

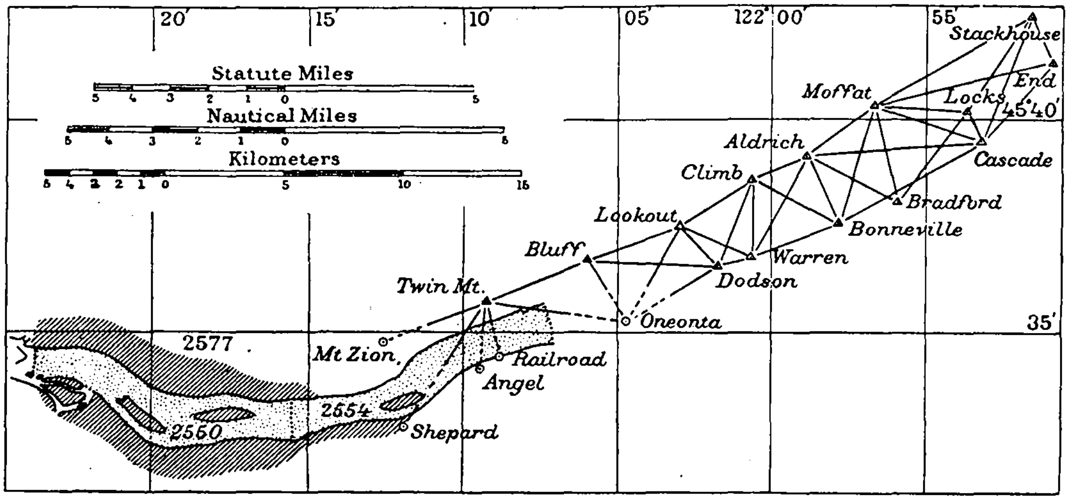
Topography:
- 13 square miles area covered.
- 52 miles shore line of rivers surveyed.
- 8 miles shore line of creeks surveyed.
- 16 miles shore line of ponds surveyed.
- 36 miles of road surveyed.
- 1 topographic sheet completed.

Triangulation:
- 30 square miles area covered.
- 14 stations occupied.
- 54 geographic positions determined.

California, January 7 to March 15.

Hydrography:
- 33 miles of line sounded.
- 2 tide stations occupied.
- 1 hydrographic sheet completed.

No. 31



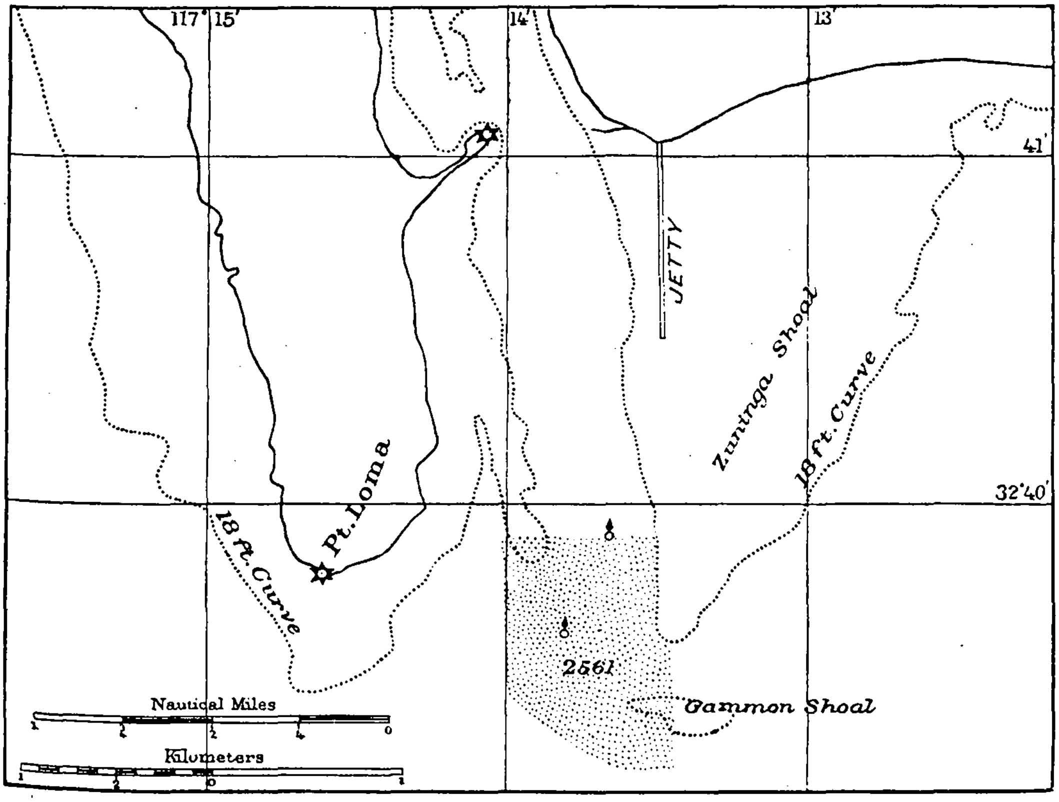
Triangulation, topography and hydrography, Columbia River.

The survey of the Columbia River below the Cascades was in progress at the beginning of the fiscal year under the direction of Assistant Morse. Assistant E. B. Latham was a member of the party during the whole season, and Mr. C. W. Fitzgerald, watch officer, joined the party on July 15 and aided in the work after that date. The different classes of work made steady progress at such times during the season as the conditions permitted them to be most advantageously executed until October 17, when the season closed. The stretch of river from Corbetts Landing to Multnomah Falls is peculiar. Here the river emerges from the Cascade Mountains, and during the summer season the prevailing winds are moderate and draw up the river. In the autumn the winds change and blow down the river most of the time. They are stronger than the summer winds and often blow with great violence—so great that people living along the shore do not try to cross the river in small boats, and even the steamboats sometimes find it difficult to make headway against them. The winds are stronger on the portion between Corbetts Landing—about two miles below Rooster Rock—and Cape

Horn than elsewhere on the river. Frequently a strong east wind would blow at this place, often interrupting work, when farther down the river the weather would be favorable. It was this consideration that decided the question of closing work for the season, as it was not thought advisable to continue the work when the rainy season was setting in and rains, river fogs, and east winds would inevitably cause great delay in the execution of the field work.

Assistant Morse expresses his appreciation of the valuable assistance rendered during the progress of the work by Messrs. Latham and Fitzgerald.

No. 32.



Hydrography, entrance San Diego Bay, California.

Reported changes in the bar off the entrance to San Diego Bay rendered it necessary to have a hydrographic examination made in this locality, and this work was assigned to Assistant Morse. Mr. C. W. Fitzgerald, watch officer, and Mr. F. G. Crist, deck officer, were instructed to report to Assistant Morse and aid in the work. The party reached San Diego on January 7, and made all necessary arrangements for the hydrographic work. A tide staff was erected at the tide station previously occupied at La Playa, just inside the entrance to the bay, and another was erected alongside the jetty, outside the entrance, on its west side and about one-third of the length of the jetty from its outer extremity. A forty-eight-hour series of simultaneous tide observations was made at these stations and a plane of reference deduced at the jetty gauge which agreed with the plane previously established by the United States engineers.

The necessary signals were erected and on January 17 the bar was visited, but the water was too rough for sounding. Some practice work was done and experiments were made to determine a method by which the gasoline launch engine could be kept going at full speed and still have the speed of the launch reduced sufficiently for sounding work. Past experience with similar launches had shown them most reliable when the engine was kept at full speed, and it was found that this condition could be maintained and the launch kept at proper speed by towing three washtubs, one being towed from each quarter and one amidships, astern. From January 18 to 30 the water on the bar was too rough for sounding, and it continued in this condition, except on January 31, February 1, 14, and 15, and March 4, 5, 12, and 13. The area under examination consisted of a rectangular space about three-fourths of a mile long, north and south, and one-half of a mile wide. With such interruptions in work it was found that changes in the shoals occurred as the result of storm action, and on March 13 as many lines as possible were run both north and south and east and west 50 meters apart. Although the lines sounded in this way did not cover the entire area to be surveyed, the work was sufficient to serve the purpose intended, as the bar proper had been satisfactorily surveyed, and the shoals to the eastward would probably change again. The work closed on March 14 and the party disbanded.

CHARGE OF SUBOFFICE. CALIFORNIA. AUG. F. RODGERS.

TIDE OBSERVATIONS.

The suboffice of the Survey in San Francisco was continued under the charge of Assistant Rodgers. Numerous duties, largely matters of routine in connection with the field work, were assigned to him during the year. Assistant Rodgers supervised the tide observations at the Presidio, where a continuous record was obtained during the year, and kept the tide indicator on Alcatraz Island in order. Mr. John S. Blough served throughout the year as writer and W. J. Diercks continued to serve as messenger. Information of interest to the Survey, collected by Assistant Rodgers, was promptly transmitted to the Office.

ASTRONOMIC OBSERVATIONS. NORTHWEST BOUNDARY. C. H. SINCLAIR.

The reconnaissance along the forty-ninth parallel in the Rocky Mountain region of the Northwestern part of the United States was in progress, under the joint auspices of the United States Coast and Geodetic Survey and the United States Geological Survey, at the beginning of the fiscal year, as stated in the previous annual report, at Midway, British Columbia. The azimuth station was placed in line on the west bank of Boundary Creek between monument No. 63, 4 191 feet east, and monument No. 66, 5 454 feet west. An azimuth was determined and a meridian line was established and marked with two iron posts. The magnetic declination was determined on three days with a compass declinometer. Boundary mark No. 64 had been torn down, but the foundation was in good condition and the monument was rebuilt to a height of 5 feet. There was no center mark found in this foundation. All the other boundary marks in this vicinity were in good condition. They are square pyramids of stone, with a base 6 by

6 feet and 5 feet high. The latitude station was 63.6 feet north of the azimuth station, and the instrument was mounted on a well-seasoned pine log 6 feet long buried 3 feet in the ground.

The astronomic observations were completed at Midway on July 16, and the party moved 12 miles east to Carson, British Columbia, and established a latitude station alongside monument No. 53. The zenith telescope was mounted on a piece of dry timber 12 by 12 inches and 6 feet long, buried 3 feet in the ground. Latitude, azimuth, and magnetic observations were made and a meridian line established and marked by two iron posts, one at the station and the other 204.7 feet north, not far from a large pine tree. An examination of the line was made for a distance of 6 miles to the eastward, and all of the boundary monuments were found in good condition except No. 52. This monument had been torn down, but the square stone foundation was in good condition and a mound of stone and earth 5 feet high was built over it.

On July 29 the party moved 10 miles east to monument No. 43, at Russell, where latitude and azimuth observations were made. The zenith telescope was mounted on a dry pine log 14 inches in diameter and 6 feet long buried 2½ feet in the ground. A meridian line was established and marked by two pieces of railroad iron, one placed at the azimuth station on the line 97.9 feet east of monument No. 43 and the other 1 037 feet north, on the east side of the road. A pile of stones was built around each piece of iron and a cross cut on its top to mark the line. The boundary was examined as far east as monument No. 40 and as far west as No. 46, and the monuments within these limits found in fair condition.

The work on this section of the line was completed on August 10, and the party moved about 100 miles east to Phillips, British Columbia. The mark at this place was a wooden center post 10 inches in diameter set in the square foundation of a pyramidal stone pile and a vista cut to the east for half a mile through the woods. This monument is No. 8, according to the American list, and was rebuilt to a height of 8 feet. Latitude, azimuth, and magnetic observations were made. The azimuth station was 180 feet east and 6.7 inches north of monument No. 8, and was marked by an iron post. A meridian line was established and marked by placing a square tamarack post 1 637 meters north of the azimuth station, on the high bench above Phillips Creek, in the edge of the woods.

The season was so advanced that it was decided to suspend work on Tobacco Plains and proceed to Wigwam Valley to avoid possible delay from early snow on the high divide which it was necessary to cross in order to reach the valley. On August 26 the party started to Wigwam Valley by road to Rich's ranch and thence by trail to the valley. The boundary was marked at this place by two pyramidal cairnes in a well-defined vista nearly a mile in length. The eastern monument, No. 6, was well up the slope and the other, No. 7, was across the narrow valley on the west slope, nearly half a mile apart. No. 7 was in shape, with some of the stones slightly misplaced, but the entire top of No. 6 had fallen down. This monument was built around a decayed stake left in the foundation as a center. The latitude station was established in the valley 19.75 inches south and 264 meters west of monument No. 6. Latitude, azimuth, and magnetic observations were made. The azimuth station was placed 8.36 meters east and 1.75 inches north of monument No. 6, so as to command a view to the west, because there was no opening in the forest in any other direction. The tangent was marked by two iron posts, one at the azimuth station and the other 801 meters to the west on the slope above monument No. 7. A line was cut through the forest for a mile and a half to the summit of the mountain to the east, which overlooks the valley of the Flathead, and the tangent was marked by a wooden post set on the summit. A vista was also cut for some distance to the west, so as to get a view of a lofty summit upon which the tangent from Phillips was to be connected with the tangent from Wigwam. With the cooperation of the United States Geological Survey party a junction of these two tangents was made, a line was adjusted between them, and the vista was cut through the forest for the entire distance of 13.45 miles between the monuments and the adjusted line, marked by iron posts on the prominent summits. An old latitude station, established in 1861, was recovered and verified by new observations.

The party left the Wigwam Valley and returned to Phillips on September 26. A vista was opened up the side of the mountain to the first summit to the east and the tangent was marked by an iron post on the summit, which is 3 500 feet above the plain. The latitude station at East Kootenai was established 324 meters west of monument No. 9 and 905 meters east of monument No. 10. The latitude station of 1861 was half a mile west and 1 540 feet south of this station. An azimuth was determined at a point 179 meters west of monument No. 9, and a meridian line established from the station 381 meters long, and both ends marked with an iron post. An iron post was also set on the east bluff of the river bottom 494 meters west of monument No. 9. The old vista on the west side of the Kootenai was cleared nearly to monument No. 11, at the base of the main mountain range, and an attempt was made to locate a point on the tangent where it crosses the main divide 13 miles to the west, but it was found to be impracticable to get pack animals through the dense forest without opening a trail most of the way, and it was too late in the season to undertake such a task. The old vista between monuments No. 8 and 9 was cleared and an iron post was placed on the parallel about halfway between them.

The work was completed on October 12 and the party moved to Waneta, British Columbia, on the Columbia River. A latitude station was located on the west side of the railroad about 20 meters northwest of the station platform at the small town in United States territory called Boundary. The zenith telescope was mounted on three railroad ties sunk 3 feet in the ground for latitude observations, and azimuth and magnetic observations were also made. On the west side of the river, about 400 meters from the bank, monument No. 31 was found in a vista. A tangent was passed through this monument and prolonged across the river to the east bank. A piece of railroad iron 6 feet long was buried 3 feet in the ground near the latitude station to mark the tangent and a similar piece was set on the high bench to the east so as to preserve the direction for extending the line. In 1859 and 1860 two monuments, Nos. 29 and 30, were set—one by the Americans and one by the British representatives—129 yards apart to mark the boundary near this place, but both were destroyed by placer miners who dug up the ground to a depth of 6 or 8 feet. Not far from the astronomic station a quartz bowlder, set on end, with a cross cut on top and the letters "U.S.L.M.," on the south side was found alongside a small pile of stone, probably a mark established by the General Land Office. The southwest corner of monument No. 31 had fallen down, but the cairn will serve without repair as a conspicuous mark for a long time. Monument No. 32, on the first summit west of the Columbia River, was visited and it was found in a very good state of preservation. The old vista up the side of the mountain was plainly distinguishable, but was well grown up and needs clearing as far as monument No. 32. The work closed and the party was disbanded on October 19. Assistant O. B. French joined the party on August 30, and aided in the work from that date to the close of the season.

TIDE OBSERVATIONS. WASHINGTON.

An automatic tide gauge was kept in operation throughout the year at Seattle, Washington. W. C. Meyer, observer.

DIVISION OF ALASKA.

HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

E. F. DICKINS, Commanding,
Steamer *Gedney*.

H. F. FLYNN, *Assistant*.
W. H. BURGER, *Aid*.
W. W. MARKOE, *Surgeon*.
J. W. McGRATH, *Watch Officer*.
F. G. CRIST, *Deck Officer*.

SUMMARY OF RESULTS.

Hydrography:
- 202 square miles area covered.
- 892 miles of lines sounded.
- 2 tide stations established.
- 2 hydrographic sheets completed.

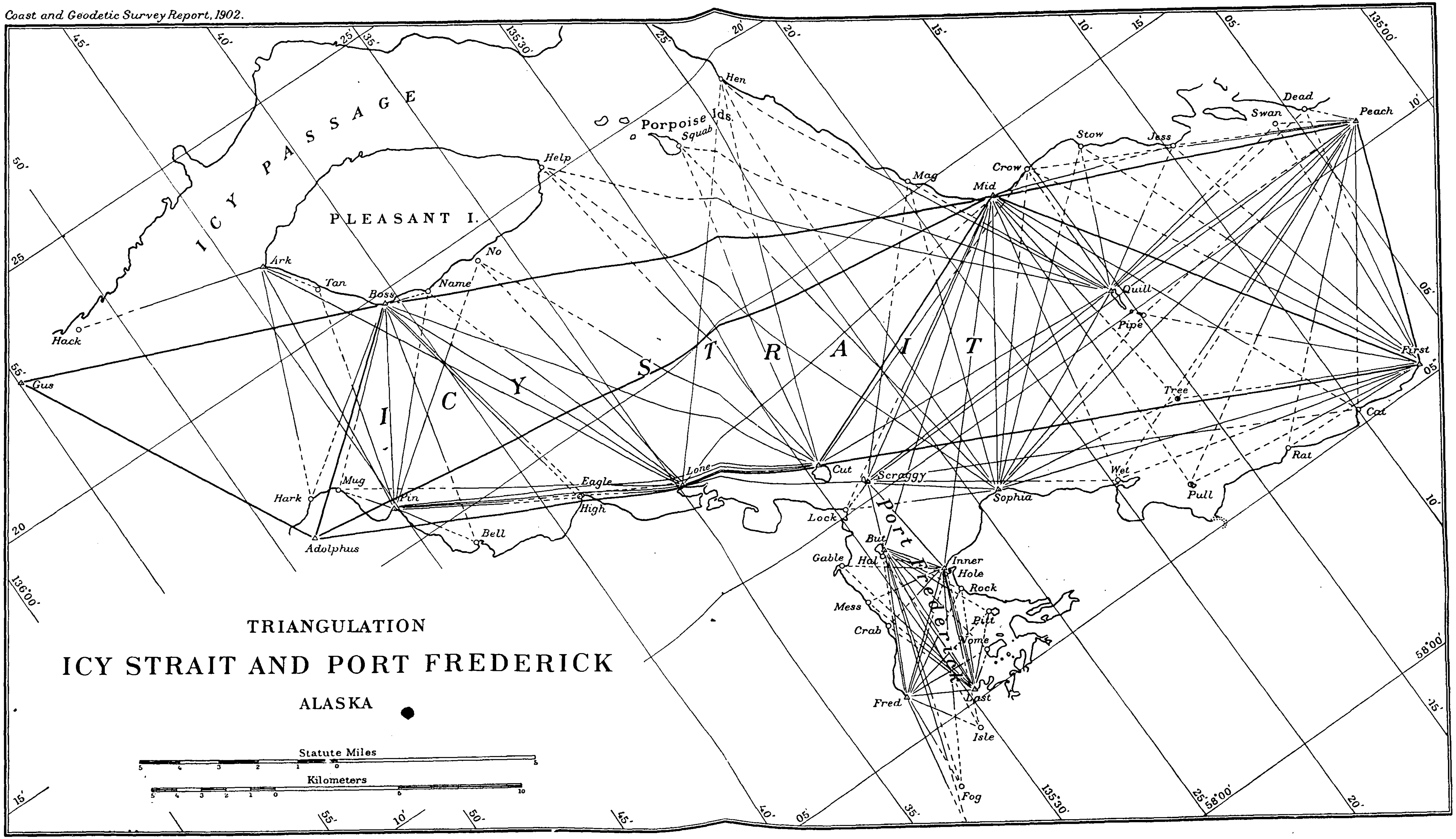
Topography:
- 154 miles of shore line surveyed.
- 3 topographic sheets completed.

Triangulation:
- 310 square miles area covered.
- 18 stations occupied.
- 39 geographic positions determined.

On July 1, 1901, the steamer *Gedney*, Assistant E. F. Dickins, commanding, was at Killisnoo, Alaska. Launch No. 117 was prepared for field work, and the vessel proceeded on July 2, towing the launch to Dundas Bay, where Assistant Dickins had a conference with Assistant Pratt, commanding the *Patterson*, in regard to the work to be executed, and on July 4 went on to Hooniah.

The erection of signals began on July 5, and on the 8th all within reach of this anchorage were completed. The vessel was moved to Swansons Harbor on July 9, a tide gauge was erected, and tide observations were begun. The hydrographic work began on July 12 and the topographic work on July 15. Progress was made as rapidly as the weather permitted, and on the 28th all the work within convenient reach of the anchorage was completed and the vessel returned to Hooniah. Simultaneous tide observations were made at Swansons Harbor and Hooniah anchorage on two days to connect the tidal planes, similar work having been done previously to connect the tides at Hooniah anchorage with those at Funter Bay. The work in this region was continued whenever the weather permitted until October 10, when the survey of the shore line and the hydrography of Icy Strait, from Chatham Strait to Cape Adolphus, and of Port Frederick, from its entrance to a point 2 miles south of Hooniah anchorage, was completed.

Coast and Geodetic Survey Report, 1902.



The hydrographic work was done by Messrs. McGrath and Crist. In Icy Strait the lines of soundings were run about 400 meters apart and the soundings made at intervals of the same distance, the position of each sounding being determined. Near the shore, in the small bays and on all shoals and reefs, the soundings were made nearer together and the dangers well developed.

The topographic work was done by Assistant Flynn with W. H. Burger, aid, as rodman, and was confined to the shore line in order to keep this work up with the hydrography. The position and height of the mountain peaks were determined whenever practicable. The region is densely timbered and rises so abruptly from the shore line that it was impossible to sketch in the contours on the shore where the work was in progress, and the opposite shore was too indistinct to permit this character of work to be done.

The main scheme of triangulation had been completed by the party under direction of Assistant Pratt, and it was only necessary to determine some intermediate positions for the use of the hydrographers and topographers.

Tide observations were made continuously day and night during the whole season.

The work for the season closed on October 10, and the *Gedney* sailed next day for Sitka, where the launch was stored; and on October 23, after completing all necessary preparations, the *Gedney* sailed in company with the *Patterson* and *McArthur* for Seattle, and reached that port on November 1.

Assistant Dickins refers as follows to the members of the party:

I found Assistant Flynn to be a very valuable and efficient officer. He took great interest in the work and was always ready and willing to do everything in his power to advance it. He had charge of and executed all the plane table work, assisted in the triangulation and computations, and stood watch when the vessel was under way. In fact, I can not speak too highly of the energetic and faithful manner in which he performed all his duties, and our success during the season was largely due to his assistance.

Mr. W. H. Burger, aid, had had very little experience in the work, but he felt an interest in it and was anxious to learn. I found him always ready and willing to undertake all work assigned to him. He assisted in the triangulation, topography, and computations, and performed all his duties faithfully and well.

Mr. F. G. Crist, deck officer, was as usual always ready and willing to perform all duties assigned him, and I consider the hydrographic work accomplished largely due to his experience and efforts. He is a good watch officer and attends to all his duties faithfully and well.

Dr. W. W. Markoe, assistant surgeon, was attentive to his duties and was always ready to stand watch or take an active part in the field work.

Mr. James Mitchell, chief oiler in charge, was as usual very careful and attentive to all his duties, and kept everything in his department in good order.

Of the petty officers and crew, with only two exceptions, I can not speak too highly. They got along well together and did their work cheerfully and well.

MAGNETIC OBSERVATIONS. ALASKA. H. M. W. EDMONDS.

The magnetic work at Sitka, Alaska, was assigned to H. M. W. Edmonds, magnetic observer, and he reached Sitka on July 15, 1901. The preliminary preparations for the construction of buildings for a magnetic observatory had been made by J. A. Fleming, aid, before Mr. Edmonds's arrival. He relieved Mr. Fleming and immediately assumed charge of all operations relating to the work. The weather conditions were very unfavorable for the work of constructing the buildings on account of the almost incessant rain, and the buildings were not completed until October 16. The interior of the building was dried with difficulty, the instruments were installed, and the photographic record of the variation of the magnetic forces began on November 25. While the construction of the observatory was in progress readings were made daily at hourly intervals between 7 a. m. and 3 p. m. at the astronomic observatory for the purpose of determining the magnetic declination. After January 1 a continuous photographic record of the variation in the magnetic declination and horizontal intensity was obtained, with short interruptions for occasional adjustment of instruments. Observations to determine absolute values of the magnetic elements were made every Monday and Thursday, and observations were also made to determine the constants depending upon changes in temperature. Special observations were made at the old station on the Parade Ground for the purpose of referring the observations made in previous years to the observatory. Special observations were also made at regular intervals in connection with a programme adopted for international work. The two principal sources of difficulty in the work are the prevalence of clouds and dampness. A great deal of time was lost in making attempts to secure observations for time, and many expedients were adopted to minimize the effects of dampness. The work was in successful operation at the close of the fiscal year.

BASE LINES.
HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

J. J. GILBERT, Commanding,
Steamer *Pathfinder*.

SUMMARY OF RESULTS.

Base lines:
- 2 measured.

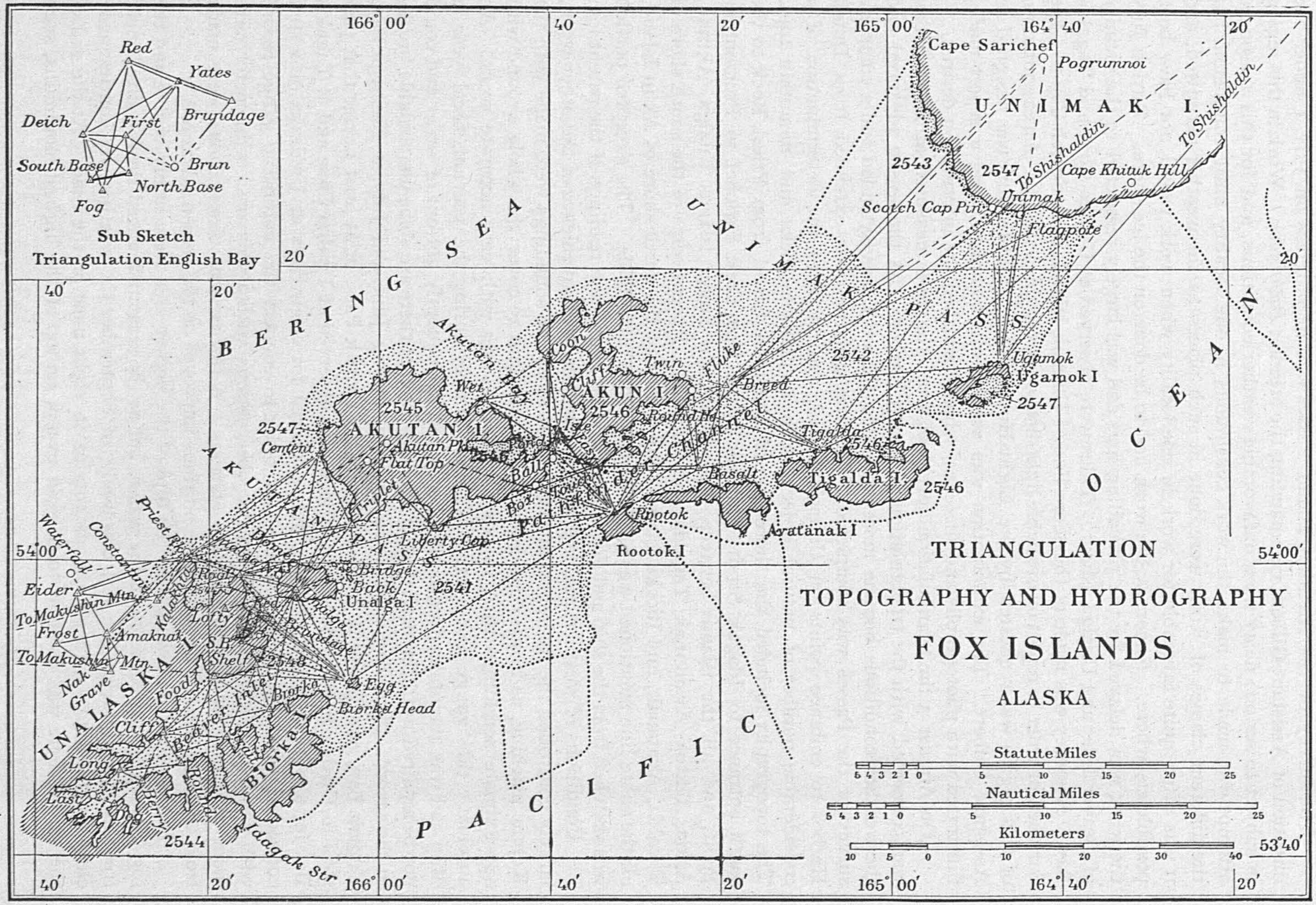
Hydrography:
- 1 000 square miles area covered.
- 1 000 miles of lines sounded.
- 7 tide stations established.
- 2 current stations established.
- 8 hydrographic sheets completed.

Topography:
- 290 square miles area covered.
- 445 miles of general coast line surveyed.
- 4 hydrographic sheets completed.

Triangulation:
- 900 square miles area covered.
- 39 stations occupied.
- 52 geographic positions determined.

C. C. YATES, *Assistant*.
V. R. LYLE, *First Watch Officer*. Sept. 15 to 27.
J. J. MURPHY, *Surgeon*.
J. T. GOLDSBOROUGH, *Chief Engineer*.
W. M. ATKINSON, *Second Watch Officer*.
L. M. FURMAN, *Third Watch Officer*.
F. H. BRUNDAGE, *Aid*.
C. F. DEICHMAN, *Captain's Clerk*.
R. C. McGREGOR, *Deck Officer, Third Class*.
J. F. PFAU, *Draftsman*.

No. 34.


TRIANGULATION
TOPOGRAPHY AND HYDROGRAPHY
FOX ISLANDS
ALASKA
Sub Sketch
Triangulation English Bay
Red
Yates
Brundage
Deich
First
Brun
South Base
North Base
Fog
BERING SEA
UNIMAK PASS
AKUTAN PASS
PACIFIC OCEAN
UNIMAK I.
Cape Sarichef
Pogrumnoi
To Shishaldin
Cape Khituk Hill
Scotch Cap Pt.
Unimak
Flagpole
Ugamok
Ugamok I
AKUN I.
AKUTAN I.
Akutan Bay
Akutan Pk.
Flat Top
Cement
Wet
Coon
Cliff
Twin
Fluke
Breed
Round Hd.
Tigalda
Tigalda I.
Basalt
Rootok
Rootok I.
Aiatanak I
Liberty Cap
Bridge
Back
Unalga I
Priest Rk.
Constantine
Waterfall
Eider
To Makushin Mtn.
Frost
Amaknak
Lofty
Grave
Nak
Food
Cliff
Long
Last
Dog
Beaver Inlet
Biorka
Biorka I.
Biorka Head
Egg
UNALASKA I.
Idagak Str.
2541
2542
2543
2544
2545
2546
2547
2548
166° 00′
165° 00′
164° 40′
54° 00′
53° 40′
Statute Miles
Nautical Miles
Kilometers

The survey of the Aleutian Island Passes was in progress on July 1 under the direction of Assistant Gilbert, commanding the steamer *Pathfinder*. Work in this region is subject to serious delay from unfavorable weather conditions, and for this reason no attempt was made to make the work continuous in one locality until completed, but the different classes of work were done in such places as the weather permitted, and it was often quite favorable for work in one locality when work would not have been possible elsewhere. Generally the work had to be done on the lee shore. During July the work was delayed by the prevailing fogs and was largely restricted to the vicinity of Beaver Inlet and Unalga Island. Tides were observed at Unalga Cove and Tagalda Bay. A survey was made of the shore line of Unimak Island, from Scotch Cap to Cape Sarichef, in order to report on available light-house sites in this locality. An examination of this region was requested by the Light-House Board, and this duty was assigned to Assistant Gilbert. The examination was successfully completed and a report made, illustrated with photographs and sketches, which furnished the information desired.

On August 3 the triangulation developed from the base measured at English Bay was connected with the triangulation of Dutch Harbor. As the season advanced and the weather conditions became more favorable, the work was extended and a complete survey of the Passes was completed. The triangulation was extended from Dutch Harbor to embrace points on Unimak Island, and includes the determination of a considerable number of natural objects such as pinnacle rocks and mountain tops. The topography included the shore line of Unalaska Island from Priest Rock to the south entrance to Idagak Strait; Unimak Island from Cape Sarichef to Promontory Point, and all the islands between these limits, the larger islands Unalga, Akutan, Akun, Aektok, Avantanak, Tagalda, and Chirikof. Except some of the south shore of Tagalda, Avatanak, and Biorka islands, and a little of the north shore of Akun Island, all the shore line mentioned was actually run with a plane table. The excepted portion was sketched from the ship and depends on sextant angles and readings of the patent log.

Conditions of weather, sea, and wind, as well as the convenience of the other work, largely controlled the hydrographic work. Most of the soundings were made with the Kelvin machine, as it was considered more important to cover the whole ground with approximate soundings than to cover a limited area with very accurate work. An automatic tide gauge was erected at Dutch Harbor during the previous fiscal year in May and was maintained until October 5, but it frequently got out of order and could not be repaired until the next visit of the ship, so that there are some unavoidable breaks in the record. Ten day tides were observed during June and July at Kashega Bay, Umnak Bay, and Eagle Bay, all bordering on Umnak Pass, or at least nearer that pass than to Unalga Pass. Tides were afterwards observed at Unalga Cove and at Tagalda Bay for about one month. Tides were observed for a few days at Unalaska on a staff connected with the old bench mark in order to connect the automatic gauge record with previous observations. Magnetic observations with a compass declinometer were made at a number of triangulation stations. A few current observations were made from time to time. The weather conditions improved as the season advanced.

During the first two months the tops of the higher hills were rarely visible and the fog frequently settled down to the water, but as the season advanced the fog lifted more frequently, and during the last two weeks of September the weather was continuously clear and pleasant, with all the mountains in sight most of the time. At the end of the season there was no snow to be seen except on top of the highest mountains, such as Akutan Peak and Mount McKuskim. There were not many heavy blows, but it is remarkable that the wind was persistently from the northward, generally from the northwest, and there was a heavy surf most of the time on the shores exposed in this direction. The Bering Sea shores were thus more frequently exposed to storm than the North Pacific shores, but other things being equal the Pacific swell is heavier than the Bering Sea swell.

Assistant Gilbert's report also contained valuable information for the coast pilot of this region. The work for the season closed on September 27 and the vessel proceeded to Dutch Harbor on her way to the Philippine Islands.

The following is extracted from Assistant Gilbert's report:

> Mr. Yates acted as executive officer until Mr. Lyle joined the ship about the middle of September, and was efficient and careful, and the ship has never been better cared for than while he was serving in that capacity. I desire also to testify to his devotion to any work assigned to him. The triangulation was executed and the base lines were measured by him.
>
> Mr. Brundage did good service with the plane table and proved he was not afraid of hard work. He did the greatest portion of the topography and made the magnetic observations.
>
> Mr. Atkinson took commendable interest in the hydrography, which he planned and executed for the purpose of gathering sufficient data for a reliable chart of the Passes, showing everything important to navigation, but without wasting valuable time trying to make the sounding lines symmetrical.
>
> Mr. Furman had charge of the sounding machines and was very efficient and attentive to all his duties.
>
> Mr. J. T. Goldsborough has taken his accustomed interest in the department under his charge and it is due to him that the engines and machinery are in most excellent condition.
>
> Dr. Murphy and Mr. Deichman have attended to their duties in a most satisfactory manner and both took regular watches at sea. Mr. Deichman was especially valuable as a signal builder. Mr. McGregor stood his regular watch at sea and in port and assisted with the sounding machines and sextant work. He is a valuable officer. Mr. Pfau has been most industrious and valuable.

BASE MEASURE.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
RECONNAISSANCE.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

J. F. PRATT, Commanding,
Steamer *Patterson*.

R. B. DERICKSON, *Assistant*.
W. G. APPLETON, *First Watch Officer*.
F. H. THOMPSON, *Surgeon*.
W. I. EISLER, *Second Watch Officer*.
A. L. GIACOMINI, *Deck Officer, First Class*.
L. H. WESTDAHL, *Deck Officer, First Class*.
W. E. PARKER, *Junior Aid*.
R. J. CHRISTMAN, *Draftsman*.

SUMMARY OF RESULTS.

Base measure:
- 1 base line measured.

Hydrography:
- 135 square miles (nautical) area sounded.
- 518 miles lines sounded.
- 4 tide stations established.
- 4 hydrographic sheets completed.

Magnetic observations:
- 4 stations occupied.

Reconnaissance:
- 400 square miles area covered.

Topography:
- 95 square miles area covered.
- 166 miles of coast line surveyed.
- 6 miles of rivers and creeks surveyed.
- 5 topographic sheets completed.

Triangulation:
- 350 square miles area covered.
- 44 stations occupied.
- 52 geographic positions determined.

The survey of Icy Strait and Cross Sound was in progress at the beginning of the fiscal year, under the direction of Assistant Pratt, commanding the steamer *Patterson*, with Assistant Dickins, commanding the steamer *Gedney*, also engaged on the work under his general direction. At the request of Assistant Pratt, Assistant Dickins made the report of the work executed by him direct to the superintendent, and the details of the work are given under his name. All classes of work made as rapid progress as the conditions permitted until the close of the season on October 9. It was important that the sea entrance to Cross Sound and the Passes on each side of the Inian Islands should be completed during the season, and the party remained in the field much later than usual in that latitude for this purpose. In Cross Sound and Icy Strait for a distance covering about 80 miles there are very few anchorages suitable for vessels.

Only four—Swansons Harbor, Hooniah Anchorage, the head of Port Althorp, and Inian Anchorage—were found sufficiently free from ice and strong tidal currents to make them reasonably safe. It was necessary to utilize Bartlett Bay, Dundas Bay, Mud Bay, and Dad Anchorage in spite of the dangers found in them, and Mite Harbor was also utilized, although it was so small that it was necessary to moor the *Patterson* to trees because there was not room enough for her to swing at anchor. Inian Anchorage was discovered during the season and it has comparatively little ice and no currents. The tidal currents were, as a rule, very strong and tide rips in places were very heavy. These with the ice gathered in solid masses made surveying work in these waters very hazardous.

On October 10 the *Gedney* was notified to close operations for the season, and the two vessels proceeded to Sitka, where the steam tender *Cosmos* and the launch were hauled out of the water and housed for the winter. The vessels then proceeded to Juneau, where the *McArthur* was found waiting, and the three vessels made the trip south together, and the *Patterson* reached Seattle on October 31.

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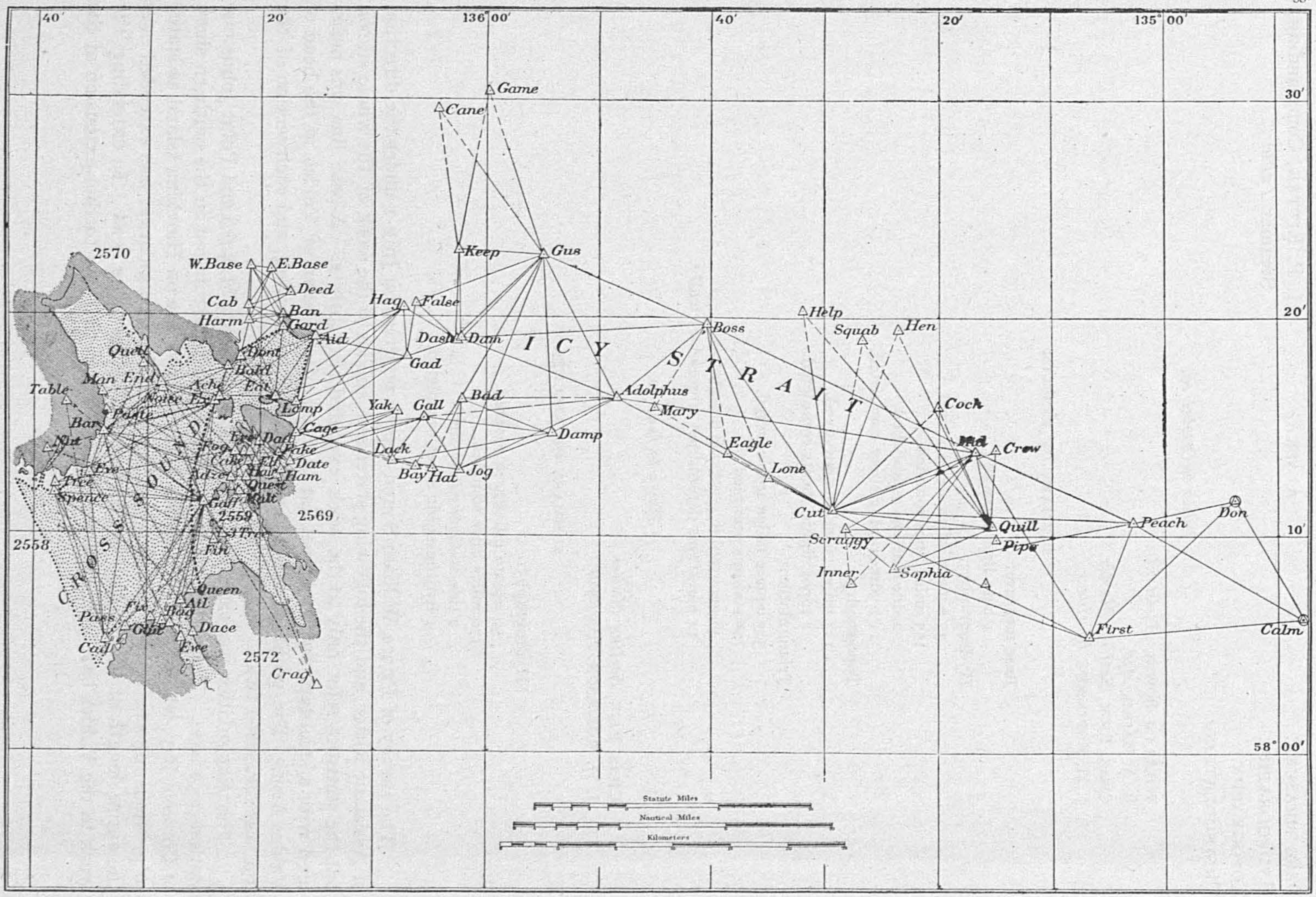


Triangulation, topography and hydrography, Icy Strait and Cross Sound, Alaska.

BASE MEASURE.
HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

H. P. RITTER, Commanding,
Steamer *Taku*.

July 1 to October 10.

WILLIAM BOWIE, *Assistant.*
B. A. BAIRD, *Aid.*
CHAS. FICK, *Sailing Master.*
J. H. ROBINSON, *Engineer.*

SUMMARY OF RESULTS.

Base measure:
1 base line measured.
Hydrography:
35 square miles area covered.
155 miles lines sounded.
2 tide stations established.
1 hydrographic sheet completed.
Topography:
124 miles coast line surveyed.
2 topographic sheets completed.
Triangulation:
305 square miles area covered.
28 stations occupied.
48 geographic positions determined.
14 elevations determined trigonometrically.

May 3 to June 30.

CHAS. FICK, *Sailing Master.*
J. H. ROBINSON, *Engineer.*

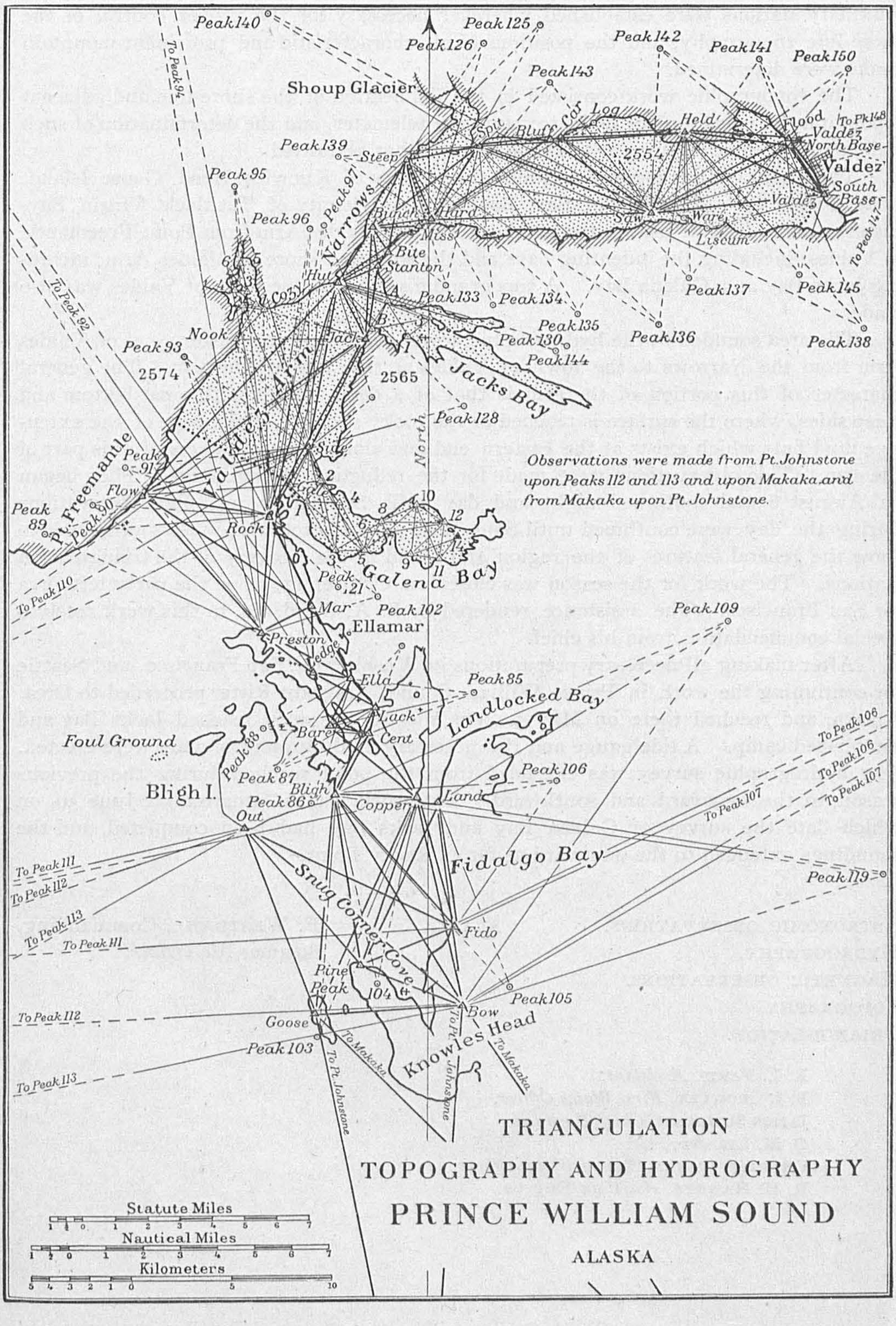
SUMMARY OF RESULTS.

Hydrography:
50 square miles area covered.
170 miles lines sounded.
2 tide stations established.
1 hydrographic sheet completed.

The survey of Prince William Sound was in progress on July 1 under the direction of Assistant Ritter, and the following statement applies to the work of the whole season but the statistics refer only to the work executed after July 1. A base line was measured with a steel tape on the gravel flat in front of the town of Valdes, at the head of Valdes Arm. The profile of the line was obtained by leveling, and each section of the line was measured twice.

The triangulation was extended from the line between Makaka and Point Johnstone stations as a base. These stations form a part of the triangulation on the southern shore of Cordova Bay, which started from the Makaka base line on Hawkins Island as stated in previous reports. With this line as a base line, the triangulation was extended over the entire length of Valdes Arm to the town of Valdes at its head. In extending the work to the Valdes base line, stations were so located that any further extension of the

No. 36.



TRIANGULATION
TOPOGRAPHY AND HYDROGRAPHY
PRINCE WILLIAM SOUND
ALASKA

work in lateral directions could be done with a minimum amount of trouble and expense. Auxiliary stations were established wherever necessary for the proper control of the shore-line topography, and the positions of all characteristic and prominent mountain peaks were determined.

The topographic work consisted in the delineation of the shore-line and adjacent topography by using a plane table, sextant, and telemeter, and the determination of such salient topographic features as the time and weather permitted.

The localities thus mapped included the vicinity of Knowles Head, Goose Island, Snug Corner Cove, Landlocked Bay, Boulder Bay, vicinity of Tatitlack, Virgin Bay, eastern shore of Bligh Island, the northern shore of Valdes Arm from Point Freemantle to Valdes, including the indenting bays and the southern shore of Valdes Arm, including Jacks Bay and Galena Bay. A topographic survey of the town of Valdes was also made.

The area sounded in the hydrographic work comprised the eastern end of Valdes Arm from the Narrows to the town of Valdes at the head of the arm. The general character of this portion of the arm is that of a deep trough with a flat bottom and steep sides, where the surface is reached at the rocky shore or at the edge of the extensive mud flats which exists at the eastern end and along the north shore of this part of the arm. Tide observations were made for the reduction of soundings. They began on August 8 and continued night and day until September 10. The observations during the day were continued until September 30. Photographic views were made to show the general features of the region and to aid in the recovery of the triangulation stations. The work for the season was closed on October 11, when the party left Orca for San Francisco. The assistance rendered by B. A. Baird, aid, in this work receives special commendation from his chief.

After making all necessary preparations in Washington, San Francisco, and Seattle for continuing the work in Prince William Sound, Assistant Ritter proceeded to Orca, Alaska, and reached there on May 3. On May 12 the party reached Jacks Bay and established camp. A tide gauge and the necessary hydrographic signals were erected. The hydrographic survey was extended from the point reached during the previous season, to the westward and southward. The work was in progress on June 30, on which date the survey of Galena Bay and Jacks Bay had been completed, and the soundings extended to the westward as far as Rocky Point.

ASTRONOMIC OBSERVATIONS.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

ALASKA.

F. WESTDAHL, Commanding, Steamer *McArthur*.

R. L. FARIS, *Assistant*.
B. I. CROWLEY, *First Watch Officer*.
JAMES SULLIVAN, *Chief Engineer*.
O. M. LELAND, *Aid*.
CHARLES LYMAN, *Second Watch Officer*.
R. H. HAWKES, *Assistant Surgeon*.

SUMMARY OF RESULTS.

Astronomic observations:
- 1 azimuth determined.
- 1 latitude determined.
- 2 longitudes (chronometer) determined.

Hydrography:
- 260 miles lines sounded.
- 6 tide stations established.
- 3 current stations occupied.
- 1 hydrographic sheet completed.

Magnetic observations:
- 4 stations occupied.

Topography:
- 112 square miles area covered.
- 230 miles general coast line surveyed.
- 3 topographic sheets completed.

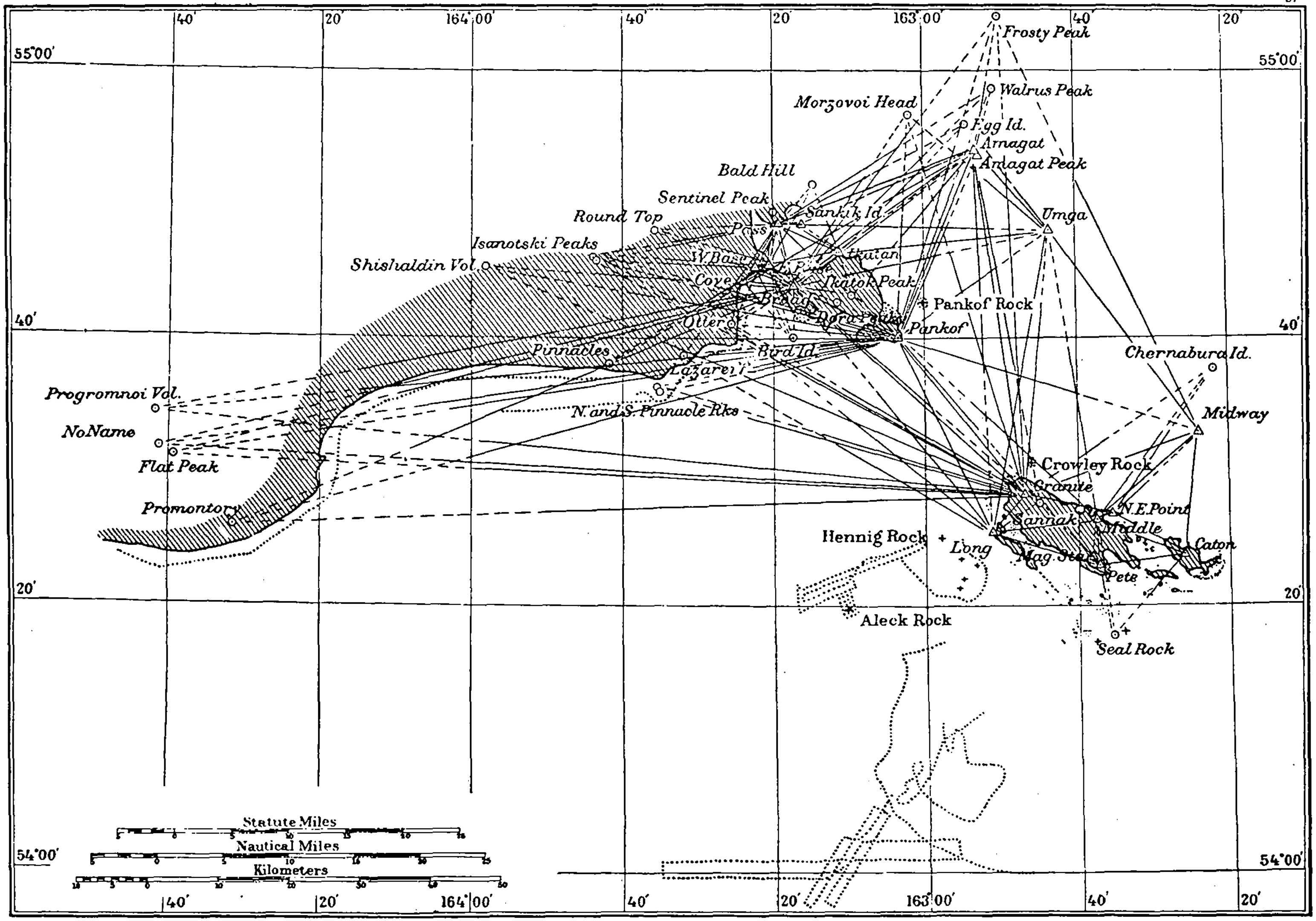
Triangulation:
- 17 stations occupied.
- 47 geographic positions determined.
- 9 elevations determined trigonometrically.

The survey of the Sannak Islands was in progress on July 1 by the party on board the steamer *McArthur*, with Assistant Ferdinand Westdahl in command. The numerous difficulties and dangers encountered in the work caused great delay in its progress and taxed the ingenuity and endurance of the officers and men to the utmost. The daily work proved to be a struggle with wind, rain, or fog, or a combination of these, and frequent changes of anchorage were necessary with a change of direction of the wind, to keep the ship reasonably secure from danger. Camping parties were frequently landed for short periods, and the different classes of work progressed when the weather conditions permitted.

On July 26, in passing to the eastward of Cape Pankof, the Pankof Breaker was seen and its position determined. On July 28 the ship steamed to Dora Harbor and the necessary soundings were made on the 30th. Soundings were made in East Anchor Cove on August 3 and the work completed on August 5. On the 7th the work on Ikatan Peninsula was completed. Soundings were made in Acherk Harbor on August 15 and in Northeast Harbor on the 23d. Peterson Bay was sounded on September 6, and on the 7th and 8th search was made by the ship, with a native otter hunter on board, for outlying rocks in the vicinity of the reported position of Lenard Rock, but nothing was found. Many indications of the existence of a submerged ledge were seen, such as seals, otters, birds, and numerous schools of whales and grampus. Erom the statements of the native otter hunter on board and others on shore, both white men and natives, Assistant Westdahl reports that he is convinced that a rocky shoal lies somewhere near the reported position of Lenard Rock, that there is only one such shoal instead of three, and that it only breaks in heavy weather during northeast or southwest swell.

On September 9 the wind increased to a gale and the search was abandoned. The weather continued stormy and the vessel proceeded to Caton Harbor on the 12th, and the topography of Caton Island was finished on the 15th. On the 16th the vessel went

No. 37.



Triangulation, topography and hydrography, Sannak Islands to Unimak Pass, Alaska.

to Acherk Harbor for water, and the weather being clear a sunken rock off the harbor was located.

On September 17 the vessel anchored in Otter Cove to resume plane-table work where it had been suspended in July. In landing here through the surf, on a short steep beach of shingle on the southeast face of West Cape Lazaref, the boat was upset and the occupants were thrown into the surf, but all reached the shore in safety. After many failures a line was floated ashore and the damaged boat was finally hauled through the surf, and later in the day when the tide turned and during a lull in the surf the men on shore waded out to a boat held in the surf and were carried on board ship. The next morning the instruments and boat gear were brought on board.

The season was now drawing to a close, and as a result of local conditions, with a continuous surf, even in offshore winds, the usual method of surveying the shore line with a plane table had to be abandoned on account of the inaccessible shores, and a reconnaissance survey was made with a boat pulling along the shore with the ship farther offshore determining the position of available objects as signals by the aid of the peaks, etc., already fixed in position by the triangulation previously executed. The officer in charge of the boat sketched the shore line and determined the position of the boat whenever practicable, observing on the ship when anchored, in case it was necessary, while from the ship bluffs and peaks were located and their heights computed. When the sea became too rough to use the boat the work was continued by the ship.

This reconnaissance was extended from Otter Cove to Scotch Cap Cape, where the reconnaissance joined the work of Assistant Gilbert, commanding the *Pathfinder*. The vessel proceeded to Dutch Harbor for coal and water, and on September 29 a search was made for Aleks and Henning rocks. Aleks Rock was found, but no rock was found answering the description of Henning Rock as reported.

The ship left Acherk Harbor on the 30th and steered around the outlying breaks to the westward of Sannak and Long islands for a final search, and one new break between this group and Long Island was located. The wind increased almost to a gale, further search was abandoned, and the field work closed for the season.

The ship then proceeded to Kadiak Bay, on her way to Seattle, and coast pilot notes and sketches were made en route. The following is quoted from the report of Assistant Westdahl:

In the case of the officers who have served in my party during the season in Alaska, I take great pleasure in saying, in addition to what I have stated in my report on the fitness of those who have been detached, that they have rendered good and faithful service to the Survey under most trying conditions of weather.

I desire especially to commend Assistant R. L. Faris, for to him is largely due the success the party attained in carrying out the instructions of the superintendent. His knowledge of all branches of the work, his untiring zeal and good judgment, and his hearty cooperation with me in taking advantage of every hour of suitable weather to push the work are worthy of all praise.

REGISTER OF GEOGRAPHIC NAMES. HAWAIIAN ISLANDS. W. D. ALEXANDER.
REGISTER OF TRIANGULATION STATIONS.
TIDE OBSERVATIONS.

The work in the Hawaiian Islands, except the Magnetic Observatory, was continued under the direction of Assistant Alexander. He completed a list of all the fish ponds of the islands for the United States Fish Commission, giving the Hawaiian name of each, its area, condition, and present ownership. The index of the native names of the lands and the topographic features of the islands, such as capes, harbors, bays, elevations, rivers, etc., was completed. A set of tracings of the triangulation executed before the annexation of the islands was made and forwarded to the office. A register of the stations occupied in the Hawaiian triangulation was in progress at the close of the fiscal year. An automatic tide gauge was kept in operation throughout the year at Honolulu.

MAGNETIC OBSERVATIONS. HAWAIIAN ISLANDS. J. A. FLEMING.

The construction of a magnetic observatory and the installation of the instrumental outfit was assigned to Mr. J. A. Fleming, aid. He arrived at Honolulu on August 7, and began immediately to make the necessary preparations for the erection of buildings. A general magnetic survey had been made of the site selected near Sisal by Assistant L. A. Bauer, Inspector of Magnetic Work during the previous fiscal year, by the determination of the magnetic elements at ten stations covering the vicinity of the site. A special survey was made of the selected area of 4.3 acres and the lease of the ground was concluded. A contract was made for the erection of the necessary buildings, and the work progressed as rapidly as the existing conditions permitted. A well was dug and a windmill erected to supply water, and all other preliminary work was completed. The buildings were completed on November 28 and observations were made to test their nonmagnetic quality. After thorough ventilation the instruments were installed and the regular observatory work began on December 31.

From January 1 the photographic record of the variation in the magnetic elements was continuous until the close of the fiscal year, with such slight interruptions as were necessary in adjusting the instruments. Meteorological observations were made daily and observations for time were made once a week. Observations were made twice every week to determine the absolute value of the magnetic elements, and special observations were made twice every month as a part of the programme for international magnetic work. William Weinrich, magnetic observer, reported for duty on May 10 and assisted in the observatory work after that date.

Aid Fleming expresses his appreciation of the kindness and courtesy extended to him by Mr. W. E. Wall, surveyor-general of the Territory; Mr. A. H. Turner, manager of the Sisal plantation, and Assistant W. D. Alexander. He also expresses his thanks to Mr. Philip Savary, the contractor for the buildings, for favors received from him.

COMBINED OPERATIONS. PHILIPPINE ISLANDS. G. R. PUTNAM.

The important work of surveying the coasts of the Philippine Islands was continued under the direction of Assistant G. R. Putnam, who remained in charge of the Suboffice at Manila, representing the Superintendent of the Coast and Geodetic Survey in all matters of detail requiring immediate decision. In performing this duty he adopted plans for the field operations, issued instructions for field work, compiled all data secured, and prepared and published charts of the waters surveyed. Notices to Mariners and Coast Pilot Notes were prepared and published. He was aided in this work by such advice and instructions issued from Washington as became necessary by the conditions surrounding the work and the necessities of the case required.

By act No. 222 of the United States Philippine Commission, passed September 6, 1901, the bureau of Coast and Geodetic Survey was named among the bureaus placed under the executive control of the Department of Commerce and Police, one of the departments of the Philippine government. This act was subsequently approved, ratified, and confirmed by the United States Congress in "An act temporarily to provide for the administration of the affairs of civil government in the Philippine Islands, and for other purposes," approved July 1, 1902.

On January 1, 1902, the plan for cooperation between the insular government and the United States Coast and Geodetic Survey for the prosecution of survey work in the Philippine Islands was carried into effect, so that during the half year certain classes of expenditures were defrayed by each, the United States paying the salaries, subsistence, and traveling expenses to and from the islands of the officers of its regular corps and of the experts for the Manila office, all expenses connected with the United States steamer at work in the islands, and with all instrumental outfit and stationery sent from the United States, and the expense of printing Philippine charts in Manila and in Washington. Since January 1 the Insular Government has paid the operating expenses of the small steamer purchased by it, the field expenses of the various survey parties on shore, and the expenses of the office in Manila, except the salaries of the officers and experts above mentioned, and the expense of printing charts. The above plan was followed as being practically the manner of division of expense proposed in the plan approved by the Secretary of the Treasury, and submitted on September 3, 1901, for the consideration of the United States Philippine Commission.

Assistant Putnam reported to the Secretary of the Department of Commerce and Police in all matters appertaining to the Insular Government, and has conformed to the regulations of that government in the matter of accounts, property returns, etc.

Field parties have been at work almost continuously during the year, as follows, the chief of party being first named:

J. J. Gilbert, assistant (steamer *Pathfinder*), arrived at Manila in November, 1901, and has since been engaged in survey work in the Philippine Islands, under the orders of the Superintendent at Washington. After making important local surveys at Romblon, Cebu, and Ormoc with this vessel, an extended survey of San Bernardino Strait and its eastern approaches, along the north coast of Samar and the southeast coast of

Luzon, was carried out. This work being on a somewhat exposed coast required a vessel of good capacity and equipment.

J. E. McGrath, assistant; astronomic determination of base positions, commenced field work in June, work in progress.

H. C. Denson, assistant; triangulation and topography of Lingayen Gulf completed; surveys vicinity of Aparri, north coast of Luzon, commenced, work in progress.

H. W. Rhodes, assistant (steamer *Research*); general harbor surveys at Santa Cruz, Luzon; Halsey Harbor, Culion Island; Tabaco, Luzon, and reconnaissance of the western part of Paluan Bay, Mindoro. (Relieved from duty in May.)

R. B. Derickson, assistant (steamer *Research*); extension of surveys in vicinity of Tabaco and Albay Gulf (commencing in May). Work in progress.

H. C. Mitchell, aid; astronomic determinations of base positions; longitude lines determined Cebu–Misamis, Misamis–Zamboanga, Iloilo–Capiz, Capiz–Masbate, Masbate–Legaspi; latitudes determined Misamis–Capiz.

C. E. Morford, aid; harbor survey at Gubat, southwest coast of Luzon, commenced in June, work in progress.

J. S. Hill, observer; astronomic determinations of base positions; longitude lines mentioned above; latitudes determined at Zamboanga and Masbate.

The field work comprised harbor and channel surveys, the determination of geographic positions, and more extended hydrographic and topographic surveys of the coast.

Harbor surveys were made at Santa Cruz, Tabaco, Gubat, and Matnog, on the island of Luzon; Halsey Harbor, on the island of Culion, and at Cebu and Romblon. These surveys included triangulation, hydrographic survey of the water area, and topographic plane-table survey of the shore and immediate vicinity. Hydrographic surveys were made in the vicinity of Manila and Cavite, and at San Fernando and Bolinao, on the west coast of Luzon. Topography and triangulation were carried on in the vicinity of Sorsogon, Luzon.

Extended coast surveys, including triangulation, hydrography, and topography, were made in San Bernardino Strait and its eastern approaches, along the coasts of Samar and Luzon; in the vicinity of Albay Gulf, including Rapu Rapu Pass, the northern portion of Port Sula to Tabaco Bay, and the south shore of Albay Gulf, joining the work in San Bernardino Strait; and in Ormoc Bay, Leyte. The triangulation and shore line of Lingayen Gulf, Luzon, were completed. Triangulation and topography were extended about 15 miles to the eastward of Aparri, north coast of Luzon, and a hydrographic survey of the outer anchorage at Aparri was made.

Tide observations for use in the hydrographic work, and to furnish data for tide predictions, were made at 19 stations. At Manila these observations were continuous throughout the year, and at several other points the records cover several months.

Geographic positions, to establish base points for future surveys, astronomic observations for latitude and longitude, were made at the following points: Legaspi, Sorsogon, Pasacao, *Luzon;* Masbate; Leyte, *Panay;* Dumaguete, *Negros;* Catbalogan, *Samar;* Maasin, *Leyte;* Misamis and Zamboanga, *Mindanao.* The longitude determinations were made by the telegraphic method, for which purpose the lines and cables of the Signal Corps were used.

Magnetic observations were made at 13 places, to supply the information required for the charts. Where practicable, true meridian lines were established.

Office work: At the Manila office of the Survey the work of equipping and supplying the field parties was carried on, preliminary computations were made, charts were prepered for publication by lithography in Manila, notices to mariners of new hydrographic information were prepared and published, the compilation of revised sailing directions for the Philippine Islands was undertaken and one part published, and information was supplied in response to official and other requests. Valuable information was received from the Naval and Military authorities, and from others.

The drafting work continued under the immediate direction of Mr. William Welch until his departure for the United States, March 24, 1902. Mr. P. B. Castles arrived on April 21, and took charge of this work. The force of Filipino draftsmen was increased from three to six during the last half year, this being found necessary to get out the results of the work promptly. During the year 18 charts, 2 new editions of charts, and and 4 sketches were published by lithography in Manila. The charts have been received from the lithographer and issued.

J. C. Dow, acting nautical expert, reported for duty on April 16, and was engaged at the suboffice in the compilation and verification of sailing directions and notices to mariners. Sailing directions for the north and west coasts of Luzon, from Cape Eugano to Manila Bay, were prepared and sent to the printer, and sailing directions for other sections of the Philippine Islands are in preparation.

E. R. Frisby, computer, reported for duty on April 21, 1902, and was engaged at the suboffice in revising the computations of work as needed for publication and in general care and examination of the records. The plan proposed for forwarding records to Washington and the retention of the necessary data at Manila was put in force.

The force at the Manila suboffice at present consists of 13 persons, as follows: One assistant in charge, 1 expert computer, 1 nautical expert, 1 chief draftsman, 1 clerk, 6 junior draftsmen, 1 junior clerk, 1 messenger.

During the absence of the *Pathfinder* at Amoy, C. C. Yates, assistant, remained at Manila from April 13 to May 29 and rendered valuable service in revising the proposed scheme for general charts of the Philippines and in getting up a general design for small surveying steamers for work in the Philippines. J. C. Dow, acting nautical expert, assisted in both these matters with valuable suggestions. Mr. Yates also revised various computations and made magnetic comparisons at the observatory.

The members of the field force were all at Manila for various short intervals. Messrs. Bach and Gordon, recorders, who reported for duty April 21, assisted with the computing work at the office for some time before joining field parties.

Information has been received from the naval authorities, army engineers, masters of vessels, and others. Information was supplied from the suboffice, in response to inquiries, to representatives of the various branches of the Government service and to others.

HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

PHILIPPINE ISLANDS.

H. C. DENSON.

SUMMARY OF RESULTS.

Hydrography:
- 100 nautical miles of lines sounded.
- 2 tide stations established.
- 1 hydrographic sheet completed.

Topography:
- 53 square miles area surveyed.
- 242 miles of coast line surveyed.
- 29 miles of roads surveyed.
- 20 miles of shore line of creeks and rivers surveyed.
- 5 topographic sheets completed.

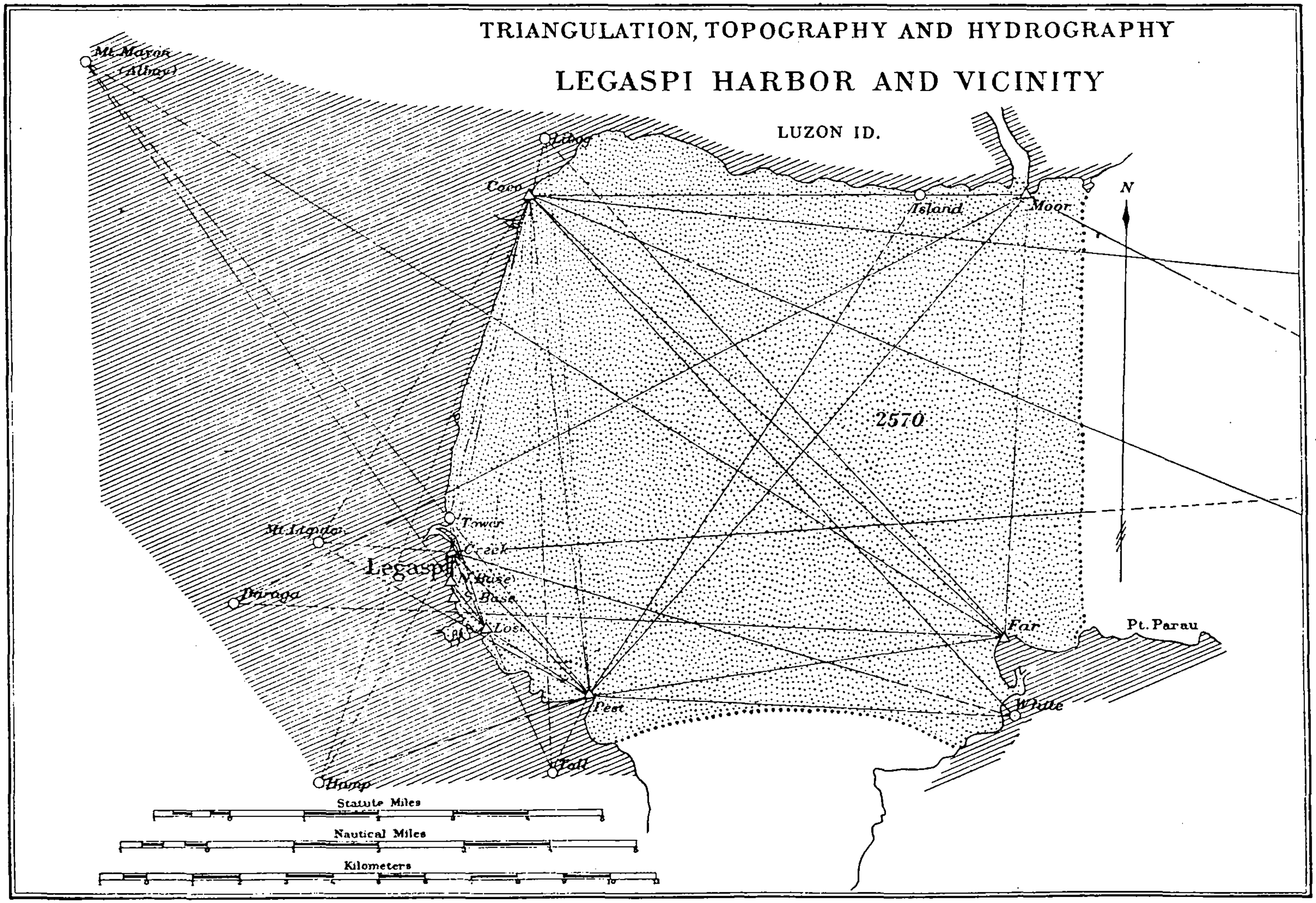
Triangulation:
- 69 stations occupied.

A portion of the survey of the coast of the Philippine Islands was assigned to Assistant Denson and he reached Legaspi, island of Luzon, on July 16. A party was organized and field operations began on the 18th and continued until October 6. The progress of the work was seriously delayed by the violent rain storms which are frequent in this region at that season of the year. A small steam launch was hired for use in the hydrographic work, but the launch had previously been engaged by the army authorities and could not be secured on as many days as were necessary to fully develop the approaches to the anchorage, but enough was done to recommend a new course for entering the port, which shortens the distance to be traveled by vessels by 6 miles. An automatic tide gauge was erected in a small river about 200 meters above its mouth, but on the following night a storm of unusual violence so changed the bar at the mouth of the river that the readings were not satisfactory, and a tide staff was erected outside the mouth of the river and connected with the automatic gauge at Tabaco by a series of simultaneous reading on the two gauges through a period of sixty hours.

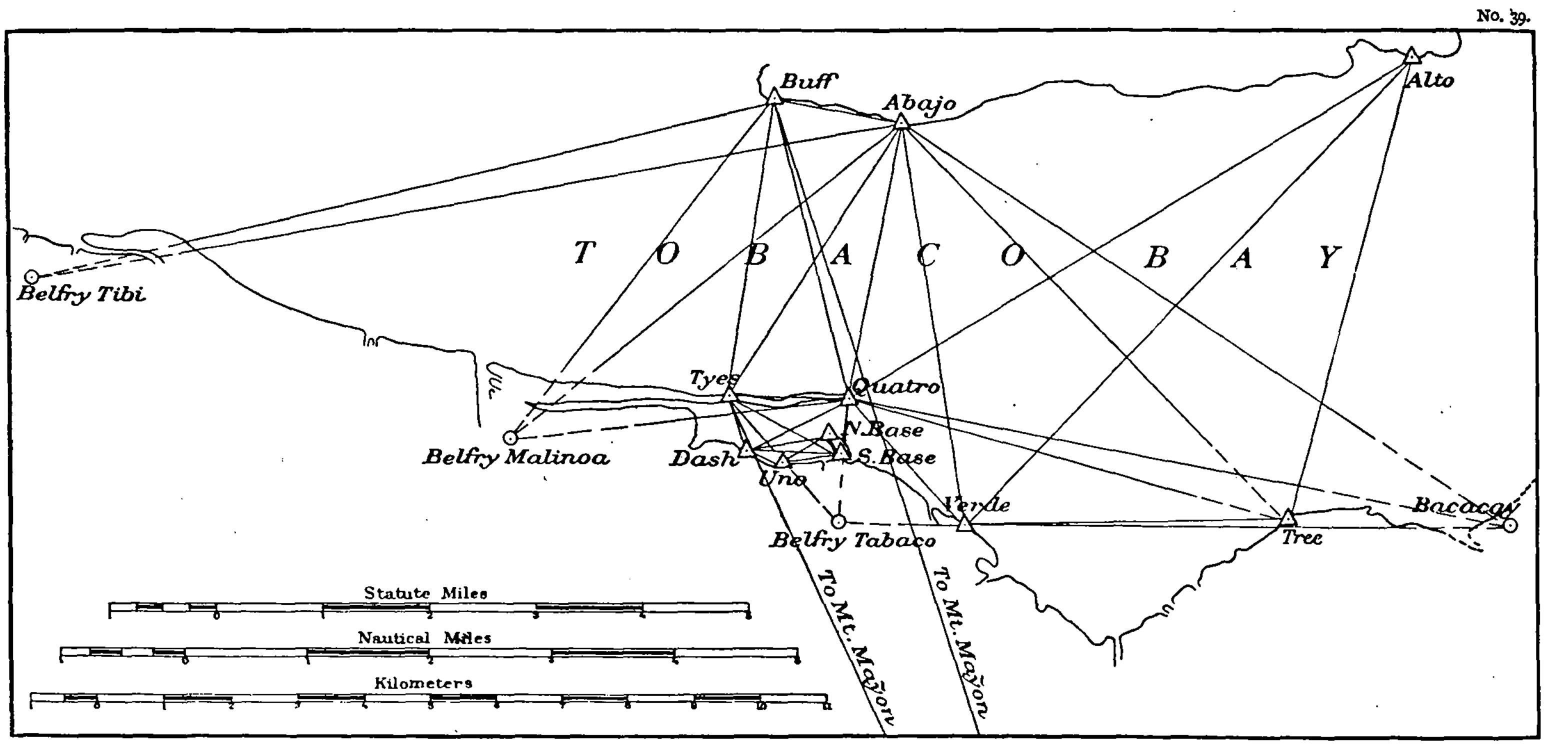
After completing the work at Legaspi, Assistant Denson and his recorder proceeded to Tabaco. Field operations began there on October 17 and continued until December 23, when the work closed. No hydrographic work was done at this place, as a suitable boat for such work could not be obtained and the northeast monsoon was prevailing. An automatic tide gauge was erected at Tabaco, and a continuous record covering five weeks was obtained. The work accomplished at this place is shown on sketch No. 39.

In January Assistant Denson began the extension of the work done in the Lingayen Gulf during the previous year. Field operations began on January 16 and continued until June 7. Work began in the vicinity of Sual and was extended toward Bolinao, at the northwest corner of the gulf, until a connection was made with the work previously executed at that place. The land at the head of the gulf is flat and is covered, a short distance from the shore, with cocoanut palms, and in order to avoid the numerous stations and cutting which would have been necessary to carry the triangulation around the shore, the gulf at this point was crossed by a large quadrilateral, which deter-

No. 38


TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY
LEGASPI HARBOR AND VICINITY
LUZON ID.
Mt. Mayon (Albay)
Libog
Coco
Island
Moor
N
2570
Tower
Mt. Lignon
Creek
Legaspi
Base
Daraga
Los
Far
Pt. Parau
Pest
White
Tall
Hump
Statute Miles
Nautical Miles
Kilometers

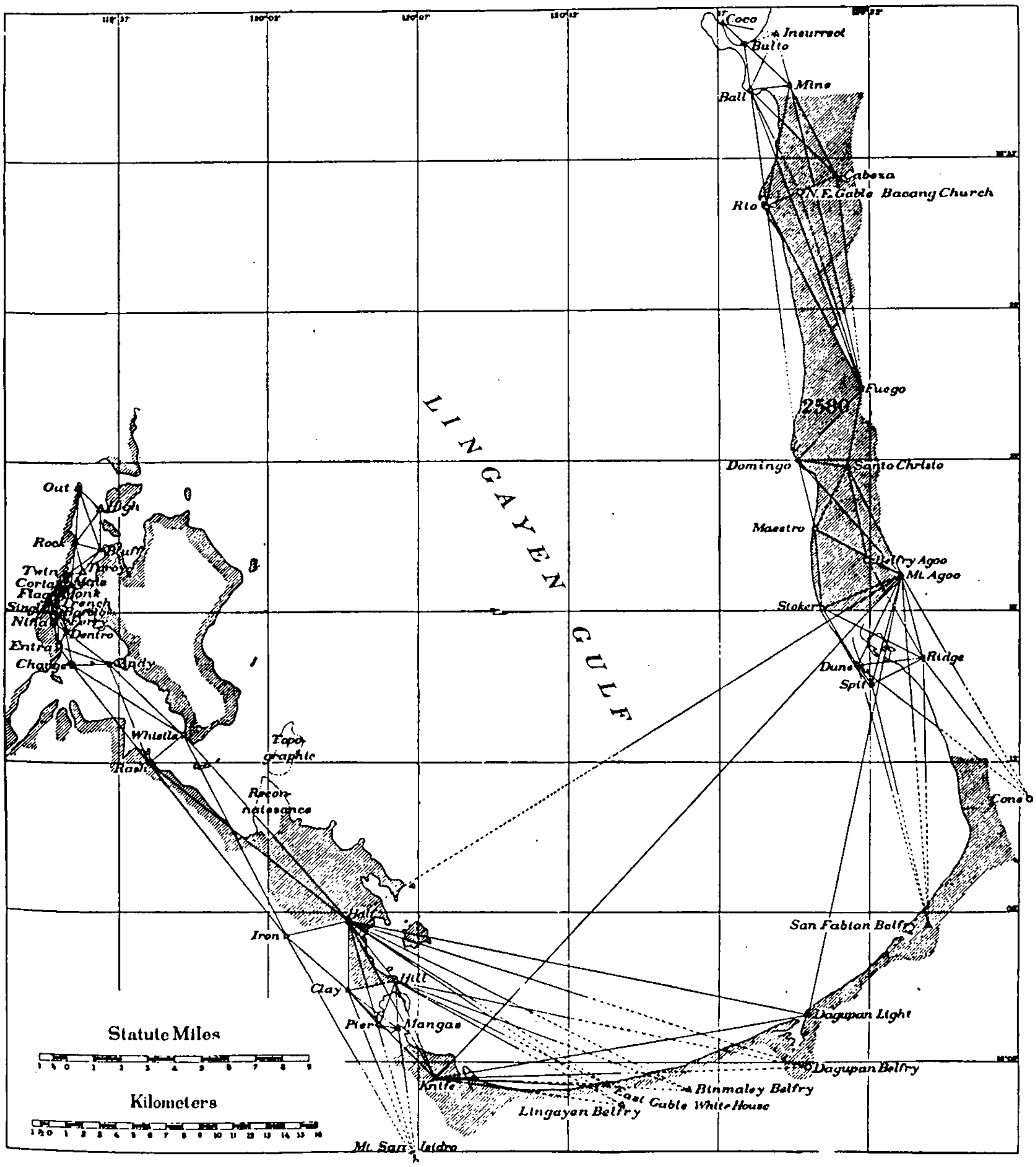
No. 39.



Triangulation, Tabaco Bay, P. I.

mined the geographic position of Mount Agoo, in the vicinity of Santo Tomas. Mount Agoo was then connected with the triangulation previously executed in the vicinity of Santo Tomas, and care was taken to determine the position of such objects

No. 40.



Triangulation and topography, Lingayen Gulf, P. I.

as would be useful in the hydrographic survey. The triangulation was then extended to the northward until it joined the triangulation at San Fernando, Union, at the northeast corner of the gulf.

The survey of the shore line was included on three topographic sheets—one extending from Sual to Bolinao, another from Sual to Santo Tomas, and the third from Santo Tomas to San Fernando. Surveys were made during the preceding year of the ports of Sual, Bolinao, Santo Tomas, and San Fernando, and the work mentioned above joined these surveys together and completed the survey of the shore line of the Lingayen Gulf. The report of Assistant Denson includes some valuable information for the Coast Pilot.

BASE MEASURES.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

PHILIPPINE ISLANDS.

R. B. DERICKSON, Commanding steamer *Research*.

N. G. GRAYSON, *First Watch Officer*.
W. W. MARKOE, *Surgeon*.
E. E. ALLEN, *Chief Engineer*.
H. O. PIXLEY, *Extra Observer*.
H. M. DAVIE, *Deck Officer*.

SUMMARY OF RESULTS.

Base measures:
- 1 base line measured.

Hydrography:
- 19 square miles area covered.
- 203 miles lines sounded.
- 1 tide station established.
- 8 current stations occupied.

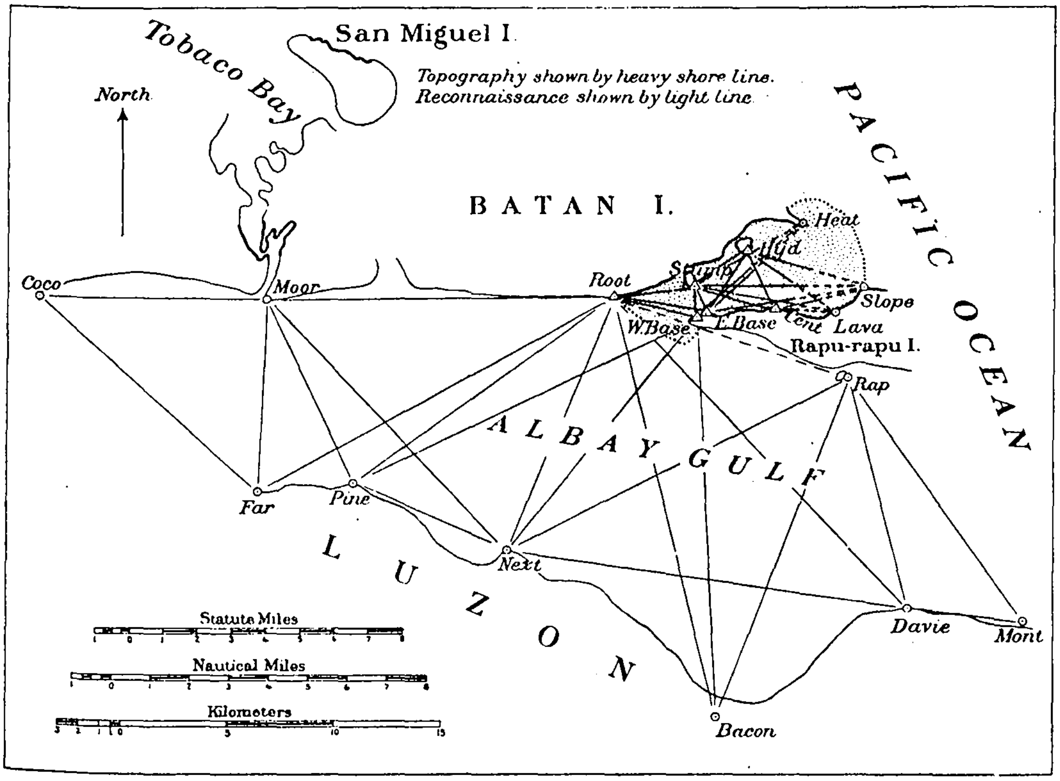
Magnetic observations:
- 1 station occupied.

Topography:
- 27 square miles area covered.
- 19 miles shore line surveyed.
- 23 miles low-water line, flats, and reefs surveyed.

Triangulation:
- 14 square miles area covered.
- 5 stations occupied.

On May 13, 1902, Assistant Derickson took command of the steamer *Research* at Port Tabaco, east coast of the island of Luzon, relieving Assistant H. W. Rhodes. The party on the steamer was actively engaged in field work at the time mentioned, and the statistics given above cover the work of the party from the date given to the close of the fiscal year. Four miles of shore line on the east coast of the island of San Miguel and 3 miles of shore line in Sula Pass were surveyed. A base line was measured on the west end of the island of Rapu Rapu, and the triangulation was extended from it to the eastward through Rapu Rapu Pass, which lies between the island of Batan and the island of Rapu Rapu. A survey was made of the shore line in the pass, and the low-water line covering 16 miles of flats and reefs in the pass was located. An automatic tide gauge was maintained at Port Tabaco. The work in Albay Gulf was in progress at the close of the fiscal year.

No. 41.



Triangulation, topography and hydrography, Albany Gulf, P. I.

BASE MEASURE.
HYDROGRAPHY.
MAGNETIC OBSERVATIONS.
TOPOGRAPHY.
TRIANGULATION.

PHILIPPINE ISLANDS.

J. J. GILBERT, Commanding, Steamer *Pathfinder*.

C. C. YATES, *Assistant*.	
V. R. LYLE, *First Watch Officer*.	Nov. 17 to Dec. 21.
W. M. ATKINSON, *First Watch Officer*.	Dec. 22 to May 27.
C. W. FITZGERALD, *First Watch Officer*.	May 28 to June 30.
J. J. MURPHY, *Surgeon*.	Nov. 17 to May 28.
J. T. GOLDSBOROUGH, *Chief Engineer*.	
F. H. BRUNDAGE, *Aid*.	Nov. 17 to Dec. 24.
B. A. BAIRD, *Aid*.	Dec. 21 to June 30.
W. M. ATKINSON, *Second Watch Officer*.	Nov. 17 to Dec. 21.
R. H. HAWKES, *Assistant Surgeon*.	
L. M. FURMAN, *Third Watch Officer*.	Nov. 17 to May 29.
E. S. DANIELS, *Acting Watch Officer*.	June 1 to June 30.
C. F. DEICHMAN, *Captain's Clerk*.	
R. C. MCGREGOR, *Deck Officer*.	Nov. 17 to Nov. 30.
L. H. WESTDAHL, *Deck Officer*.	Dec. 20 to June 30.
J. F. PFAU, *Draftsman*.	

SUMMARY OF RESULTS.

Base measure:
- 4 base lines measured.

Hydrography:
- 142 square miles area covered by soundings.
- 1 125 miles of lines sounded.
- 5 tide stations established.
- 7 hydrographic sheets completed.

Magnetic work:
- 1 station occupied.

Topography:
- 81 square miles area covered.
- 240 miles of coast line surveyed.
- 29 miles of roads surveyed.
- 8 topographic sheets completed.

Triangulation:
- 161 square miles area covered.
- 88 stations occupied.
- 117 geographic positions determined.

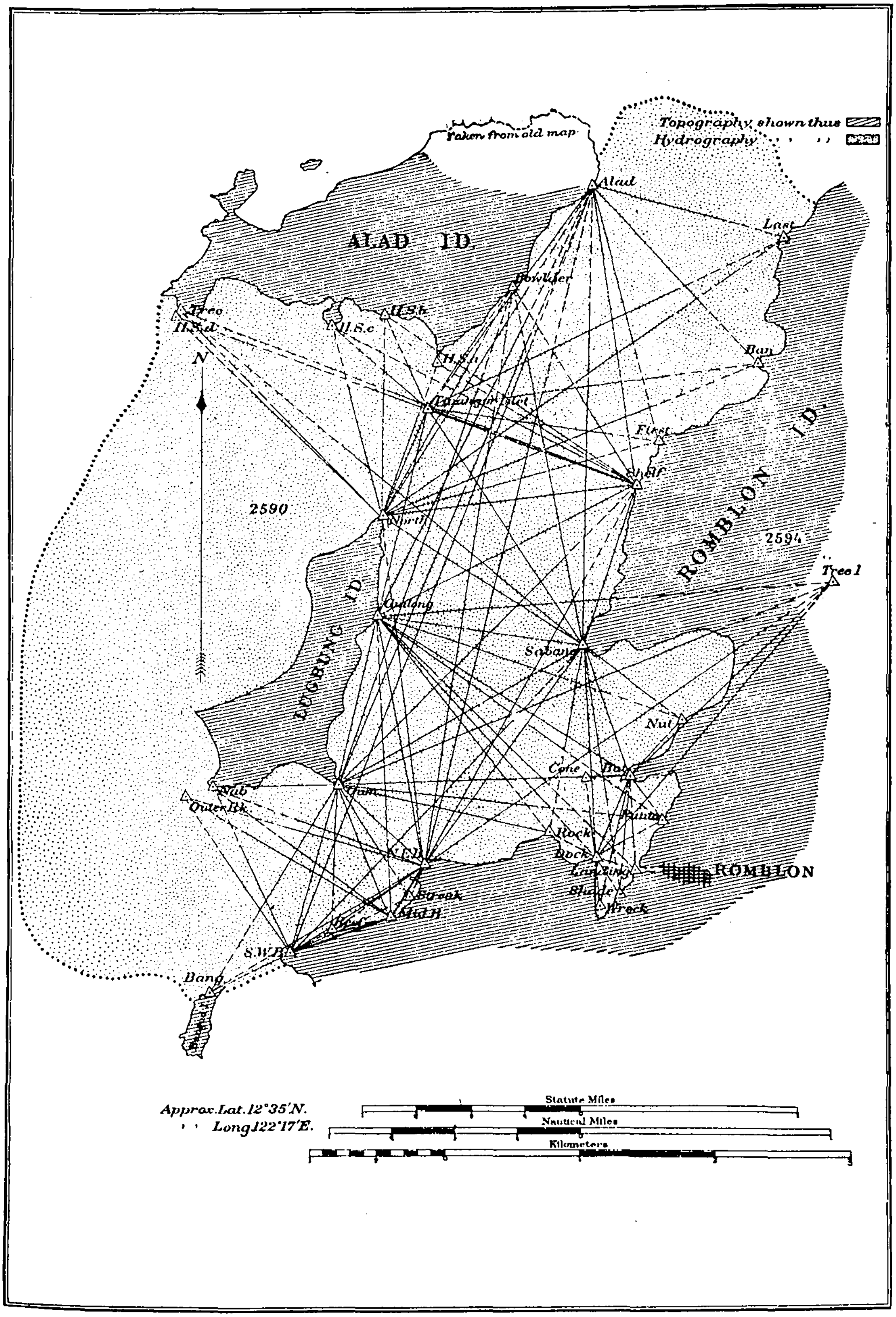
Survey work in the Philippine Islands was assigned to Assistant J. J. Gilbert, commanding the steamer *Pathfinder*, and he sailed from Dutch Harbor, Alaska, on October 7, 1901, for Manila, via Yokohama and Nagasaki, Japan. Repairs were made at Nagasaki and the vessel reached Manila on November 17.

On the way to Manila the vessel ran close to "Raleigh Rock," referred to in the North Pacific Ocean and Japan Directory, and a photograph of the rock was secured. Assistant Gilbert reports this rock as identical with "Record Island," as described in the volume mentioned above.

At Manila, Assistant Gilbert consulted in regard to the work to be done with Assistant Putnam, the director of coast surveys in the Philippine Islands, and called upon Admiral F. K. Rodgers, commanding the fleet, Gen. A. R. Chaffee, commanding the army, and Prof. Dean Worcester, of the provisional government, and consulted with them on the same subject. He and Assistant Putnam then had a meeting with a large number of the masters of the merchant service and discussed the existing conditions and the most pressing demands for immediate work. All agreed that no reliable work had been done on the east coast of the islands, but that it would be impossible to work on that coast during the existing northeast monsoons, which were expected to last several months. The work will be exceedingly difficult at any time on these exposed coasts, as the rainy season begins when the northeast monsoons subside and the rains are very frequent and heavy in this region.

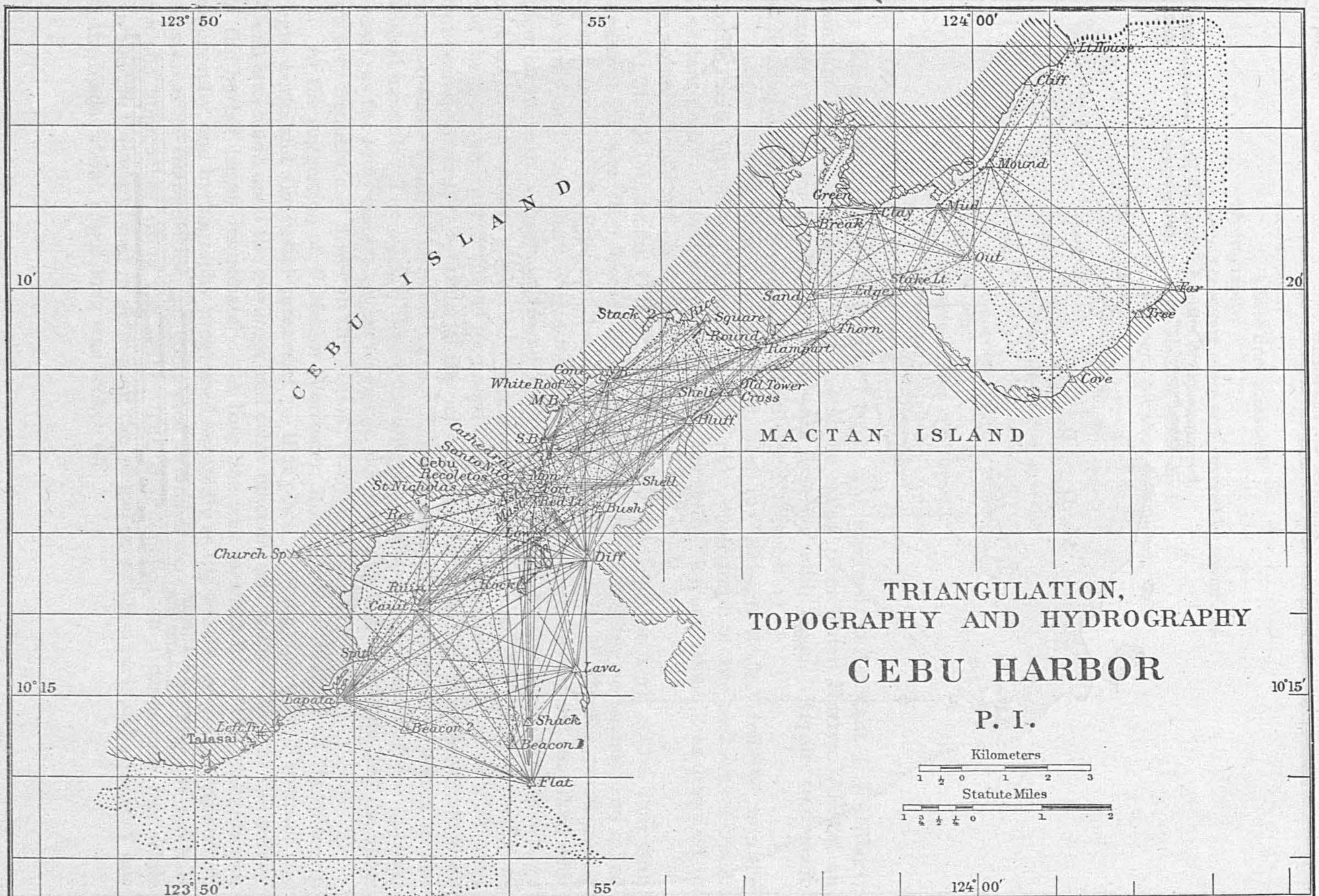
At the suggestion of Professor Worcester, Romblon was selected as the place to begin work, and the vessel proceeded to that place, arriving there on November 29. A call was made upon the governor and other officials, and preparations for the survey of the harbor began immediately. A base line was measured, and the triangulation, topography, and hydrography progressed as rapidly as the weather conditions permitted. As soon as the triangulation was completed two days were spent sounding out the harbor and approaches, using the ship. The ship touched on a dangerous reef while engaged in this work, and in getting off the propeller struck a rock and a piece of one of the blades about 1 foot long was broken off.

No. 42.



Triangulation, topography and hydrography, Romblon Harbor, P. I.

No. 43.


TRIANGULATION,
TOPOGRAPHY AND HYDROGRAPHY
CEBU HARBOR
P. I.
Kilometers
1 ½ 0 1 2 3
Statute Miles
1 ¾ ½ ¼ 0 1 2
123° 50′
55′
124° 00′
10′
20′
10° 15
10°15′
CEBU ISLAND
MACTAN ISLAND
Lt.House
Cliff
Mound
Green
Clay
Mud
Break
Out
Stake Lt.
Sand
Edge
Far
Tree
Stack 2
Rice
Square
Round
Thorn
Rampart
Cone
White Roof
Old Tower
Cross
Shelf
M.B.
Bluff
Cove
Cathedral
S.B.
Santo Nino
Cebu
Recoletos
Mon
St.Nicholas
Fort
Shell
Ast
Mast
Red Lt
Bush
Ree
Low
Church Sp.
Diff
Ruin
Rock
Cauit
Spit
Lava
Lapata
Left Tr.
Talasai
Beacon 2
Shack
Beacon 1
Flat

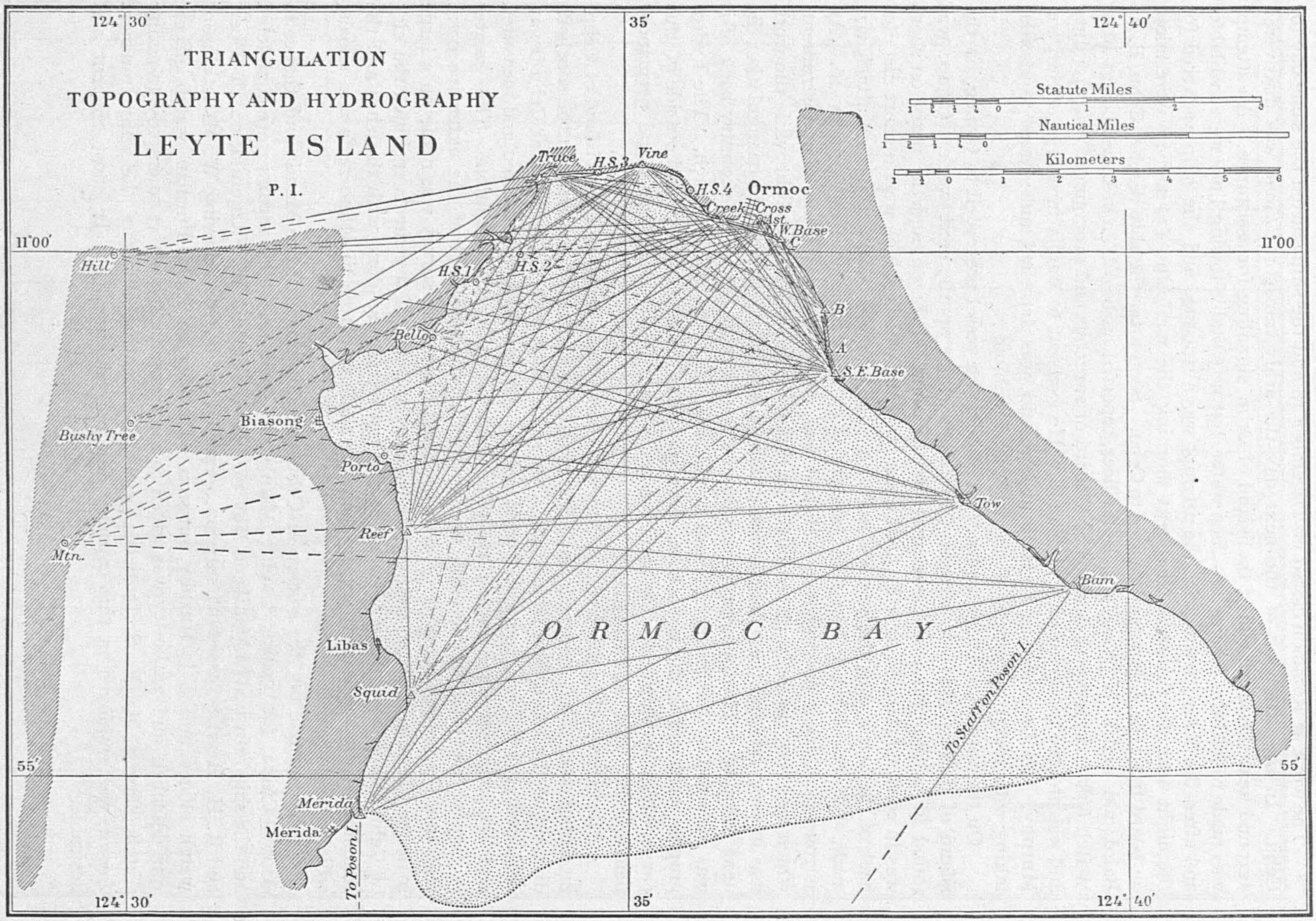
The work at Romblon closed on December 18 and the ship started the same day for Cebu. In the afternoon of the next day the army transport *Liscom* was discovered aground near the north end of the island of Cebu, signaling for assistance. An attempt was made to pull the *Liscom* into deep water, but no suitable towing lines were available, and after the lines parted twice the attempt was abandoned and the ship anchored for the night near the *Liscom*. The next morning the mails and 120 soldiers were taken on board from the *Liscom* and carried to Cebu. Soon after the ship reached Cebu, B. A. Baird, aid, and L. H. Westdahl, deck officer, reported on board. On December 21 First Watch Officer Lyle was examined by a board of surgeons and pronounced unfit for duty and was ordered to the hospital at Manila. He was sent to Manila in charge of Surgeon Murphy. On December 24 F. H. Brundage, aid, was detached and started to Manila, taking with him the records of the work at Romblon.

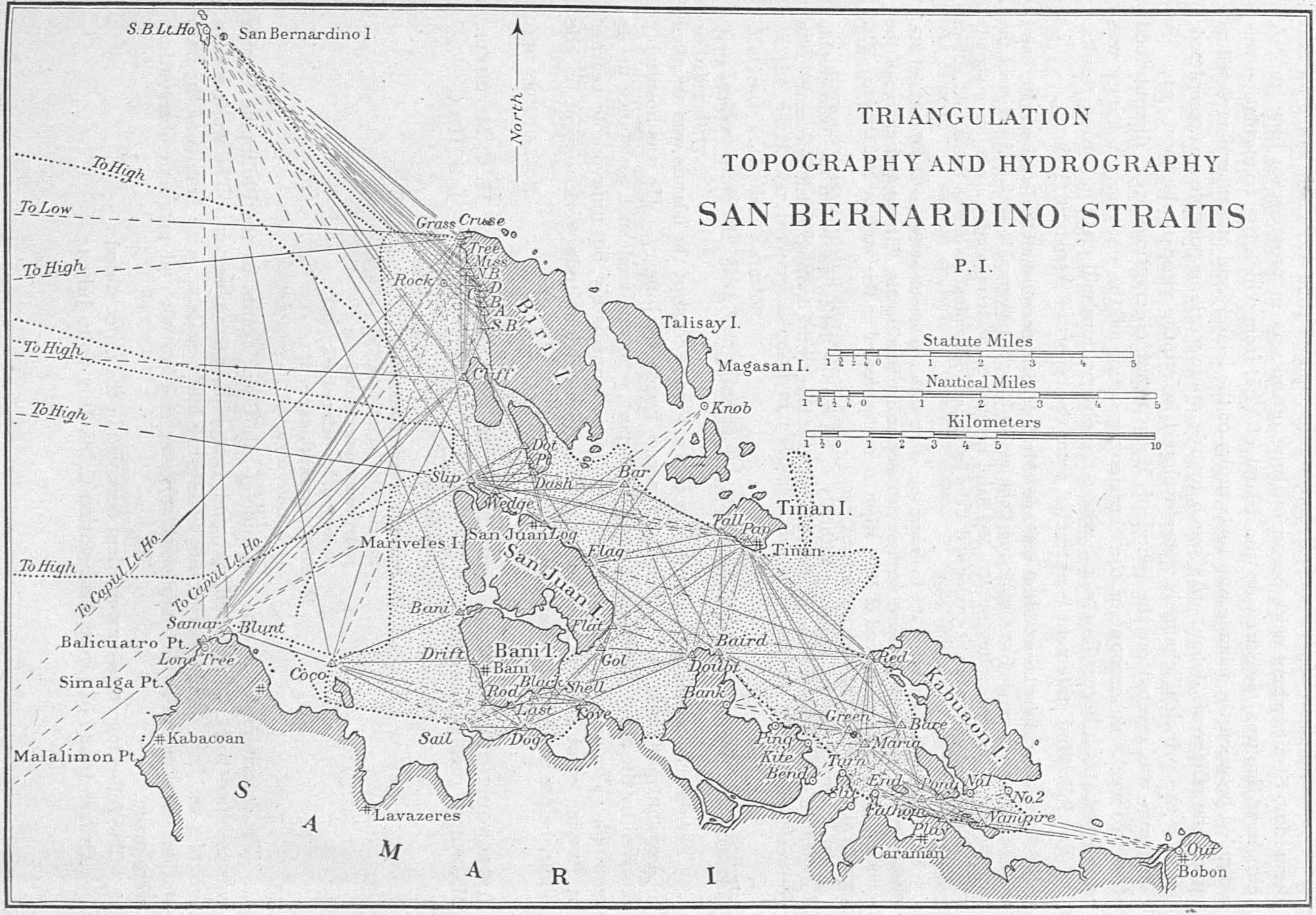
On the return of Dr. Murphy from Manila the vessel proceeded to Ormoc, on the island of Leyte, where it seemed desirable to take up the next work. Ormoc was found to be the center of disturbance on the island of Leyte, and the party on shore was in constant danger of being fired upon from the woods, which were a short distance back of the beach, but the natives knew that the party was armed and no attack was made. Work at Ormoc began on January 1 and was completed on January 26. An astronomic station previously established was occupied with a meridian instrument, which was very carefully placed in the meridian on the only clear night while the work was in progress, and the azimuth thus obtained was transferred to the triangulation the next morning. The topography was limited to the shore line, as the country back of it was occupied by the insurgents and it was not safe to go off the beach. The hydrographic work out to the 10-fathom curve was done with the launch and outside of this curve with the ship. A tide staff was set up near the beach at Ormoc and permanent bench marks were established.

After completing the work at Ormoc the vessel proceeded to Cebu, island of Cebu, in accordance with a request from the commanding general of the army in the southern division of the Philippine Islands, for a survey of that port. The work at Cebu began on January 28 and was completed on March 21. A base line was selected and measured and the necessary geographic positions determined by triangulation. The greater portion of the topographic work was very difficult on account of the extensive coral reefs and the bordering mango swamps. The topographic survey was made on a large scale for the benefit of the military authorities, and one of the sheets included the city of Cebu. The hydrographic work at the entrances was done with the ship and the remainder with the launch, except some in shallow places to define reefs and shoals, which was done with a boat.

After completing the survey at Cebu the ship proceeded to Manila and thence to Amoy, China, for repairs, leaving Manila on April 12. The repairs were completed and the ship returned to Manila on May 26. On the 28th C. W. Fitzgerald, watch officer, and R. H. Hawkes, assistant surgeon, reported on board, relieving W. M. Atkinson, watch officer, and J. J. Murphy, surgeon. On May 29 L. M. Furman, watch officer, was detached and authority was given to the commanding officer to employ an acting watch officer. Mr. E. S. Daniels, formerly navigating officer of the army transport *Logan*, was employed in this capacity and proved himself to be most efficient and desirable.

No. 44.


TRIANGULATION
TOPOGRAPHY AND HYDROGRAPHY
LEYTE ISLAND
P. I.
Statute Miles
Nautical Miles
Kilometers
124° 30'
35'
124° 40'
11°00'
55'
Truce
H.S.3
Vine
H.S.4
Ormoc
Creek
Cross
Ast.
N.W.Base
C
Hill
H.S.1
H.S.2
B
A
Bello
S.E.Base
Biasong
Bushy Tree
Porto
Tow
Reef
Mtn.
Bam
ORMOC BAY
Libas
Squid
To Staff on Poson I.
Merida
Merida
To Poson I.


TRIANGULATION
TOPOGRAPHY AND HYDROGRAPHY
SAN BERNARDINO STRAITS
P. I.
Statute Miles
Nautical Miles
Kilometers
North
S. B Lt. Ho.
San Bernardino I.
To High
To Low
To High
To High
To High
To High
To Capul Lt. Ho.
To Capul Lt. Ho.
Grass
Cruse
Tree
Muss
N.B.
D
B
A
S.B.
Rock
Biri I.
Talisay I.
Magasan I.
Knob
Cliff
Dot
Pt
Slip
Dash
Bar
Wedge
Tinan I.
Tall
Pap
Tinan
Mariveles I.
San Juan
Log
Flag
San Juan I.
Bani
Samar
Blunt
Balicuatro Pt.
Lone Tree
Simalga Pt.
Coco
Drift
Bani I.
Bani
Flat
Gol
Baird
Doubt
Red
Kabuaon I.
Rod
Black
Shell
Last
Cove
Bank
Sail
Dog
Kabacoan
Malalimon Pt.
Green
Bare
Maria
Ping
Kite
Bend
Turn
End
Pond
No.1
No.2
Fathom
Vampire
Play
Caraman
Lavazeres
Out
Bobon
S A M A R I

The complement of men was filled at Manila, and on June 6 the ship sailed for San Bernardino Strait, where work began on June 9 and was in progress on June 30. A short base line was measured on the island of Viri, from which the triangulation was extended between the islands, and topography of the islands and of Samar completed as far as the village of Bobon. As much hydrographic work as possible was completed, but only the principal channels were developed before the close of the fiscal year. A tide gauge was erected on the island of Macarit, but observations were discontinued after two weeks on account of the threatening action of the natives. A gauge was established at San Bernardino Island, where the observations will yield important results.

The following statement is extracted from the report of Assistant Gilbert:

All the officers have been faithful workers. Mr. Yates has measured all the base lines, Mr. Baird and Mr. Pfau assisting, and at Ormoc and Cebu assisted in the topographic work and executed the triangulation at San Bernardino Strait. Mr. Baird assisted in the triangulation by building signals and in the topographic work at Ormoc and Cebu by sextant determination of reef limits, and at San Bernardino Strait did plane-table work.

Mr. Atkinson had charge of the hydrographic work with the launch at Ormoc and Cebu, and Mr. Fitzgerald had charge of the same work at San Bernardino Strait. Mr. Furman had charge of the sounding apparatus until the end of May, when he was succeeded in this work by Mr. Daniels. Mr. Furman also made current observations at Cebu.

Mr. Deichman, besides attending faithfully to his routine duties, assisted in the hydrographic work with the launch and the ship. Mr. Pfau was kept busy by the drafting, which he executed with great care and industry.

ASTRONOMIC OBSERVATIONS. PHILIPPINE ISLANDS. J. E. MCGRATH.

The determination of longitude of points along the coast of the islands was assigned to Assistant McGrath, and he reached Pasacao, Luzon, on June 17. He was hospitably received by the army officer commanding the post, who rendered such assistance as he required. The necessary preparations were made immediately, but unfavorable weather at Pasacao or at Legaspi, the base station, prevented longitude work, except on one night, before the close of the fiscal year.

ASTRONOMIC OBSERVATIONS. PHILIPPINE ISLANDS. H. C. MITCHELL.
MAGNETIC OBSERVATIONS. J. S. HILL.

SUMMARY OF RESULTS.

Astronomic observations:
- 10 azimuths established.
- 10 latitudes determined.
- 10 longitudes determined.

Magnetic observations:
- 11 stations occupied.

The determination of the longitude of additional points in the Philippine Islands was assigned to H. C. Mitchell, aid, and J. S. Hill, extra observer. The work was in progress on July 1 and observations were being made at Cebu, with Manila as the base station. An azimuth was established at Cebu, and latitude and magnetic observations were made.

The following stations were then occupied in the order stated:

Ormoc, island of Leyte, base station Cebu, July 10 to July 17.

Tacloban, island of Leyte, base station Cebu, July 29 to September 13.
Maasin, island of Leyte, base station Cebu, September 18 to October 4.
Dumaguete, island of Negros, base station Cebu, November 1 to November 26.
Misamis, island of Mindanao, base station Cebu, December 8 to February 2.
Zamboanga, island of Mindanao, base station Misamis, February 12 to February 28.
Capiz, island of Panay, base station Iloilo, March 21 to March 27.
Palanog, island of Masbate, base station Capiz, April 18 to April 24.
Legaspi, island of Luzon, base station Palanog, June 6 to June 20.

Latitude and magnetic observations were made and an azimuth was established at all of these places.

Cebu and Ormoc are connected by a submarine cable on which an open circuit is used, but during the exchange of time signals, land-line batteries were put on and a closed circuit substituted. A plane-table sketch of Ormoc and of Maasin was made. At Maasin the sketch included the shore line, and some soundings were made at the anchorage off the town.

At Dumaguete the astronomic station was referred to permanent marks by triangulation.

Serious delays during the season resulted from unfavorable weather and while waiting for transportation from station to station. The work was in progress at the close of the fiscal year between Legaspi and Pasacao, island of Luzon, with Assistant J. E. McGrath at the latter station.

In November Mr. José Vano Reyes, aid, was detached from the party and ordered to other duty.

ASTRONOMIC OBSERVATIONS. PHILIPPINE ISLANDS. C. E. MORFORD.
BASE MEASURE.
HYDROGRAPHY.
TOPOGRAPHY.
TRIANGULATION.

SUMMARY OF RESULTS.

Astronomic work:
- 2 azimuths measured.

Base measure:
- 2 lines measured.

Hydrography:
- 19 square miles area covered.
- 320 miles lines sounded.
- 3 hydrographic sheets completed.

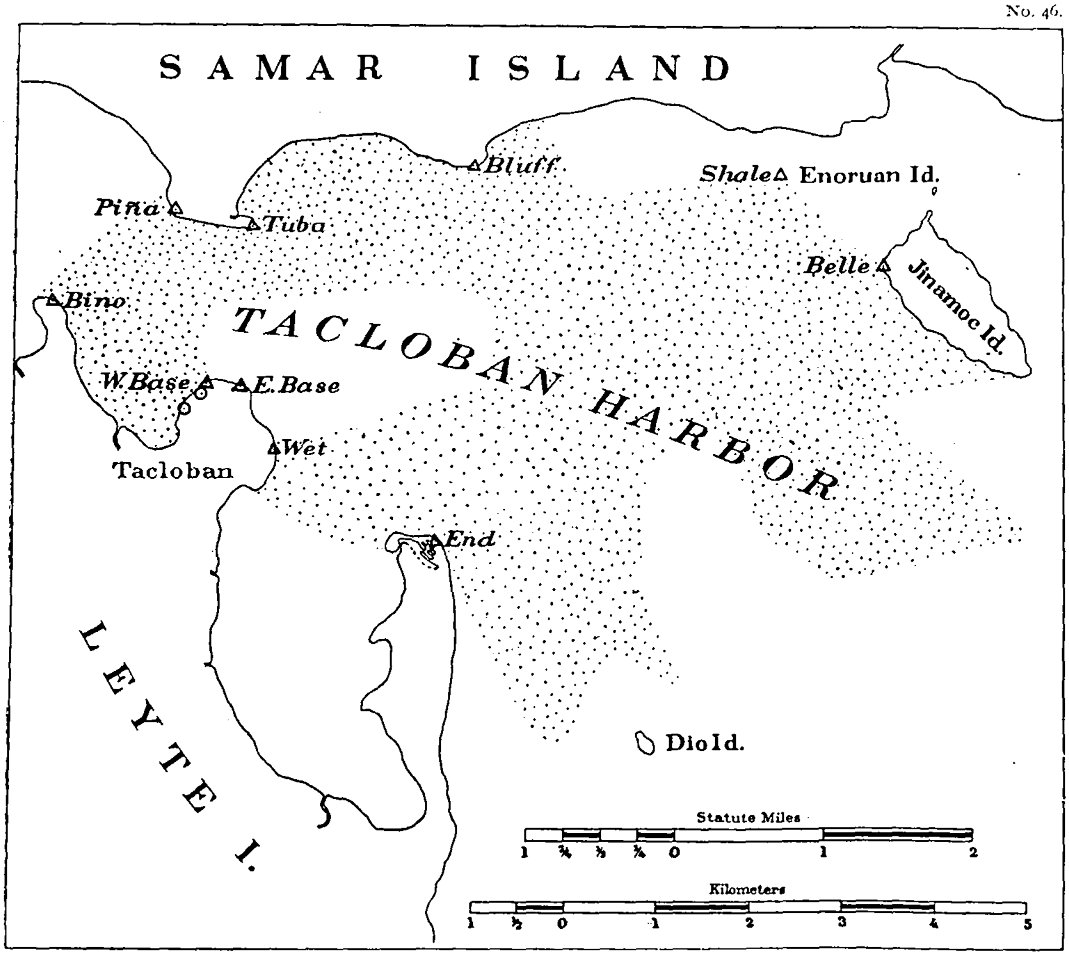
Topography:
- 11 square miles area covered.
- 7 miles shore line surveyed.
- 9 miles shore line reefs surveyed.
- 15 miles road surveyed.
- 4 topographic sheets completed.

Triangulation:
- 4 square miles area covered.
- 8 stations occupied.

The survey of the harbor of Tacloban, Leyte, was in progress on July 1 by the party of C. E. Morford, aid, Coast and Geodetic Survey. The work was continued whenever the weather permitted and was completed on July 19.

Topographic work in Manila Harbor was taken up on August 6 and continued until August 28. The heavy rains which prevailed in the region caused considerable delay in the work.

No. 46.



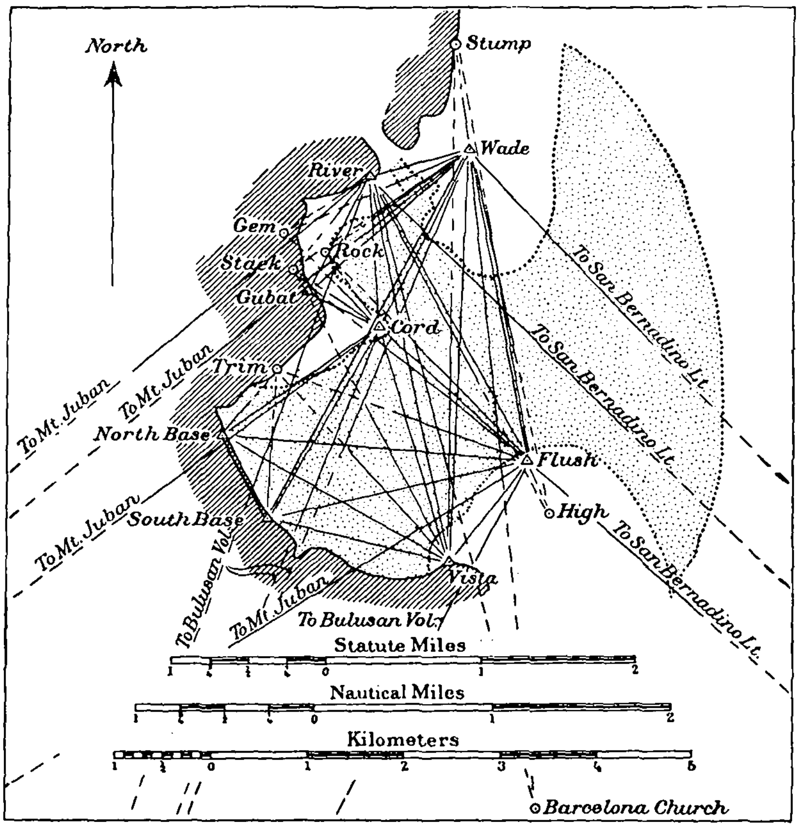
Triangulation and hydrography, Tacloban Harbor, P. I.

The work of surveying Port Mariveles was begun on September 4 and continued until September 26.

In June the survey of the harbor at Gubat, Luzon, was assigned to Mr. Morford and he began the work on June 6. This work was in progress at the close of the fiscal year.

The accompanying sketches show the area covered by the work, and the statistics furnished in Mr. Morford's report are given above.

No. 47.



Triangulation, topography and hydrography, Port Gubat, P. I.

Astronomic observations.	Philippine Islands.	H. W. Rhodes, Commanding,
Base measure.		Steamer *Research*.
Hydrography.		
Magnetic observations.		
Topography.		
Triangulation.		

N. G. Grayson, *First Watch Officer*.	Oct. 23 to May 12.
W. W. Markoe, *Surgeon*.	Apr. 9 to May 12.
E. E. Allen, *Chief Engineer*.	
C. E. Morford, *Aid*.	
H. M. Davie, *Deck Officer*.	Dec. 12 to May 12.
H. O. Pixley, *Extra Observer*.	
H. Bernhardt, *Recorder*.	Oct. 9 to Dec. 8.

SUMMARY OF RESULTS.

Astronomic observations:
- 2 latitudes determined.
- 2 azimuths determined.

Base measure:
- 2 lines measured.

Hydrography:
- 151 square miles area covered.
- 1 071 miles lines sounded.
- 6 tide stations established.
- 7 sheets completed.

Magnetic observations:
- 3 stations occupied.

Topography:
- 72 miles coast line surveyed.
- 3 sheets completed.

Triangulation:
- 29 square miles area covered.
- 71 stations occupied.
- 99 geographic positions determined.

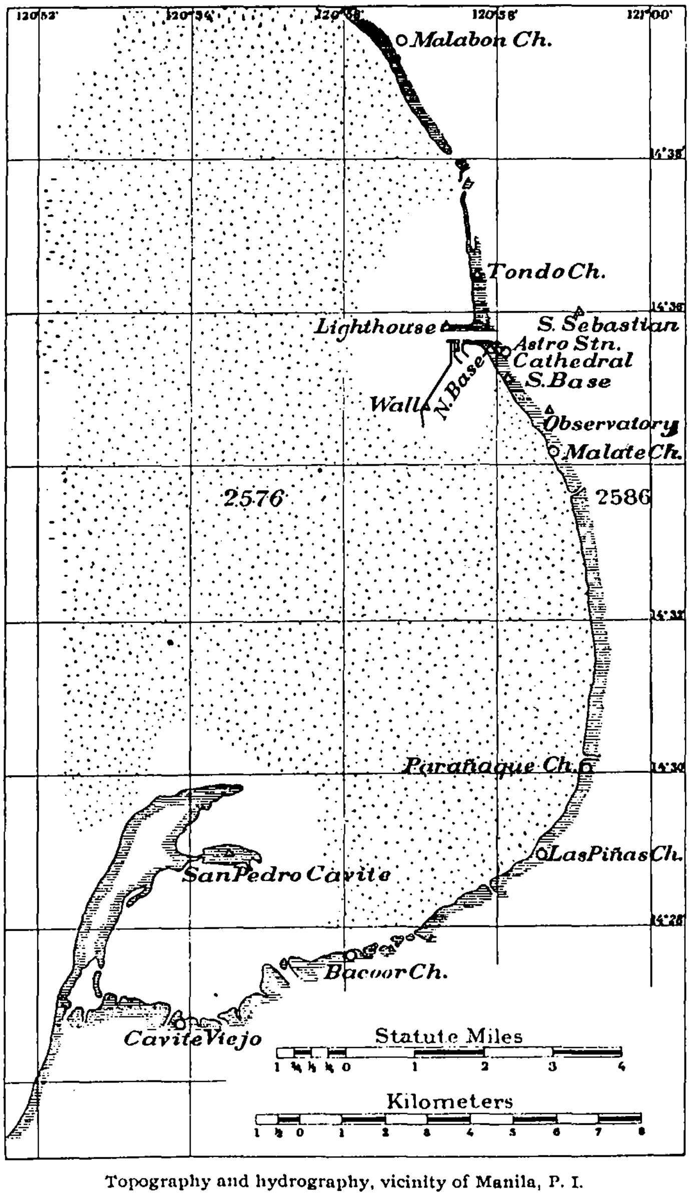
A portion of the survey of the coast of the Philippine Islands was assigned to Assistant H. W. Rhodes, commanding the steamer *Research*, and he began field operations in Manila Bay on October 10, 1901. Hydrographic work in the bay was continued until the 29th, except for a few days when necessary repairs were made to the ship. On October 30 the vessel went to Mariveles Bay and began hydrographic work in this bay and at the entrance to Manila Bay. This work was continued until November 3.

After making some necessary repairs to the machinery of the ship at Manila, the vessel proceeded, on November 16, to San Fernando de Union, island of Luzon, and made a hydrographic survey of South Harbor and approaches, including Fagg Reef.

From November 29 to December 13 a survey was made of Port Bolinao and approaches. A survey of the harbor and approaches at Santa Cruz was made between December 17 and January 15, and the vessel then returned to Manila for repairs.

The work at Santa Cruz developed numerous and extensive coral reefs in the harbor and in the approaches. A narrow channel between two reefs leads to a good anchorage, comparatively close inshore, with good holding ground.

No. 48.

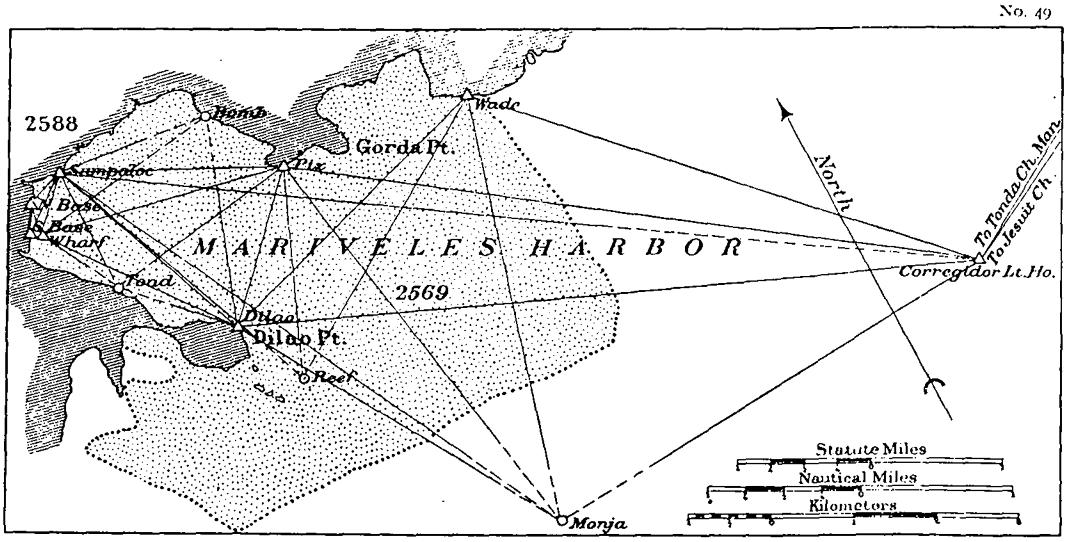


Topography and hydrography, vicinity of Manila, P. I.

On February 6 the vessel proceeded to the Island of Culion and began the survey of Halsey Harbor. Halsey Harbor, on the west coast of the island of Culion, was found to be an excellent harbor with a good entrance and clear approach. A topographic reconnaissance was made of the portion of the island which has been proposed as a site for establishing a leper colony. The necessary triangulation, topography, and hydrography were completed on March 25, and a reconnaissance was then made of Pamatusin Cove in Paluan Bay, Island of Mindoro.

The vessel returned to Manila for repairs and supplies and then proceeded to Legaspi, Luzon.

No. 49



Triangulation, topography and hydrography, Mariveles Harbor, P. I.

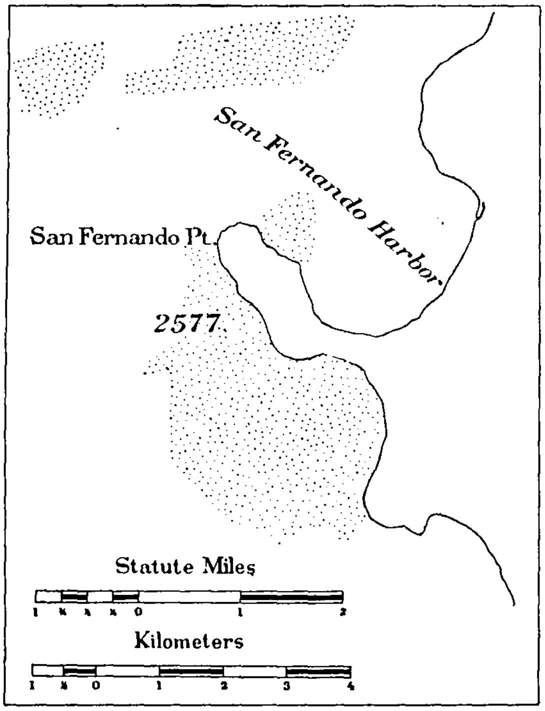
A survey of the approaches to Tabaco Bay and also of the north half of the bay was completed before May 13, on which date Assistant Rhodes was relieved of the command of the vessel by Assistant R. B. Derickson.

The hydrographic work in Tabaco Bay and entrance showed a fairly good entrance between extensive reefs, with deep water close to the shore, inside the bay.

The weather from January to May was generally fair, with a fresh northeast monsoon blowing.

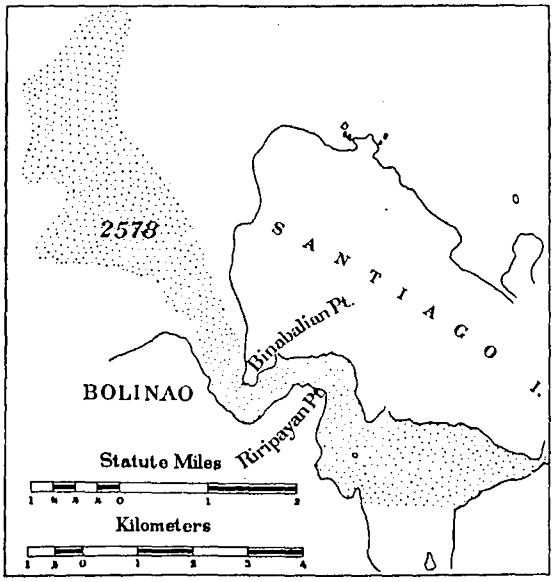
The limited capacity on the vessel for storing water seriously delayed the work during the entire season, as it was necessary to replenish the supply frequently, and much time was spent in doing so. Assistant Rhodes states that credit is due the officers of the party for the interest and ability displayed in the execution of the duties assigned to them. The natives employed as seamen on board the vessel in most cases showed an aptitude for the work and gave general satisfaction.

No. 50.

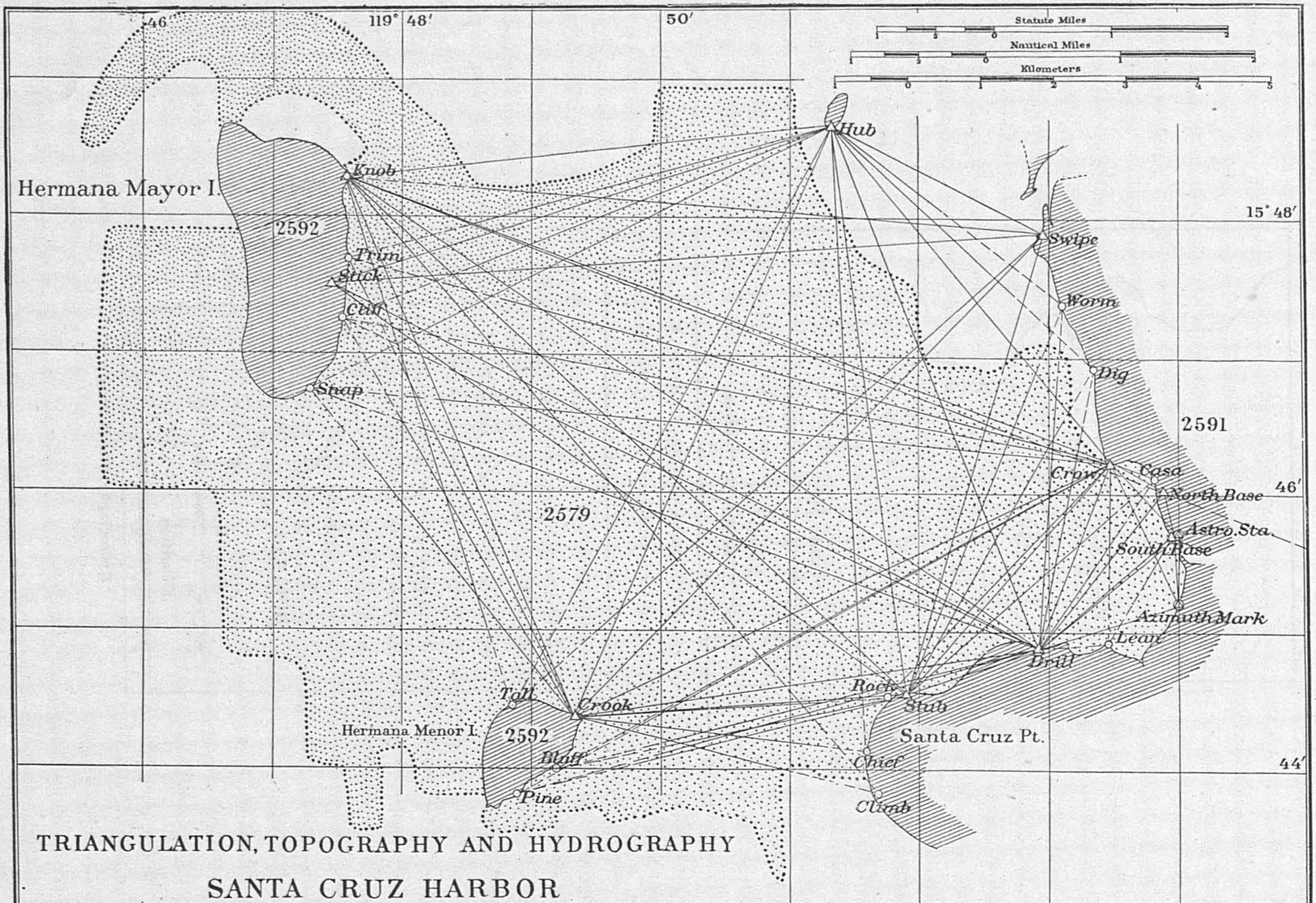


Hydrography, San Fernando Harbor, P. I.

No. 51.

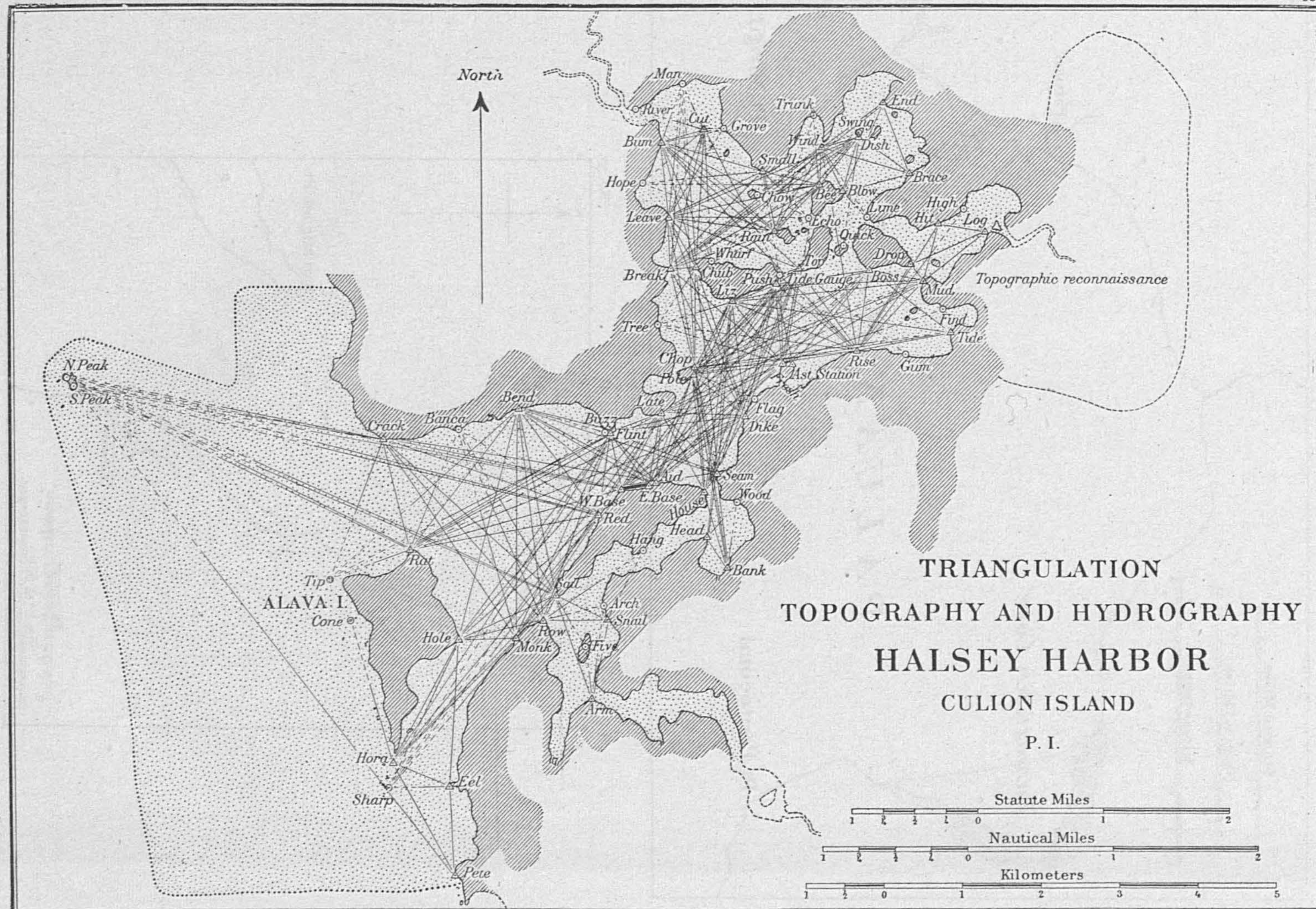


Hydrography, Port Bolinao, P. I.

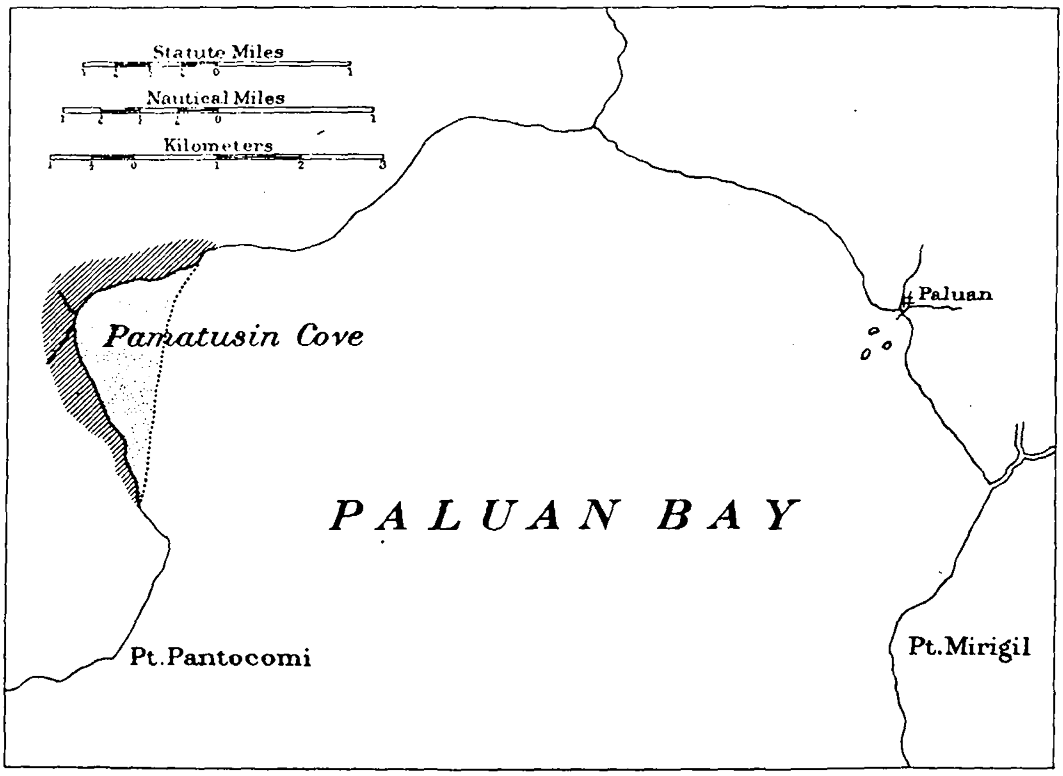


TRIANGULATION, TOPOGRAPHY AND HYDROGRAPHY

SANTA CRUZ HARBOR

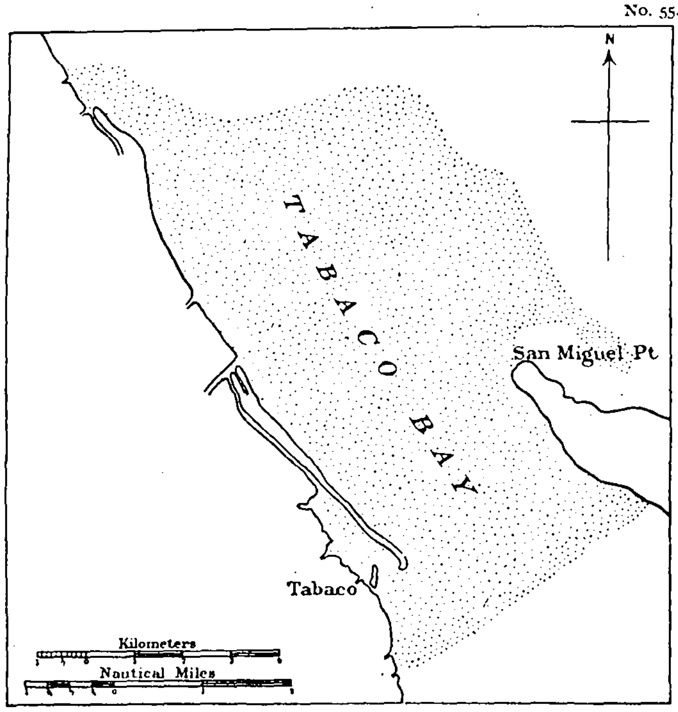

TRIANGULATION
TOPOGRAPHY AND HYDROGRAPHY
HALSEY HARBOR
CULION ISLAND
P. I.
North
Topographic reconnaissance
ALAVA I.
N. Peak
S. Peak
Crack
Banca
Bend
Buzz
Flint
Aid
W. Base
E. Base
Red
Rat
Tip
Cone
Hole
Sail
Row
Monk
Five
Arch
Snail
Arm
Hang
Head
House
Seam
Wood
Bank
Dike
Flag
Late
Chop
Post
Ast. Station
Rise
Gum
Tide
Find
Mud
Boss
Drop
Tide Gauge
Push
Liz
Chub
Tor
Whirl
Rain
Echo
Quick
Lime
Blow
Bee
Chow
Small
Wind
Swing
Dish
End
Brace
High
Hit
Log
Trunk
Grove
Cut
Man
River
Bum
Hope
Leave
Break
Tree
Hora
Sharp
Eel
Pete
Statute Miles
Nautical Miles
Kilometers

No. 54.



Reconnaissance, Paluan Bay, P. I.

No. 55.



Hydrography, Tabaco Bay, P. I.

HYDROGRAPHY. PORTO RICO. R. L. FARIS, Commanding,
TOPOGRAPHY. Steamer *Blake*.

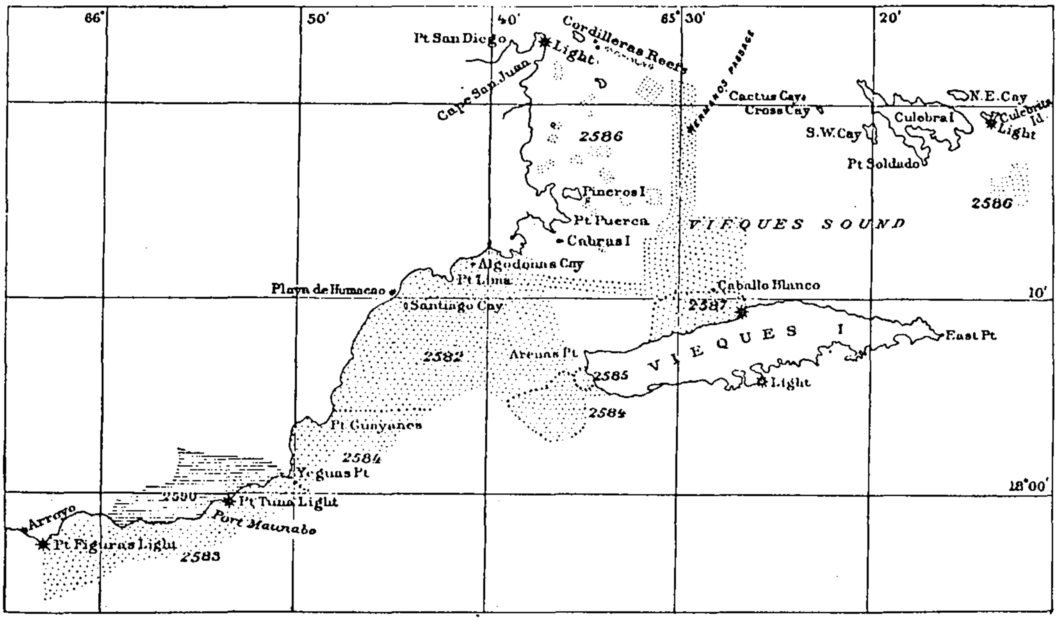
R. B. DERICKSON, *Assistant*.
CHARLES LYMAN, *First Watch Officer*.
G. E. MARCHAND, *Surgeon*.
L. M. HOPKINS, *Chief Engineer*.
O. M. LELAND, *Aid*.
GEORGE E. SELBY, *Aid*.
W. F. GLOVER, *Second Watch Officer*.
GEORGE OLSEN, *Deck Officer*.

SUMMARY OF RESULTS.

Hydrography:
153 square miles (nautical) area covered.
2 532 miles (nautical) lines sounded.
7 hydrographic sheets completed.
5 tide stations established.

Topography:
18 square miles area covered.
12 miles coast line surveyed.
1 topographic sheet completed.

No. 56.

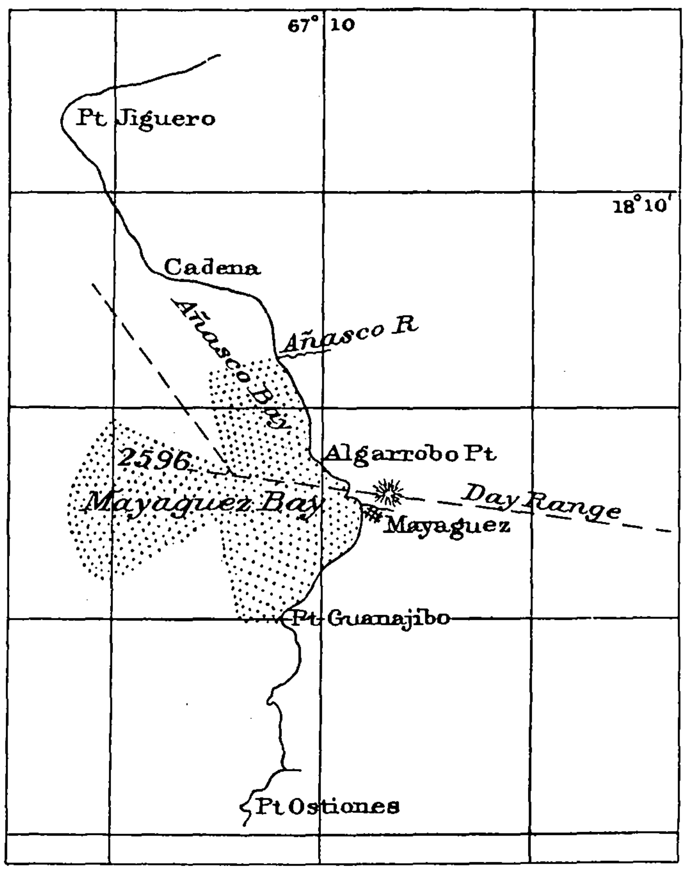


Topography and hydrography, southeast coast of Porto Rico.

The continuation of the survey of Porto Rico was assigned to Assistant Faris, and on December 14 he took command of the steamer *Blake*, relieving Assistant P. A. Welker. Preparations for the field work were made and on December 21, the *Blake* sailed from Baltimore for San Juan, P. R., en route to Mayaguez.

The vessel reached Mayaguez on the 29th and the steam launch *Rudy* was immediately prepared for service. A party was landed under charge of Assistant Derickson to make a hydrographic survey of the harbor and immediate approaches, and on January 1 the *Blake* returned to San Juan enroute to the southwest coast. The work at Mayaguez was a continuation of the survey begun during the previous year by Assistant G. L. Flower. A tide staff was established and referred to a suitable bench mark, the necessary signals were erected, and the sounding began at the southern extremity of the harbor. The lines were run as nearly perpendicular to the shore line as practicable, at distances apart of 100 to 150 meters, and these were crossed by lines at similar distances approximately parallel to the shore. The work was completed previous to

No. 57.



Hydrography, Mayaguez Harbor, P. R.

January 17, and on that date Assistant Derickson was detached from the ship and ordered to other duty.

The work assigned to the *Blake* was the hydrographic survey of the southeast coast of Porto Rico from Arroyo to Point Arenas, including the area offshore to the 160-fathom curve, and the development of the harbor and anchorages within the limits stated above. On January 6 the topographic work, in charge of Aid Leland, began at Point Viento, and the necessary signals were erected. This work was extended along the coast from Point Viento to Yeguas Point, a distance of about 12 miles, and inland to cover the region visible from the coast line.

The hydrographic work assigned to the party, as stated above, was successfully completed. Thirty-two doubtful spots in Vieques Sound were thoroughly examined and carefully developed, including Grampus Shoals. A survey was also made of Port Mulas Harbor and Mosquito Reefs. The survey of Mayaguez Harbor was completed, and White Rock was found, by using a gas-pipe drag, and located. The rock is erroneously located on the Spanish chart of 1898, and this location was thoroughly examined for the purpose of ascertaining whether any such rock existed at the point indicated, but none was found. A special development of Mondango Reef, Mayaguez Harbor, was also made and the position of the ranges used in entering the harbor was determined. The hydrography off Boca Quebrada Point, on the south side of Arenas Point anchorage, was developed in order to complete the survey of the anchorage.

At no time during the season was it found to be practicable to make soundings from a rowboat, and much of the work with the ship was done in a heavy swell. The special hydrographic work in Fajardo Roads and vicinity included the examination of twenty-six shoals.

Tide observations were made at Mayaguez, Point Tuna, Santiago Cay, and Port Mulas. A comparison of the tidal planes was made by simultaneous observations at Point Tuna and Santiago Cay, at Point Tuna and Port Mulas, and at Mayaguez and Puerto Real.

The work closed on May 29, and on June 3 the vessel sailed from San Juan for Baltimore and reached that place on June 10. The following is quoted from the report of Assistant Faris:

I wish to commend the officers under my command for their zealous attention and intelligent performance of their duties, and for their readiness to assist me in every way in their power.

I desire to make special mention of First Watch Officer Chas. Lyman for his work in always keeping the ship in a neat and healthy condition, and in always having the vessel ready for the work in hand.

I also heartily commend Mr. George Olsen for his excellent and efficient work throughout the entire season in charge of the steam launch used in the hydrographic work. His work was performed with intelligence, zeal, and close attention to duty. Much of the launch work was on an exposed coast and the sea was frequently rough, thus rendering the work exceptionally arduous.

MAGNETIC OBSERVATIONS. PORTO RICO. JOHN NELSON.
RECONNAISSANCE.
TOPOGRAPHY.
TRIANGULATION.

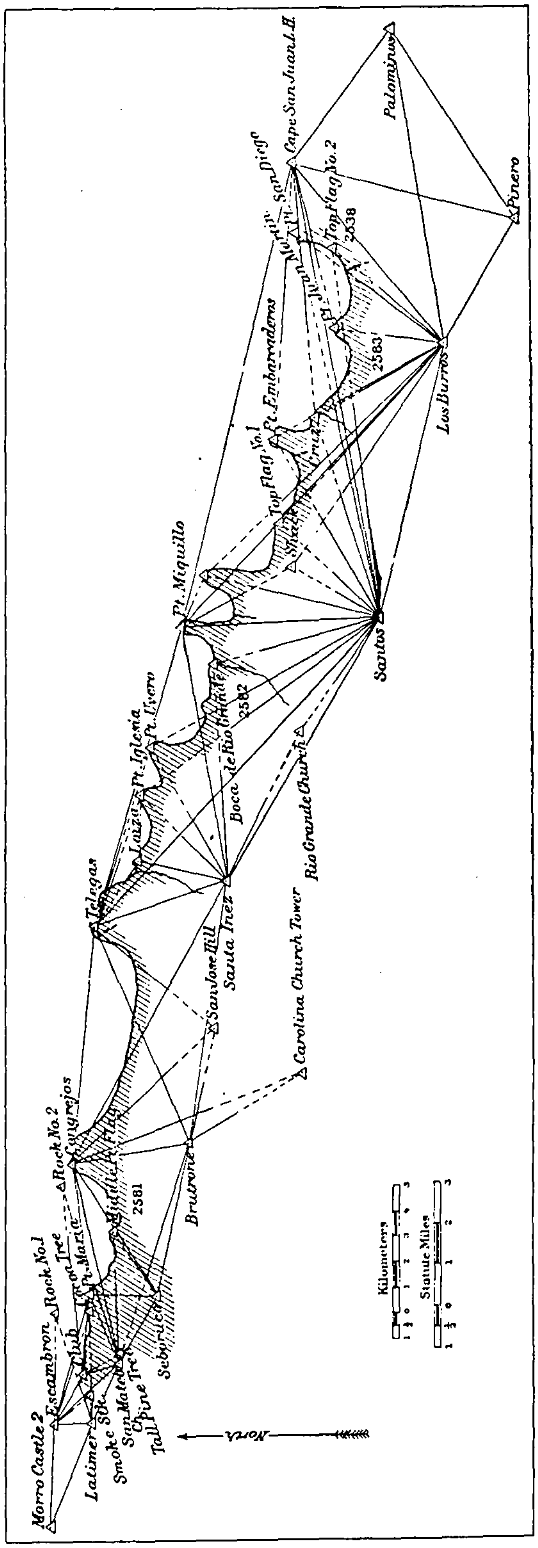
SUMMARY OF RESULTS.

Magnetic observations:
- 3 stations occupied.

Reconnaissance:
- 125 square miles area covered.
- 18 stations selected.

Topography:
- 16 square miles area covered.
- 52 miles general coast line surveyed.
- 30 miles shore line of rivers and lagoons surveyed.
- 47 miles shore line of ponds surveyed.
- 3 miles roads surveyed.
- 3 topographic sheets completed.

No. 58.



Triangulation and topography, north coast of Porto Rico.

Triangulation:
- 103 square miles area covered.
- 18 stations occupied.
- 38 geographic positions determined.

The completion of the triangulation and topographic survey along the north coast of Porto Rico, between San Juan and Palominos Island, was assigned to Assistant Nelson. He procured outfit and stores in New York, and sailed for Porto Rico on December 21, and reached San Juan on the 26th. A party was organized, and the necessary transportation was secured from the Quartermaster's Department of the U. S. Army. Field operations began on January 1, and the work was completed on April 7.

The line from El Moro to Latimer, which it was necessary to use as a base for the work, was unfavorably located, and considerable time was spent in making a reconnaissance to carry the triangulation to the eastward. During January the rain was almost continuous, with more than 15 inches of rainfall and only four fair days.

The plane table work began on February 1 and was continued to the end of the season whenever the weather conditions permitted. It was necessary to establish camps in three places during the season, and the camp outfit was moved with considerable difficulty and delay. From San Juan to Memelle there is a military road in good condition, but there are no bridges over the principal streams, and the fords are rough and dangerous, some of them becoming impassable when the streams are flooded. From Memelle to Fajardo the rough and sandy road becomes almost impassable during the wet season. The constant and heavy trade winds greatly delayed the work.

Assistant Nelson reports the valuable service rendered by W. C. Dibrell, aid, F. C. Donn, draftsman, and E. E. Torrey, foreman, during the season. Aid Dibrell was with the party from the beginning of the season until March 17, and extended the topography from San Juan to the Boca de Rio Grande. He was relieved from duty in the party on March 17, and Draftsman Donn took his place and continued the topographic work to Pt. San Diego, where it joined the work previously completed.

In accordance with later instructions, after completing the work mentioned Assistant Nelson moved his party to Fajardo after making all necessary arrangements for a survey of Mona Island. The party was taken on board the Coast and Geodetic steamer *Blake*, Assistant R. L. Faris commanding, and transported to Mona Island, but the heavy sea in the vicinity of the island made it impracticable to land the party and outfit, and as there was no prospect of more favorable conditions in the near future, the attempt was abandoned and the vessel proceeded to Mayaguez and thence to San Juan, where the outfit was dried and shipped to Washington. The party was disbanded and Assistant Nelson left San Juan for Washington on April 30.

SPECIAL DUTY.

RESURVEY OF MASON AND DIXON'S LINE.	MARYLAND. PENNSYLVANIA.	W. C. HODGKINS.

The resurvey of Mason and Dixon's line, the boundary line between the States of Maryland and Pennsylvania, was in active progress at the close of the last fiscal year, as stated in the previous annual report, under the direction of Assistant W. C. Hodgkins.

The methods adopted in the field were intended to secure an exact reproduction of the work of Mason and Dixon without any attempt to correct any of the accidental inaccuracies by which it was affected from errors of observation or of measurement in running the trial line and in marking the curved boundary. This plan was practicable because the original notes contain data referring the various monuments established to a straight line lying close to the boundary. A large proportion of the old monuments were found in place, but a large number of them had been broken or seriously mutilated, and nearly all of them were no longer standing in a vertical position. A considerable number of the original monuments were found out of the ground and some of them had been removed or destroyed. All of the monuments found in position were carefully reset in substantial bases of concrete, after being restored to as good a condition as possible, and will last for a long period if not intentionally destroyed. While running the trial line, notes and sketches were made for the purpose of preparing a topographic delineation of the country in the immediate vicinity of the boundary.

The detailed survey of the natural and artificial features of the country immediately adjoining the boundary line was advanced from the vicinity of Littlestown, Pa., to the Susquehanna River. All of the missing monuments in that distance were relocated and replaced in their proper position on the line. This work was completed about the middle of June, and the party was then moved to Hancock, Md., and similar work in that vicinity was in active progress at the close of the year.

Assistant Hodgkins was absent on duty connected with the Virginia-Tennessee boundary work from July 16 to October 31, but the work on the Mason and Dixon's line was continued during this period by his party working under his direction. He reports the diligent and satisfactory service rendered by Mr. Robert H. Blain and Mr. Edward R. Martin, who assisted him in the work.

MARKING THE VIRGINIA AND TENNESSEE BOUNDARY.	VIRGINIA. TENNESSEE.	W. C. HODGKINS. J. B. BAYLOR.

The work of re-marking the Virginia and Tennessee boundary under an order of the United States Supreme Court was in active progress at the close of the previous fiscal year, as stated in the report for that year. Assistants Hodgkins and Baylor continued the work as members of the Commission created by the court for that purpose, and good progress was made until November 4, when the field operations closed for the winter. The greater portion of this time was consumed in the location of that portion of the boundary which lies in the mountainous district between the Holston River and the northeastern corner of Tennessee, where the country is extremely rough and generally densely wooded and where, on account of serious disputes as to the true location of the boundary, it was found necessary to run two trial lines, about a mile and a half apart, across an extensive series of formidable ridges. Frequent rains also retarded operations, and it was not until September 21 that the party could return to Bristol and start westward toward Cumberland Gap. On the section west of Bristol the conditions of the country and the weather were much more favorable, and the work was extended to the Clinch River by the end of October.

Assistant Hodgkins was absent on other duty from July 1 to 15. At the close of work for the winter the boundary line had been retraced from the White Top Mountains, at the northeast corner of Tennessee, to the Clinch River and marked by durable stone monuments at all the public highways. The trees adjacent to the line were also marked.

Assistant Baylor resumed work on the boundary on June 18 and the work was actively in progress at the close of the fiscal year.

WEST INDIAN EXPOSITION. WILLIAM EIMBECK.

The greater portion of the exhibit of the Coast and Geodetic Survey which had been displayed at the Pan-American Exposition at Buffalo, N. Y., was sent to the West Indian Exposition at Charleston, S. C., and Assistant Eimbeck was assigned to duty in charge of the installation and display of the exhibit. The necessary preliminary arrangements were made in Washington, and on December 3 he proceeded to Charleston and took up the work of installing the exhibit under the direction of the chief special agent of the Treasury Department. This was successfully accomplished, and Assistant Eimbeck continued in charge until the exposition closed on May 30, 1902. He then proceeded to Washington and reported to the Superintendent on June 5.

WITHLACOOCHEE RIVER ANCHORAGE SURVEY. H. L. MARINDIN.

SUMMARY OF RESULTS.

Hydrography:
- 13 square miles area covered.
- 239 miles of lines sounded.
- 2 tide stations established.
- 1 hydrographic sheet completed.

Topography:
- 1 square mile area covered.
- 1 mile of coast line surveyed.
- 4 miles shore line of rivers surveyed.
- 1 topographic sheet completed.

Triangulation:
- 45 square miles area covered.
- 5 stations occupied.
- 26 geographic positions determined.

In response to a request from the president of the Dunnellon Phosphate Company for a hydrographic examination off the mouth of the Withlacoochee River, Florida, for the purpose of establishing an anchorage for vessels engaged in the phosphate trade, Assistant Marindin was directed to proceed to the locality and make the necessary

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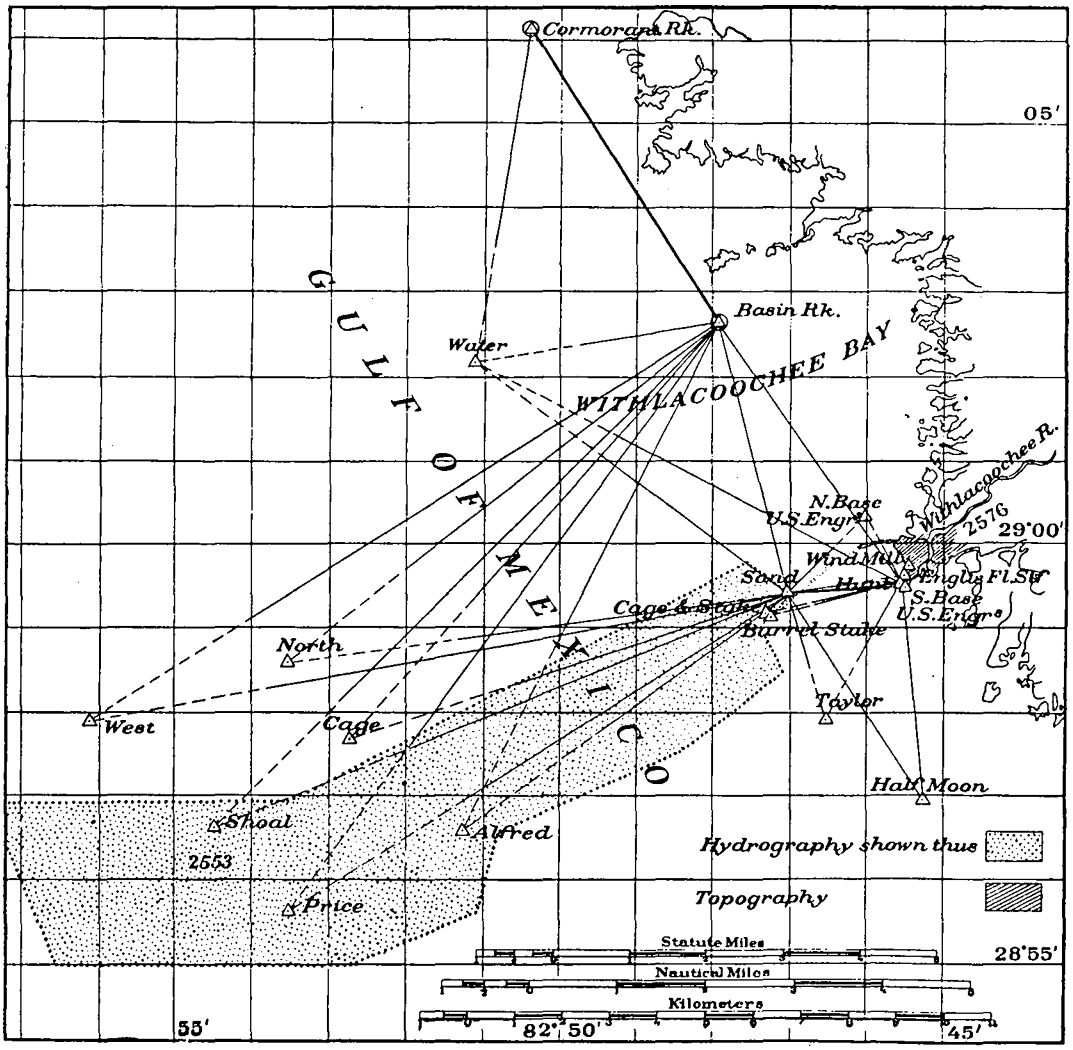


Triangulation, topography and hydrography, Withlacoochee River, Florida.

surveys. The Dunnellon Phosphate Company agreed to furnish all assistance, boats, and material required and to pay all necessary expenses of the survey.

Assistant Marindin reached Dunnellon on September 24 and began the work of recovering some of the stations of the triangulation established in this region in 1856 and 1857. Many of the old station marks had been removed or destroyed. After searching diligently for a considerable time, two stations were recovered, both of which had been established on rocks lying off shore and submerged at high tide, and the line between them was used as a base from which to start the work. The triangulation was extended from the line Cormorant Rock to Basin Rock, by means of stations on shore and in the water, to a point beyond the mouth of the Withlacoochee River. A topographic survey was made of the shore line in the vicinity of the channel established by dredging and of the islands at the mouth of the river. It was necessary to suspend work in order to allow Assistant Marindin to attend a meeting of the Mississippi River Commission, and he was absent from November 2 to November 20, when he returned and resumed work. Assistant O. W. Ferguson reported to Assistant Marindin on November 26, and remained until the completion of the work on January 24. The proposed anchorage was from 8 to 13 miles off shore and it was necessary to establish and determine two lines of "water signals" or signals erected off shore for use in the hydrographic work. A tide staff was erected at Cedar Keys and referred to the tidal bench mark at that place and at the mouth of the Withlacoochee River and a tidal plane established by simultaneous observations at these places.

This work was the result of the attempt of the Port Inglis Terminal Company and the Dunnellon Phosphate Company to systematically improve the mouth of the Withlacoochee River at their own expense under authority of Congress.

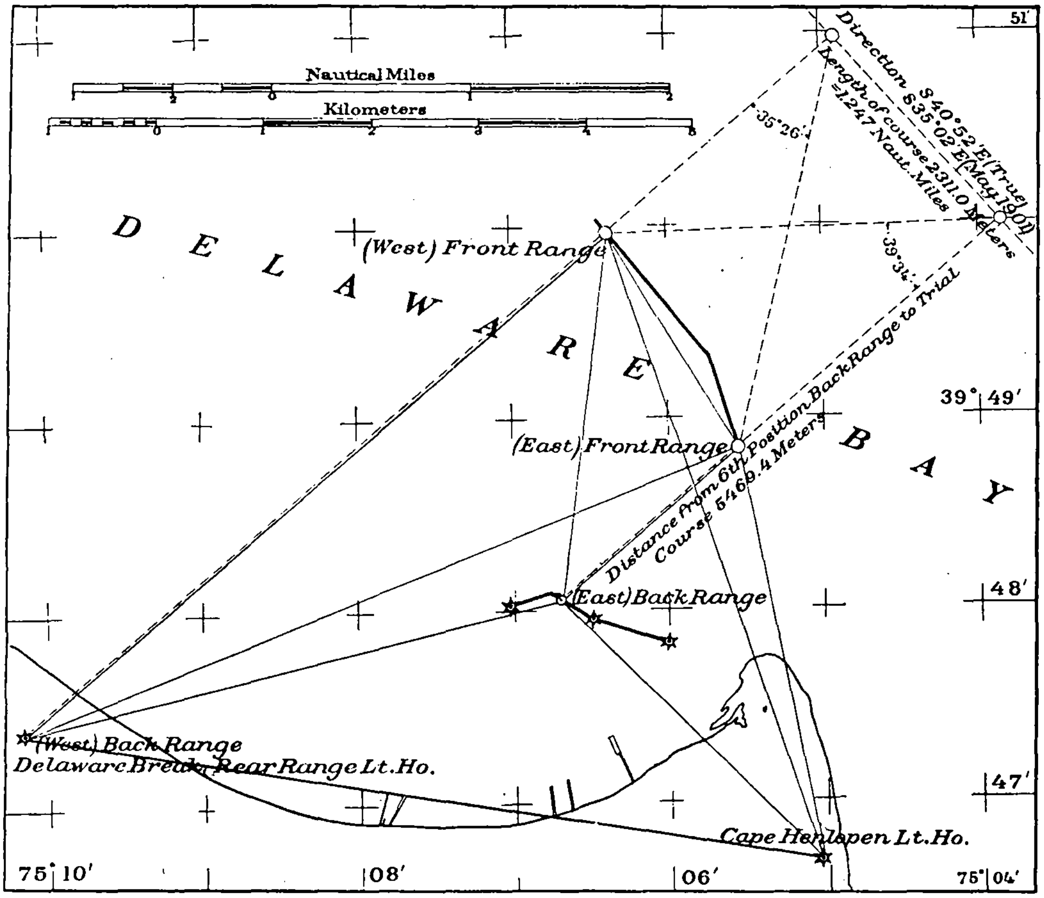
MEMBER OF MISSISSIPPI RIVER COMMISSION. H. L. MARINDIN.

Assistant Marindin continued his service as a member of the Mississippi River Commission under the appointment of the President, and performed such duties during the year as were necessary. On November 3 he proceeded to St. Louis, Mo., to attend a meeting of the Commission and then went on a trip of inspection down the river to New Orleans, returning to other duty on November 20. From March 31 to April 11, he was attending a meeting of the Commission at St. Louis and inspecting the work along the river to New Orleans. Most of his time when not actively engaged in field work was spent in attending to the work of the Commission, and from June 20 to 29 he was again attending a meeting of the Commission in St. Louis.

RE-MARKING SPEED TRIAL COURSE. DELAWARE BAY. H. L. MARINDIN.

Upon the request of Messrs. Wm. Cramp & Sons, of Chester, Pa., the duty of re-marking the speed trial course for ships established off Delaware Breakwater during the previous year was assigned to Assistant Marindin. The range marks for this trial course had been destroyed by the contractors in completing the ends of the new breakwater. On August 23 he proceeded to Lewes, Del., after consultation with Messrs. Cramp & Sons, and the work of rebuilding and relocating the range marks was completed on September 10.

No. 60.



Speed trial course, Delaware Bay.

CAPE COD SPEED TRIAL COURSE. H. L. MARINDIN.

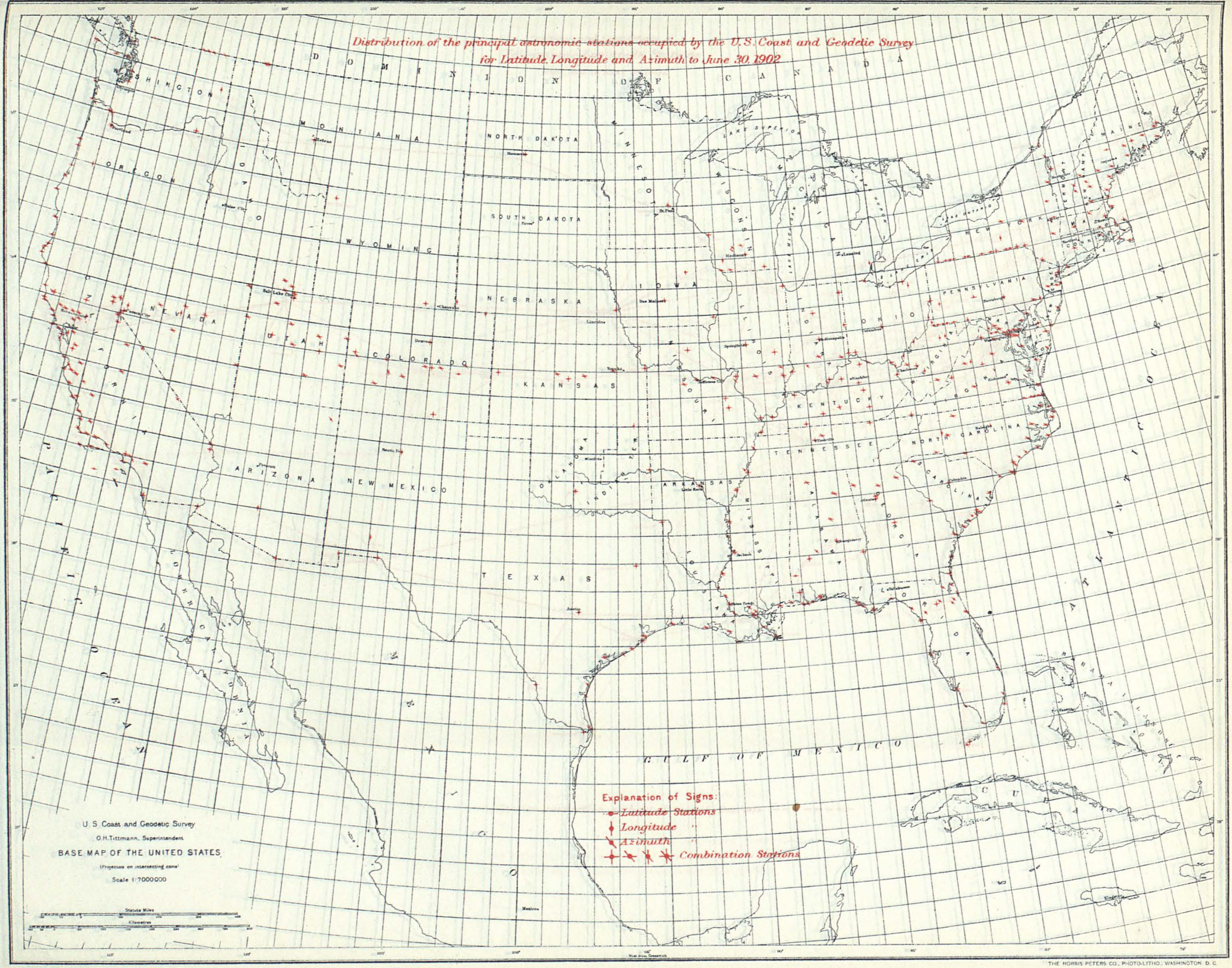
The request of the Fore River Ship Building Company, of Quincy, Mass., for an officer to verify the length of the speed trial course, established by them in the vicinity of Provincetown, Mass., resulted in the assignment of this duty to Assistant Marindin. This verification was necessary in order to satisfy the requirement of the Navy Department that all trial courses should be officially verified before being accepted for testing the speed of vessels built for the Navy. Assistant Marindin proceeded to Provincetown on June 13, and continued on the work until June 30, except between the dates June 20 to 29, when the work was suspended in order to enable him to attend a meeting of the Mississippi River Commission at St. Louis. The work was in progress at the close of the fiscal year.

PAN-AMERICAN EXPOSITION.

D. B. WAINWRIGHT.
WILLIAM EIMBECK.

On July 1 Assistant Wainwright was on duty at Buffalo, N. Y., in charge of the exhibit of the Coast and Geodetic Survey at the Pan-American Exposition. Numerous visitors examined the exhibit with great interest, and the plate-printing outfit, the tide model, and the chronograph, which were in regular operation, attracted particular attention. The chronograph was in electric circuit with the Western Union time service, and signals sent out daily at noon from the Naval Observatory at Washington were received and recorded. Leaflets printed in English and Spanish, describing the work of the Coast and Geodetic Survey, were presented to all who cared to have them, and there was an almost constant demand for verbal explanation of the instruments and apparatus.

Assistant Wainwright continued on duty in charge of the exhibit until September 1, when he was relieved by Assistant Eimbeck, who took charge on that day and remained in charge until the close of the exposition on November 2. He remained at Buffalo until November 6 engaged in preparing the exhibit for shipment, and then proceeded to Washington and reported to the Superintendent on November 8.



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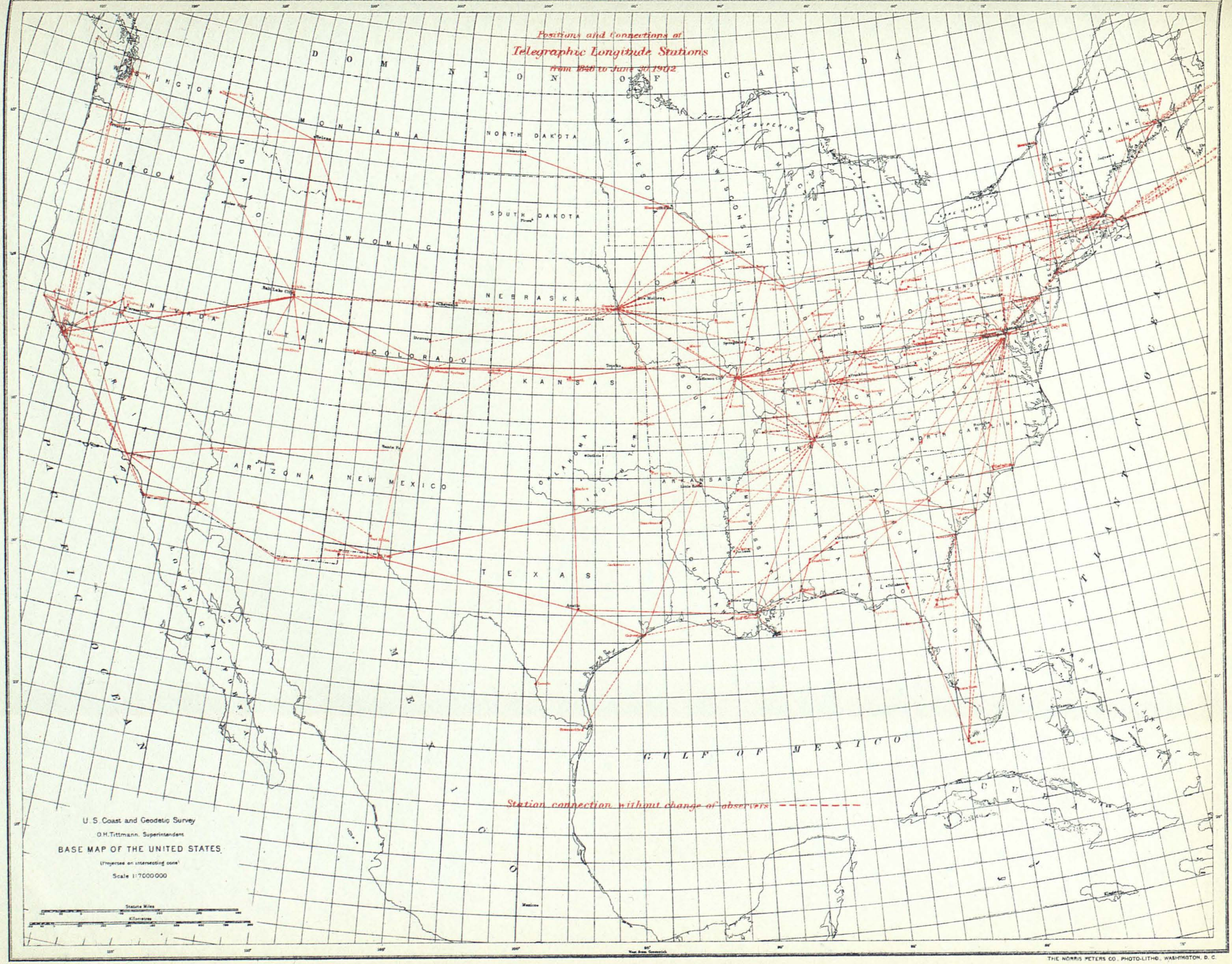
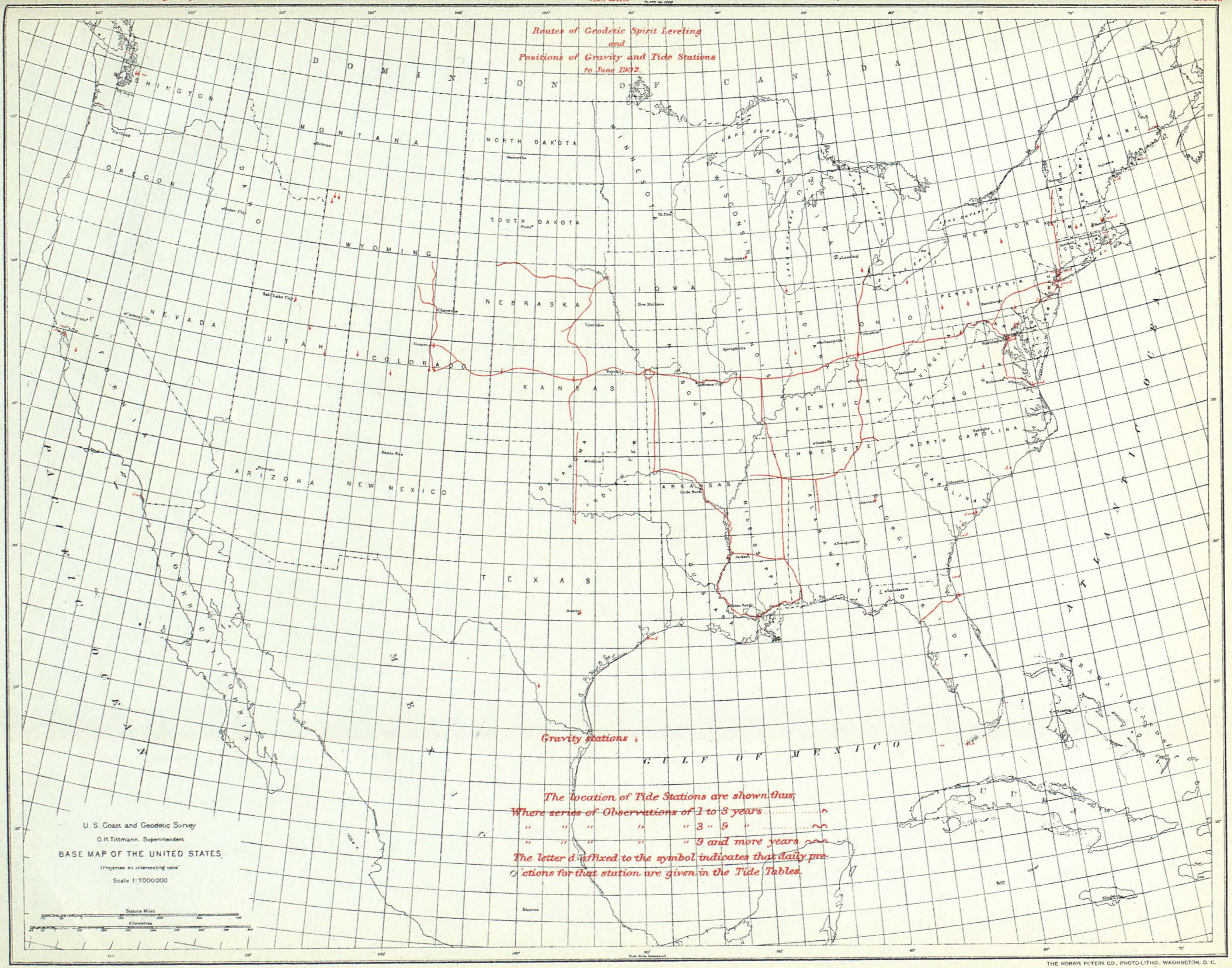
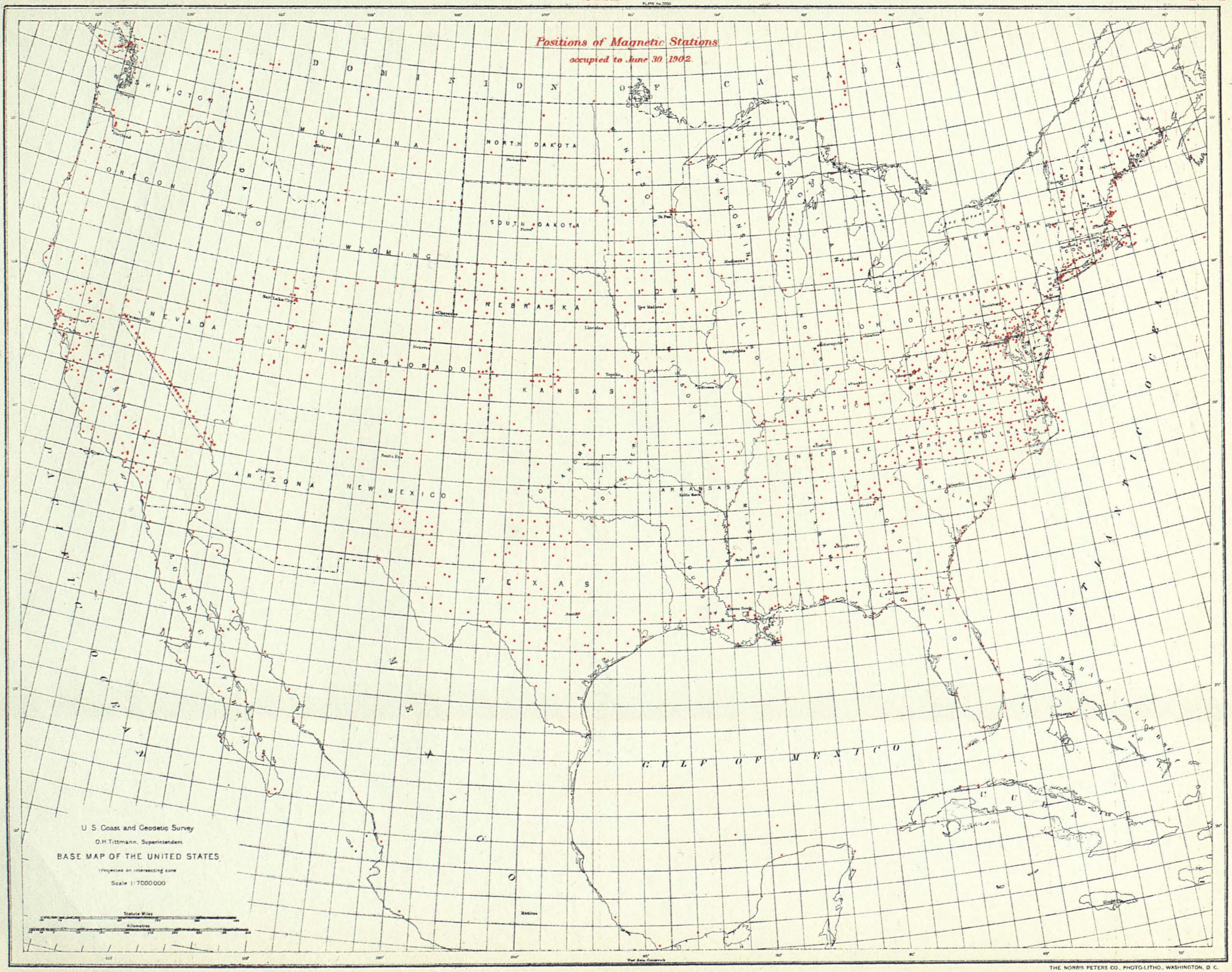

Positions and Connections of
Telegraphic Longitude Stations
from 1846 to June 30, 1902
DOMINION OF CANADA
WASHINGTON
MONTANA
NORTH DAKOTA
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
MINNESOTA
WISCONSIN
MICHIGAN
LAKE SUPERIOR
LAKE HURON
LAKE MICHIGAN
LAKE ONTARIO
NEW YORK
MAINE
PENNSYLVANIA
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
KENTUCKY
CALIFORNIA
ARIZONA
NEW MEXICO
OKLAHOMA
INDIAN TER.
ARKANSAS
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
LOUISIANA
TEXAS
LOWER CALIFORNIA
MEXICO
GULF OF MEXICO
ATLANTIC OCEAN
PACIFIC OCEAN
CUBA
BAHAMA ISLANDS
Station connection without change of observers
U.S. Coast and Geodetic Survey
O.H. Tittmann, Superintendent
BASE MAP OF THE UNITED STATES
(Projected on intersecting cone)
Scale 1:7000000
Statute Miles
Kilometres
West from Greenwich


Routes of Geodetic Spirit Leveling
and
Positions of Gravity and Tide Stations
to June 1902.
Gravity stations
The location of Tide Stations are shown thus;
Where series of Observations of 1 to 3 years
" " " " " 3 " 9 "
" " " " " 9 and more years
The letter d affixed to the symbol indicates that daily predictions for that station are given in the Tide Tables.
U. S. Coast and Geodetic Survey
O. H. Tittmann, Superintendent
BASE MAP OF THE UNITED STATES
(Projected on intersecting cone)
Scale 1:7000000
DOMINION OF CANADA
GULF OF MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
NEW MEXICO
COLORADO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
INDIAN TER.
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
CUBA
MEXICO



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

APPENDIX No. 2.

REPORT 1902.

DETAILS OF OFFICE OPERATIONS.

CONTENTS.

APPENDIX No. 2.

DETAILS OF OFFICE OPERATIONS.

OFFICE OF THE ASSISTANT IN CHARGE.

ANDREW BRAID, *Assistant in Charge.*

The Assistant in Charge of the Office has direct supervision of the work of the different divisions of the Office.

The following persons were employed under his immediate direction:

Name.	Occupation.
George A. Fairfield	Clerk.
A. B. Simons	Do.
E. B. Wills	Do.
Miss Kate Lawn	Writer.
TEMPORARY FORCE.	
C. F. De Woody	Writer (September 28 to April 30).
Miss Essie Chamberlain	Writer (May 1 to 30).
Mrs. B. J. De Sale	Writer (June 1 to 30).

The Miscellaneous Section became again a part of the immediate office of the Assistant in Charge on the 1st of March, 1902, and the manifold and arduous duties pertaining to it were performed as heretofore by Messrs. H. C. Allen and C. W. Jones. The details of the work in this section are given under the heading "Miscellaneous Section" in this Appendix. The duties of the other members of the personnel mentioned above were of the usual routine character.

COMPUTING DIVISION.

Personnel.

Name.	Occupation.
J. F. Hayford	Chief of Division.
E. H. Courtenay	Computer (July 1 to June 3).
M. H. Doolittle	Do.
A. L. Baldwin	Do.
Miss Lilian Pike	Do.
C. R. Duvall	Do.
W. H. Dennis	Do.
J. H. Millsaps	Writer.
TEMPORARY DETAILS FROM FIELD FORCE.	
A. T. Mosman	Assistant.
William Eimbeck	Do.
F. D. Granger	Do.
Edwin Smith	Do.
J. E. McGrath	Do.
John Nelson	Do.
O. W. Ferguson	Do.
W. I. Vinal	Do.
O. B. French	Do.
E. B. Latham	Do.
H. F. Flynn	Do.
William Bowie	Do.
B. E. Tilton	Aids.
W. H. Burger	Do.
W. C. Dibrell	Do.
O. M. Leland	Do.
F. H. Brundage	Do.
W. E. Parker	Do.
O. E. Carr	Do.
G. E. Selby	Do
J. K. Mills	Do
C. R. Sanderson	Do.
Jose Vano Reyes	Do.
Gilbert Young	Do.
F. B. Loren	Do.
E. L. Scott	Do.
E. R. Frisby	Computer.

The computation of the framework of the triangulation in southeastern Alaska, from the head of Lynn Canal to Port Simpson, and comprising about 1,600 points, on a uniform standard, was completed.

The computation of the primary triangulation along the ninety-eighth meridian from the thirty-ninth parallel northward to the Page Base in Nebraska, including vertical as well as horizontal measures, was completed.

The work of reducing the triangulation by the United States Lake Survey from western New York to the Olney Base in Illinois and along the Great Lakes and the St. Lawrence River to conformity with the triangulation by the Coast and Geodetic Survey already computed upon the United States Standard Datum, was begun in October and completed before the close of the fiscal year, but the preparation of the formal report upon the work and the preparation of the list of positions for publication remained to be done. This work fixed the position of about 1,700 points, which were added in this way to the register of geographic positions maintained by the Survey. The work was done by cooperation between the Lake Survey and the Coast and Geodetic Survey, regular members of the Computing Division doing the difficult work of making the more complicated adjustments and aiding in the preparation of the final lists, while computers from the Detroit office of the Lake Survey did the remainder of the work, the following persons being employed for the time stated: T. Russel, November 25 to June 30; A. D. Hollingsworth, December 19 to May 24, and W. R. Caldwell, January 2 to May 24.

During the year the manuscript of the following appendices to the Report for 1901 was prepared for publication:

Appendix 3. The measurement of nine base lines along the ninety-eighth meridian.

Appendix 4. Extension of tables for the computation of geodetic positions to the equator.

Appendix 5. Determination of the relative values of gravity in Europe and the United States.

Appendix 6. Triangulation northward along the ninety-eighth meridian in Kansas and Nebraska.

The routine work of furnishing information to parties in the field and to persons outside the Survey in response to requests was very heavy and still continues to increase, the demand for geodetic positions having been 30 per cent larger and for descriptions of stations 38 per cent larger than during the preceding year. The result of the temporary details from the field force brought the average effective force of the Division up to 11 besides the chief, and this average effective force varied from 4 in August to 17 in March. Mr. Baldwin acted as Chief of Division from January 27 to 30 and from March 25 to April 27, and his service during the year is highly commended by his Chief, who states that his intimate knowledge of both field and office methods and his good judgment, partly the result of his experience in the field, combined with his unusual ability and energy, made his services especially valuable. The other members of the Division received commendation, and their Chief states with pleasure and pride his belief that on the whole each member rendered zealous, efficient, and interested service throughout the year.

Mr. E. H. Courtenay, the senior computer, died on June 3, 1902, after forty years of valuable service. Mr. Courtenay's death is recorded under the heading "Report of the Superintendent."

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DIVISION OF TERRESTRIAL MAGNETISM.

Personnel.

Name.	Occupation.
L. A. Bauer	Chief of Division.
D. L. Hazard	Computer.
Miss J. E. Haslup	Writer.
TEMPORARILY DETAILED.	
F. M. Little	Assistant (Dec. 16–23 and June 2–30).
W. F. Wallis	Magnetic observer (July 1–17; July 29 to Aug. 16; Dec. 2–11; Jan. 2 to May 31; June 27–30).
W. Weinrich, jr	Magnetic observer (July 29 to Aug. 16; Oct. 28 to Dec. 20; Jan. 2–18).
R. W. Walker	Magnetic observer (July 1 to June 30, except Oct. 27 to Dec. 8).
J. W. Miller	Magnetic observer (July 1 to Oct. 1).
S. A. Deel	Magnetic observer (Mar. 22 to May 16; June 16–30).
G. V. Brown	Aid (June 12–24).
S. J. Barnett	Aid (June 19–30).

The revision of computation of declination, latitude, and longitude of magnetic stations occupied was kept up to date and as soon as the observatory monthly tabulations became available the observed declinations were corrected for diurnal variation.

New discussions of the secular change of declination were made at the repeat stations where observations were made during the year. From all the available analytical expressions, it was possible to determine the general distribution of the phases and amplitude of the secular motion in the United States, and hence to deduce a formula expressing the secular change in any desired locality. Such formulæ were deduced for one or more places in each State and Territory, and from them tables were derived giving the decennial values of declination and the present annual change. By means of these tables the observed values of declination in the Declination Tables were reduced to January 1, 1902. The computed values of annual change as well as those resulting directly from observations were plotted and lines of equal annual change drawn in the same manner as the lines on an isogonic chart.

In February a new chart showing the lines of equal magnetic declination and of equal annual change in the United States for January 1, 1902, was completed.

A volume of 400 pages under the title "United States Declination Tables and Isogonic Charts for 1902 and Principal Facts Relating to the Earth's Magnetism" was completed for publication. The descriptions of all magnetic stations occupied by the Coast and Geodetic Survey observers between 1881 and June 30, 1902, were included in the volume, thus bringing the publication of the descriptions of stations up to the date stated.

The observations made at the time of the solar eclipse of May 17–18 were discussed and a preliminary report was prepared. A number of magnetic instruments were compared and the constants of several others were determined and tabulated. Directions for keeping and transmitting the records of observations made at observatories and general directions for making magnetic observations in the field were prepared.

The routine work of the Division was nearly double that of the previous year.

TIDAL DIVISION.

Personnel.

Name.	Occupation.
L. P. Shidy	Chief of Division.
R. A. Harris	Computer.
J. C. Hoyt	Do.
Artemas Martin	Do.
Miss C. C. Barnum	Computer (Sept. 11 to June 30).
Miss A. G. Reville	Clerk.
Miss E. V. Campbell	Writer.
B. W. Bembry	Writer (Oct. 23 to June 30).
TEMPORARILY DETAILED.	
A. L. Rhoton	Computer (July 6 to Aug. 5).
C. A. Littlefield	Computer (Aug. 13 to Sept. 10).
Miss L. M. Handlan	Writer (Jan. 10 to June 30).
T. C. Bradley	Writer (Feb. 6 to June 30).
W. C. Shepard	Aid (June 25 to June 30).

Nonharmonic reductions were made for 93 stations, at most of which the observations were a month or less in extent, although 18 series were a year long. This work is equivalent to first reductions for about thirty-five years of continuous high and low water.

Harmonic analyses were completed for a year each of hourly ordinates at 3 stations, and also for 36 short series. This work, when the work in progress at the close of the fiscal year is included, is equivalent to the complete analysis of ten years of continuous record.

The plane of reference for the reduction of soundings was determined for 65 stations.

About twenty-four years of automatic tide-gauge record were tabulated as high and low waters, and also as hourly heights of the sea.

Tide notes were prepared for 215 stations upon 49 charts and 58 hydrographic sheets. Tidal information was furnished to the field parties and in response to requests from individuals not connected with the Survey, in 230 instances, involving the preparation of the description of 326 bench marks and tidal data for 862 stations.

Harmonic analysis was made for six months of automatic tide gauge record at Manila, P. I., and a manuscript copy of predicted tides for that port for the year 1902 was prepared for the use of the officer in charge of the suboffice at that place. Copies of the predicted tides for Wellington and Port Russell, New Zealand, with tidal differences and constants for 60 subordinate stations, were prepared and furnished in response to a request from the Secretary of the Marine Department of New Zealand.

The proof of Appendix No. 7, Report for 1900, "Outlines of Tidal Theory," was read by Mr. Harris, and he continued his studies of the various physical laws involved in the proper discussion and reduction of tidal observations.

The volume of Tide Tables for the year 1903 was prepared for printing, and the greater portion of the proof was read before June 30. In this volume full predictions for Wellington, New Zealand, were included for the first time.

There were received, examined, and registered an aggregate of about fifteen years of record from automatic tide gauges at 24 stations, together with about five years of record from box and staff gauges, consisting of 102 volumes of tide observations made by 24 hydrographic parties at 96 stations.

Of the above, automatic tide-gauge records covering one year were received from the station at Reedy Island, Delaware, maintained by the Philadelphia Maritime Exchange, two years' records from the United States engineers at Charleston, S. C., and the Navy Department loaned the Survey one year's record at the New London Naval Sation and one year's record at Olongapo, Subig Bay, P. I.

DRAWING AND ENGRAVING DIVISION.

Personnel.

Name.	Occupation.
W. W. Duffield	Chief of Division.
James M. Griffin	Clerk.
E. Meads	Writer.
Edwin H. Fowler	Chief Draftsman.
Harlow Bacon	Draftsman.
J. N. Baker	Do.
Chas. H. Deetz	Do.
F. C. Donn	Draftsman (absent Mar. 6 to June 12).
E. P. Ellis	Draftsman.
P. Von Erichson	Do.
C. M. Hahn	Do.
D. M. Hildreth	Do.
Jas. P. Keleher	Do.
A. Lindenkohl	Do.
H. Lindenkohl	Do.
J. W. McGuire	Do.
Chas. Mahon	Draftsman (July 1 to Jan. 8).
S. B. Maize	Draftsman.
E. J. Sommer	Do.
W. H. Davis	Engraver.
H. E. Franke	Do.
R. H. Ford	Engraver (July 1 to Apr. 1).
P. H. Geddes	Engraver.
F. Geoghegan	Do.
Geo. Hergesheimer	Do.
W. H. Holmes	Do.
H. M. Knight	Do.
Wm. Mackenzie	Do.
W. F. Peabody	Do.
A. H. Sefton	Do.
E. H. Sipe	Do.
H. L. Thompson	Do.
J. W. Thompson	Engraver (Aug. 20 to June 30).
W. A. Thompson	Engraver (July 1-22).
W. A. Van Doren	Engraver.
Theo. Wasserbach	Do.
F. G. Wurdemann	Do.
D. N. Hoover	Foreman of printing.
E. F. Campbell	Plate printer.
W. M. Conn	Plate printer (July 1 to Jan. 6).
R. J. Fondren	Plate printer.
Eberhard Fordan	Do.
C. J. Harlow	Do.
C. J. Locraft	Do.
C. W. Buckingham	Printer's helper (July 1 to Dec. 11).
R. V. H. Jama	Printer's helper (Jan. 25 to June 30).
E. J. Jordan	Printer's helper (Dec. 14 to Jan. 24).

DRAWING AND ENGRAVING DIVISION—Continued.

Personnel—Continued.

Name.	Occupation.
W. W. Kirby	Printer's helper (Jan. 16 to June 30).
E. M. Kline	Printer's helper.
R. F. Le Mat	Printer's helper (Nov. 19 to June 30).
W. B. Mehler	Printer's helper.
C. F. Blacklidge	Photographer and electrotyper.
L. P. Keyser	Assistant photographer.
Roy Thomas	Assistant electrotyper.
George Newman	Messenger.
Hans Bowdwin	Laborer (July 1 to Apr. 30).
C. W. Hawkins	Laborer (Apr. 28 to June 30).
H. Murray	Laborer.
Frank Thomas	Do.
S. B. Wallace	Laborer (Aug. 20 to Oct. 17).
A. A. Meredith	Extra laborer.

This Division is divided into five sections—the Drawing, the Engraving, the Printing, the Photographing, and the Electrotyping sections. Each section executed the work indicated by its title and the combined result is shown by the charts published and issued by the Survey.

During the year 311 requests for information were received and answered in the Division. The work involved the measurement of areas, shore-line, distances between various points, the preparation of tracings from original topographic and hydrographic sheets, copies of old and canceled charts, negatives, blue prints, and the construction of special maps.

DRAWING SECTION.

During the year the following drawings were completed for photolithographing or engraving:

Chart No.	Title.	Scale.
109	Boston Bay and Approaches	1-80 000
281	Hudson River, New York to Haverstraw	1-10 000
413	Pensacola Bay Entrance	1-10 000
904	Virgin Passage and Vieques Sound	1-100 000
920	Porto Rico	Mercator.
921	Fajardo Harbor and Approaches	1-10 000
922	Ensenada Honda, Porto Rico	1-10 000
927	Ponce Harbor, Porto Rico	1-20 000
928	Guayanilla Harbor, Porto Rico	1-10 000
929	Guanica Harbor, Porto Rico	1-10 000
1003	Cuba to Porto Rico	Mercator.
4714	Mindoro Island and Adjacent Coasts	Mercator.
6146	Columbia River, Vancouver to Reed Island	1-40 000
6377	Anacortes Harbor, Washington	1-40 000
6381	Roche Harbor, Washington	1-10 000
6445	Seattle Harbor, Washington	1-20 000
8502	Cape St. Elias to Shumagin Islands	Mercator.
8520	Prince William Sound	1-80 000
8521	Port Valdez, Alaska	1-40 000
8860	Unimak and Akutan Passes	Mercator.

Number of drawings finished for new charts 20
Number of drawings unfinished for new charts 10

In addition to the foregoing, 564 charts were revised (includes second and third revision of the same chart), corrected, and verified for new editions or new prints. Forty-eight hydrographic projections were constructed for the use of the field parties or in the Office. Two hundred and forty-four topographic and 269 hydrographic sheets were inked, lettered, plotted, revised, or made ready for approval and filing.

A large number of illustrations, including 68 sketches and 15 photographs, were prepared for publication in the Annual Report of the Superintendent for 1901, and 35 sketches were prepared for the Report for 1902.

The history sheets maintained in connection with all new charts, new editions, and corrections to charts provide a very valuable source of information, and it is comparatively easy to ascertain from them any desired information concerning the charts. The use of the standard alphabet with spacing device greatly facilitated the work of lettering. The plate of slanting Roman letters was completed.

A large portion of the title and notes for field sheets was transferred to them by the use of negatives from these sheets of letters, and a great saving in the expense of this item was effected.

In connection with the new charts of San Francisco Bay, the larger scale charts were completed first and the drawings were then reduced by photography to the scale required for the smaller scale charts, thus enabling the draftsmen to trace directly instead of drawing by the use of squares.

The publication of preliminary editions of charts was in many instances greatly facilitated and hastened by combination of drawings and engraved plates, the shore line, hydrography, and curves of equal depth being engraved, and the topography being put in place by photolithography. In connection with the new heliogravure process it was found desirable to make the drawing on a larger scale than that desired for the chart and make the necessary reduction by photography.

The personnel of the section showed steady improvement and interest in their work.

ENGRAVING SECTION.

The following original plates were completed:

Chart No.	Title.	Scale.
281	Hudson River, New York to Haverstraw	1-40 000
541	New York Harbor, Upper Bay and Narrows	1-10 000
6444	Port Orchard, Wash.	1-20 000

The following plates were corrected for new editions of charts:

Chart No.	Title.	Scale.
10	Cape Henry to Cape Lookout	1-400 000
111	Nantucket Sound and Eastern Approaches	1-80 000
112	Vineyard Sound and Buzzards Bay	1-80 000
120	New York Bay and Harbor	1-80 000
125	Cross Ledge to Penns Neck	1-80 000
126	Penns Neck to Philadelphia	1-80 000
139	Oregon Inlet to Cape Hatteras	1-80 000
145	Cape Hatteras to Ocracoke Inlet	1-80 000
155	Hunting Island to Ossabaw Island	1-80 000
156	Savannah to Sapelo Island	1-80 000
186	Choctawhatchee Inlet to Pensacola Entrance	1-80 000
187	Pensacola Bay to Mobile Bay	1-80 000
194	Mississippi River, Passes to Grand Prairie	1-80 000
250	Eastern Entrance to Nantucket Sound	1-40 000
325	Portland Harbor	1-20 000
347	Vineyard Haven	1-10 000
369	New York Bay and Harbor	1-40 000
379	Cape Henlopen and Delaware Breakwater	1-20 000
391	Potomac River, Indian Head to Georgetown	1-40 000
431	Charleston Harbor	1-30 000
440	Tybee Roads, Savannah River, and Wassaw Sound	1-40 000
445	Charleston and Vicinity	1-20 000
447	Brunswick Harbor and Turtle River	1-40 000
490	Entrance to Pensacola Bay	1-30 000
913	Great Harbor, Culebra Island, West Indies	1-6 500
921	Fajardo Harbor and Approaches	1-10 000
5500	Point Pinos to Bodega Head	1-200 000
5581	San Francisco Entrance	1-40 000
5600	San Francisco to Point Arena	1-200 000
6057	Yaquina River Entrance	1-20 000
6140	Columbia River, Entrance to Upper Astoria	1-40 000

The following miscellaneous plates were completed:

Plate No.

2713. Standard Notes.
2714. Standard Scales and Compass.
2715. Index Map, Seal, and Compass.
2734. Catalogue Plate, Porto Rico.
2735. Catalogue Plate, Philippine Islands.
2736. Catalogue Plate, Philippine Islands.

Recapitulation of work done in the engraving section:

Number of original plates commenced	8
Number of original plates completed	3
Number of original plates unfinished	15
Number of new editions commenced	21
Number of new editions completed	31
Number of new editions unfinished	19
Number of miscellaneous plates finished	6
Number of plates corrected for printing	959

During the year a large number of plates were required for new editions, and in nearly all instances new bassos were brought up from earlier altos which were not worn by use. This necessitated a large amount of work to bring the new basso up to date, but was necessary in order to keep the printing plates up to full strength.

The introduction, toward the close of the year, of a negative plate of the standard Roman alphabet, with spacing device, made it possible to transfer, by the use of wax, titles and general lettering to the copper plates much more rapidly than it is possible to construct each letter.

The Chief Engraver, Mr. W. A. Thompson, died on July 22, 1902, after a long and faithful service. A record of his service appears under the heading, "Report of the Superintendent."

PRINTING SECTION.

During the year the files of bond proofs from all the plates made by the Survey, except the four-plate map of the District of Columbia, were completed. Previous to the month of June charts were printed in sufficient numbers to supply the current demand promptly, but in June the number ordered by the Navy Department was unusually heavy, averaging 391 charts per day, and this, with the current demand for other purposes, exceeded the printing capacity of the Section.

Number of impressions made for Chart Section	57 868
Number of impressions made for proofs	4 365
Number of impressions made for standards	151
Number of impressions made for transfers (lithographers)	114
Number of impressions made for transfers (Drawing Section)	856
Number of impressions made on bond	5 609
Total number of impressions	68 963

Of the charts delivered to the Chart Section, 1,137, namely, Nos. 369, 380, and 381, required two impressions for each chart.

In addition to the number of charts printed in the Printing Section, the following charts have been published by photolithography and sent to the Chart Section for distribution:

NEW CHARTS.

Chart No.	Title.	Scale.
79	Chesapeake Bay	1–200 000
413	Pensacola Bay Entrance	1–10 000
904	Virgin Passage and Vieques Sound	1–100 000
920	Porto Rico	Mercator.
921	Fajardo Harbor and Approaches	1–10 000
922	Ensenada Honda, P. R	1–10 000
928	Guayanilla Harbor, P. R	1–10 000
6146	Columbia River, Vancouver to Reed Island	1–40 000
6381	Roche Harbor, Wash	1–10 000
6445	Seattle, Wash	1–20 000
8520	Prince William Sound, Alaska	1–80 000
8521	Port Valdes, Prince William Sound	1–40 000
8860	Unimak and Akutan Passes	Mercator.

NEW EDITIONS.

Chart No.	Title.	Scale.
T	General Chart of Alaska (edition of July, 1901)	1-3 600 000
T	General Chart of Alaska (edition of April, 1902)	1-3 600 000
376	Delaware and Chesapeake Bays	1-400 000
549	Baltimore Harbor	1-40 000
920	Porto Rico	Mercator.
4100	Hawaiian Islands	1-600 000
4231	Port of Manila, P. I	1-10 000
4241	Port Sual, P. I	1-10 000
4244	Balayan Anchorage, P. I	1-5 000
4246	San Fernando Harbor, P. I	1-15 000
4248	Port Santo Tomas, P. I	1-20 000
5984	Coos Bay, Oreg	1-20 000
6400	Sea Coast and Interior Waters of Washington	1-300 000
8050	Dixon Entrance to Cape St. Elias	1-600 000
8051	Port Canal, Alaska	1-100 000
8144	Sitka Harbor and Approaches	1-10 000
8500	Icy Cape to Semidi Islands	1-1 200 000
9100	Aleutian Islands, Alaska	1-1 200 000
9302	Bering Sea, Eastern Part	Mercator.
9370	Cape Romanzof to St. Michael	1-300 000

NEW PRINTS.

Chart No.	Title.	Scale.
244	Salem Harbor and Approaches	1-20 000
249	Buzzards Bay	1-40 000
258	Clinton Harbor and Approaches	1-10 000
259	Madison to Guilford	1-10 000
260	Guilford to Blackstone Rocks	1-10 000
261	Blackstone Rocks to South End	1-10 000
263	Oyster River Point to Milford	1-10 000
269	Stamford Harbor to Little Captain Island	1-10 000
270	Little Captain Island to Rye Neck	1-10 000
565	Passaic River	1-10 000
1000	Cape Sable to Cape Hatteras	Mercator.
1001	Chesapeake Bay to Straits of Florida	Mercator.
1002	Straits of Florida and Approaches	Mercator.
4242	Cagayan River Entrance, P. R	1-10 000
4243	Manila and Cavite Anchorages, P. I	1-30 000
4245	Port Currimao, P. I	1-5 000
4247	Darigayos Inlet, P. I	1-5 000
4249	Port Mariveles, P. I	1-5 000
4250	Albay Gulf, P. I	1-40 000
4441	Tacloban Harbor, P. I	1-20 000
4442	Port Romblon, P. I	1-15 000
4443	South Coast of Samar, P. I	1-102 400
4641	Murcielagos Bay, P. I	1-30 000
4642	Anchorages on North Coast of Mindanao	Varying.
4643	Port Jiminez, Iligan Bay, P. I	1-10 000
5002	San Diego to Point St. George	Mercator.
5052	San Francisco to Cape Flattery	Mercator.
5126	Harbor Charts of Santa Barbara Islands	Varying.
6400	Seacoast and Interior Waters of Washington	1-300 000
8218	Pybus Bay, Hobart and Windham Bays	1-40 000
8224	Gambier Bay	1-40 000
8228	Windfall Harbor and Mole Harbor	1-20 000
8281	Sitka Sound and Salisbury Sound	1-40 000
8995	Pribilof Islands	1-200 000

PHOTOGRAPHING SECTION.

Number of glass negatives made	335
Number of paper negatives made	86
Number of velox prints made	1,508
Number of vandyke prints made	353
Number of bromide prints made	114
Number of blue prints made	507
Number of negatives developed	142
Number of prints mounted	412

During the year the facilities in this section were largely increased. An experimental "Daniels Cell" was installed to be used in connection with the Austrian heliogravure process of reproducing negatives on copper plates, and one new plate was completed by Messrs. Blacklidge and Keyser. The plate was published with very little additional hand work, which included engraving one short note and the correction of a few minor defects. As a whole it proved successful, though the chart has more the appearance of a photolithograph than a print from an engraved plate, as the lines were all more or less broadened by the process. A process of transferring drawings to copper plates for engraving was perfected, using a tracing and printing on the copper with a hard purple ground, leaving the work clear and bare. Messrs. Blacklidge and Keyser deserve great credit for the development of this process of transfer.

A large number of original sheets and large scale drawings were reduced by photography for the use of the Drawing Section.

ELECTROTYPING SECTION.

Number of pounds of copper deposited	1,805
Number of square inches on which deposited	122,349
Number of alto plates made	49
Number of basso plates made	29

The demand for new alto and basso plates was supplied with difficulty on account of the condition of the plant.

Before the close of the fiscal year a new plant was ordered with greatly increased facilities and all modern improvements.

CHART DIVISION.

Personnel.

Name.	Occupation.
Gershom Bradford	Inspector of Charts and Chief of Division.
Miss L. A. Mapes	Chief of Chart Section.
W. C. Willenbucher	Draftsman.
J. T. Watkins	Draftsman (Jan. 23 to June 30).
E. H. Wyvill	Chart corrector.
H. R. Garland	Do.
J. B. Quinlan	Clerk.
A. B. Simons, jr	Buoy colorist.
Miss M. L. Handlan	Buoy colorist (July 1 to Jan. 9).
R. F. Le Mat	Buoy colorist (July 1 to Nov. 18).
H. J. Atwell	Buoy colorist (July 1 to Aug. 27).
Wm. A. Naghton	Buoy colorist (Sept. 25 to June 21).
A. P. Breeden	Buoy colorist (Feb. 6 to June 30).
Archie Upperman	Map mounter.
S. B. Wallace	Messenger (July 1 to Aug. 19).
J. H. Mason	Messenger (Aug. 20 to June 30).
TEMPORARILY DETAILED.	
P. B. Castles	Draftsman (July 1 to Jan. 24).
Vladimir Sournin	Draftsman (July 22 to Apr. 26).
Swepson Earle	Draftsman (Aug. 5 to Jan. 10).
J. A. McGregor	Draftsman (Oct. 28 to Dec. 6).
Wm. Sanger	Draftsman (Jan. 15 to Mar. 7).
Williams Welch	Draftsman (May 19 to June 30).

The Chief of Division supervised the work of the two sections into which the Division is divided, gave personal attention to the inspection of new charts and new editions of charts in their various stages of progress, and prepared a new edition of the chart catalogue for publication.

CHART SECTION.

In this Section all letters relating to the sale of charts and tide tables were prepared, the accounts with the sales agents were kept, the buoys on the charts were colored, and other routine work was done.

A few changes in the list agencies for the sale of charts were made and 5 additional agencies were established, bringing the total number in existence on June 30 up to 180.

Editions of 32 new charts, 31 printed by photolithography and one from copperplate, were issued during the year. Forty-eight new editions of charts, 34 printed from copperplate and 14 by photolithography, were also issued. Charts were received as follows:

From Drawing and Engraving Division	56,731
From lithographers	22,375
From Manila suboffice	755

The following table contains a list of charts which were prepared, published, and issued from the suboffice of the Survey at Manila, P. I., copies of which were received at the Washington Office during the year for issue:

Date of receipt.	Catalogue No.	Title.
Jan. 15	4214	Balayan Anchorage, Southwest Coast of Luzon.
	4246	San Fernando Harbor, West Coast of Luzon.
	4248	Port Santo Tomas, West Coast of Luzon.
Feb. 25	4242	Cagayan Entrance (March, 1901).
	4245	Port Currimao (July, 1901).
	4247	Darigayos Inlet (July, 1901).
	4441	Tacloban Harbor (October, 1901).
	4641	Murcielagos Bay (April, 1901).
	4642	Anchorages North Coast of Mindanao (September 1901).
Mar. 6	4249	Port Mariveles (December, 1901).
	4250	Albay Gulf (December, 1901).
Apr. 5	4643	Port Jimenez (January, 1902).
	4443	South Coast of Samar (January, 1902).
	4442	Port Romblon (January, 1902).
	4243	Manila and Cavite Anchorages (December, 1901).
June 2	4251	Port Bolinao (February, 1902).
	4252	Santa Cruz Harbor (March, 1902).

Charts were issued as follows:

Sales agents	35, 555
Sales by Office and Chart Section	1, 234
Congressional account	2, 621
Hydrographic Office, U. S. Navy	19, 211
Light-House Board	3, 035
Coast and Geodetic Survey Office	6, 904
Coast and Geodetic Survey suboffice, Manila	526
Executive Departments	4, 228
Foreign governments	336
Libraries	20
Miscellaneous	473
Total	74, 143

A comparison of the total issue of charts for the fiscal year with the issue in previous years, except for the years 1898 and 1899, when the issue for governmental purposes was abnormal, shows the total to be much larger than that of any other year and 30 per cent larger than the average annual issue. The above statement does not include the charts published and issued at the Suboffice in Manila, except those sent to Washington for distribution.

HYDROGRAPHIC SECTION.

The work of indicating the chart corrections and preparing the monthly Notices to Mariners was performed with marked ability by Mr. Wyvill. Mr. Willenbucher was employed in plotting and verifying field sheets, in the revision and verification of proofs, charts, and drawings, and on other miscellaneous work, which included the supervision of the work of various draftsmen temporarily detailed to duty in the Division.

When his health failed toward the close of the year his duties were performed by Mr. Watkins.

Statistics of work.

Original sheets prepared (plotted and drawn)	15
Volumes of field records plotted	112
Soundings plotted	172, 185
Miles of sounding lines plotted	19, 789
Sheets verified	17
Volumes of field records verified	82
Soundings verified	102, 299
Miles of sounding lines verified	3, 391
Angles, protraction verified	37, 154
Selections of hydrography verified	53
Proofs overhauled	198
Miscellaneous drawings and tracings prepared (relating to various information desired)	31

INSTRUMENT DIVISION.

Personnel.

Name.	Occupation.
E. G. Fischer	Chief of Division.
W. C. Maupin	Clerk.
Otto Storm	Instrument maker.
C. Jacomini	Do.
W. R. Whitman	Do.
M. Lauxman	Do.
J. A. Clark	Instrument maker (July 1 to Sept. 27).
C. F. Zimmisch	Instrument maker (Oct. 14 to Jan. 3).
H. G. Fischer	Instrument maker (Mar. 8 to June 30).
H. O. French	Carpenter.
G. W. Clarvoe	Do.
C. N. Darnall	Do.
Jere Hawkins	Messenger.

The energy of the Instrument Division during the year was largely devoted to repairing the numerous instruments in use by the field parties of the survey. During the year 1 209 instruments were cleaned, adjusted, and sent to the field. Work on new instruments was done whenever more pressing duties permitted, and progress was made on the construction of 12 new plane table alidades. Thirty-six acetylene signal lamps were constructed for use in triangulation. Twenty-four of these were tested by use in the field, and served the purpose for which they were constructed most admirably. Extensive changes and additions to meridian telescope No. 7, for use in the Philippines, were completed. A new leveling instrument similar to those described in Appendix 6, Report for 1900, was constructed.

Apparatus was designed and constructed for the purpose of adapting the time sending and recording instrument used in telegraphic longitude work to the instruments used in the Marconi system of wireless telegraphy, and satisfactory signals were obtained in experimental work between Nantucket Island and Nantucket light-ship and also off the coast of Long Island, New York. Mr. Fischer took part in the experiments off Long Island. Apparatus was designed and constructed to facilitate and increase the accuracy of reading the photographic traces made in magnetic observatories by the self-recording instruments. The usual routine work of the Division, such as accounting for the property of the Survey for field use, repairs to office buildings and furniture, packing instruments for shipment, etc., was kept up to date.

It is gratifying to state that apparatus and instruments designed and made by the Survey for its own use continue to meet with the approval of scientists abroad, as shown by orders to American firms to construct similar instruments from the models furnished by the Survey and under the inspection of its officers. During the year a half-second pendulum, a leveling instrument, a 5-meter iced bar, and a base tape apparatus were constructed as stated for the chief astronomer of the Dominion of Canada, under the supervision of Mr. Fischer. He also inspected several astronomical instruments constructed for the National Observatory of Mexico for final acceptance before shipment to Mexico.

He was appointed a member of the jury of awards on machinery at the Pan-American Exposition, and served in that capacity during his vacation.

W. R. Whitman was detailed for duty under the National Bureau of Standards during the whole year.

Mr. Fischer reports that the employees in the Division showed a commendable zeal and conscientious interest in the performance of their various duties.

LIBRARY AND ARCHIVES.

Personnel.

Name.	Occupation.
Edw. L. Burchard	Librarian.
J. H. Smoot	Clerk (July 1–8).
A. F. Zust	Writer.
E. K. Foltz	Do.
Mrs. M. A. Grant	Do.
T. S. Mallon	Writer (Nov. 14 to Feb. 24).
J. G. Maupin	Writer (Mar. 1 to June 30).

A working cooperation was effected with the Library of Congress, the card catalogue was revised and enlarged, and undesired literature was eliminated by transfer to the Library of Congress and to other bureaus of the Government.

The indexing of all the magnetic triangulation and hypsometric records and computations involving the preparation of about 12 000 index entries was completed.

These entries have been sorted and filed in two indexes, one of localities showing where the work was done, and the other of subjects, showing the records and computations in each class of work. The indexes are provided with numerous cross references from larger to smaller divisions and to variations in names. The set of British Admiralty Charts was arranged according to the new British Admiralty numbers, which assembles them in correct geographical order, as shown in the chart index. The series of miscellaneous maps covering the United States were listed in a map register showing the size and scale. A valuable set of military maps was received from the Imperial Austrian Geographic Institute.

The preparation of a complete list and catalogue of the publications prepared and issued by the Survey was undertaken and about three-fourths of the work was completed.

Numerous requests for information were answered and the routine work of the library was kept up to date.

Some of the rooms for filing the archives were assigned to the use of the National Bureau of Standards, and the removal and rearrangement of the records involved the use of a great deal of the time of a portion of the library force.

More than three thousand "Standard" charts showing manuscript corrections were received and filed. A large number of tracings of original hydrographic and topographic sheets were transferred to the library during the year, and all of these were registered and placed on file.

ACCESSIONS.

Items.	Purchased.	Donated.	Exchanged.	Total.
Books	126	10	156	292
Pamphlets	26	238	217	481
Serials	206	91	655	952
Maps and charts	272	26	1 400	1 698

ISSUED FOR TEMPORARY USE.

Books and pamphlets	1 559
Serials	477
Records	2 352
Original sheets	3 590
Charts	1 185

The following list shows the original records received.

Subject.	Volumes.	Cahiers.	Sheets.
Astronomy	28	44	
Geodesy	192	116	
Gravity	1		
Hypsometry	110	8	
Hydrography	314		49
Magnetism		389	
Tides	111	407	160
Topography		79	60
Total	746	1 043	269
Photographs:			
Prints	505		
Negatives	161		

MISCELLANEOUS SECTION.

Name.	Occupation
H. C. Allen	Chief of Section.
C. W. Jones	Clerk.
Thomas McGoines	Messenger.

The Miscellaneous Division was continued until February 28, 1902, with Mr. Scott Nesbitt, disbursing agent, acting as Chief of Division, and on March 1 the designation was changed as indicated in the heading, and since that date it has been under the immediate supervision of the Assistant in Charge as a section of his office.

The Section has charge of the purchase and distribution of the supplies required for use in the Office and of such supplies as are furnished to the field parties on requisition. The requisitions for printing and binding all originate in this section, and it receives and distributes all the publications of the Survey except charts.

The following publications were received from the Public Printer:

Report of the Superintendent of the Coast and Geodetic Survey, showing the progress of the work from July 1, 1899, to June 30, 1900	1 990
Report of the Superintendent of the Coast and Geodetic Survey, showing the progress of the work from July 1, 1900, to June 30, 1901	2 003
Special Publication No. 7. Geodesy. The Eastern Oblique Arc of the United States and Osculating Spheroid	3 025
Geodesy. Oblique Boundary Line Between California and Nevada, by C. H. Sinclair, Assistant; Appendix No. 3, Report for 1900	300
Drawing. Proportions and spacing of Roman letters, as ascertained from the best examples, by Williams Welch, Draftsman; Appendix No. 4, Report for 1900	300
Geodesy. The international latitude service at Gaithersburg, Md., and Ukiah, Cal., under the auspices of the International Geodetic Association, by Edwin Smith, Assistant, Coast and Geodetic Survey, and Mr. F. Schlesinger, Special Observer; Appendix No. 5, Report for 1900	100
Hypsometry. Description of Precise Levels Nos. 7 and 8, Coast and Geodetic Survey, 1900, by E. G. Fischer, Chief of Instrument Division, Coast and Geodetic Survey; Appendix No. 6, Report for 1900	100
Physical Hydrography. Manual of Tides. Part IV A. Outlines of Tidal Theory, by Rollin A. Harris; Appendix No. 7, Report for 1900	300
Geodesy. The Determination of the Mean Value of a Micrometer Screw, by Edwin Smith, Assistant, Coast and Geodetic Survey; Appendix No. 8, Report for 1900	100
Geodesy. On the measurement of nine base lines along the ninety-eighth meridian, by A. L. Baldwin, Computer and Chief of Party; with preface by John F. Hayford, Assistant, Inspector of Geodetic Work and Chief of Computing Division; Appendix No. 3, Report for 1901	400
Geodesy. Extension of tables for the computation of Geodetic positions to the equator, by John F. Hayford, Assistant, Inspector of Geodetic Work and Chief of Computing Division; Appendix No. 4, Report for 1901	600
Gravity. Determination of relative value of gravity in Europe and the United States in 1900, by G. R. Putnam, Assistant; Appendix No. 5, Report for 1901	200
Geodesy. Triangulation northward along the ninety-eighth meridian in Kansas and Nebraska, by John F. Hayford, Assistant, Inspector of Geodetic Work and Chief of Computing Division; Appendix No. 6, Report for 1901	400

United States Coast Pilot, Pacific Coast, Alaska, Part I, from Dixon Entrance to Yakutat Bay, with Inland Passage from Juan de Fuca Strait to Dixon Entrance. Fourth edition	1 000
Bulletin No. 40, fourth edition—with additions and changes. Alaska. Coast Pilot notes on the Fox Islands Passes, Unalaska Bay, Bering Sea, and Arctic Ocean as far as Point Barrow	1 020
Notice to Mariners, Nos. 273 to 278, inclusive, June to November, 1901, 4 700 each	28 200
Notice to Mariners, Nos. 279 to 285, inclusive, December, 1901, to May, 1902, including one Index (Notice to Mariner No. 280), 4 500 each	31 500
Descriptive leaflets of the United States Coast and Geodetic Survey, its general plan of operations, methods, and results:	
10 000 each of 14 leaflets, English edition	140 000
5 000 each of 4 leaflets, English edition	20 000
2 000 each of 13 leaflets, Spanish edition	26 000

The following publications were received from the House of Representatives:

Report of the Superintendent of the Coast and Geodetic Survey, showing the progress of the work from July 1, 1899, to June 30, 1900 (paper bound)	212
Report of the Superintendent of the Coast and Geodetic Survey, showing the progress of the work from July 1, 1900, to June 30, 1901 (paper bound)	264

The following publications were issued:

Annual Reports (covering the years 1851 to 1901):		
Domestic distribution—		
Individuals	1 041	
Institutions	872	
Foreign distribution—		
Individuals	262	
Institutions	115	
		2 290
Appendices to Annual Reports		2 306
Bulletins		1 464
Tide Tables, Complete, one each for 1890, 1891, 1892, 1893, 1894, 1895, 1898, 1899, 1900		9
Tide Tables, Complete, one each for 1898, 1899, 1900		3
Tide Tables, Complete, 1901		21
Tide Tables, Pacific Coast, 1901		495
Tide Tables, Atlantic Coast, 1901		41
Tide Tables, Complete, 1902		1 119
Tide Tables, Pacific Coast, 1902		6 407
Tide Tables, Atlantic Coast, 1902		719
United States Coast Pilot, Atlantic Coast, Parts I-II		24
United States Coast Pilot, Atlantic Coast, Part III		29
United States Coast Pilot, Atlantic Coast, Part IV		321
United States Coast Pilot, Atlantic Coast, Part V		206
United States Coast Pilot, Atlantic Coast, Part VI		1
United States Coast Pilot, Atlantic Coast, Part VII		199
United States Coast Pilot, Atlantic Coast, Part VIII		221
Pacific Coast Pilot, California, Oregon, and Washington		71
United States Coast Pilot, Pacific Coast, Alaska, Part I		324
Supplement to United States Coast Pilot, Atlantic Coast, Parts I-II, III, VI, VIII, February, 1900		80
Supplement to First Edition United States Coast Pilot, Atlantic Coast, Parts I-II, February 12, 1900		44

Supplement to First Edition United States Coast Pilot, Atlantic Coast, Part III, September 22, 1899	54
Supplement to the reprint of Second Edition United States Coast Pilot, Atlantic Coast, Part V, December 19, 1900	255
Supplement to First Edition United States Coast Pilot, Atlantic Coast, Part VI, February 13, 1900	20
Supplement to Third Edition Pacific Coast Pilot, Alaska, Part I, March 15, 1898.	2
Pacific Coast Pilot, Alaska, Part I, one copy each of editions of 1869, 1883, 1891.	3
Catalogue of Charts, Coast Pilots, and Tide Tables	1 117
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Descriptive leaflets of the United States Coast and Geodetic Survey, its general plan of operations, methods, and results; 14 leaflets of English edition and 13 of Spanish edition. Printed for distribution at the Pan-American Exposition at Buffalo, N. Y., and at the West Indian Exposition at Charleston, S. C.	

APPENDIX No. 3.

REPORT 1902.

TRIANGULATION IN KANSAS.

BY

JOHN F. HAYFORD,
Inspector of Geodetic Work,
Assistant, Coast and Geodetic Survey.

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ILLUSTRATIONS.

TRIANGULATION IN KANSAS.

By JOHN F. HAYFORD, *Inspector of Geodetic Work; Assistant, Coast and Geodetic Survey.*

GENERAL STATEMENT.

The primary purpose of this appendix is to bring together in convenient form for the use of engineers, information in regard to all the triangulation by the Coast and Geodetic Survey in the State of Kansas. There is also included herein a full report on one additional section of the ninety-eighth meridian triangulation, two sections between bases having already been published in Appendix 6 of the Report for 1901, entitled, "Triangulation Northward Along the Ninety-Eighth Meridian in Kansas and Nebraska." The occasion for the publication of this appendix now is the completion to the Kansas-Oklahoma line in the summer of 1902 of the ninety-eighth meridian triangulation southward from the thirty-ninth parallel. It contains some matter which is a repetition of what has already been published and which is repeated here for the sake of completeness. The engineer upon his working ground, intent only upon finding the necessary information to enable him to extend this triangulation or to base other surveys upon it, need consult only the latter part of this appendix, commencing with the explanation of the positions, lengths, and azimuths. The earlier portions set forth briefly the history of the work, the details of office and field methods, and the degree of accuracy secured in each part of the work.

The transcontinental triangulation, extending from the Atlantic to the Pacific along the thirty-ninth parallel, and the ninety-eighth meridian triangulation both cross Kansas and pass through its central portion. These two triangulations are to form the main framework for the control of all triangulation in the United States.

The portion of the transcontinental triangulation within the limits of the State of Kansas was commenced in 1885 and finished in 1896, having been in progress during this whole interval except during 1886, 1894, and 1895. A full account of the transcontinental triangulation has been published, in so far as the features of special interest to the scientists are concerned.* Only the positions for the primary stations were there published, and but few descriptions of stations. The positions of all these stations, primary, secondary, and tertiary, are published herein on the United States Standard Datum, together with all available descriptions.

The portion of the ninety-eighth meridian triangulation which lies in Kansas and to the northward of the transcontinental triangulation was executed in 1897 and 1898, and an account of it has been published, together with that portion of the transcontinental

* See The Transcontinental Triangulation (Special Publication No. 4).

triangulation, which also forms a part of the ninety-eighth meridian triangulation, in Appendix 6 of 1901, already referred to above. The positions, descriptions, and elevations of stations in this triangulation are here reproduced for the sake of completeness.

The portion of the ninety-eighth meridian triangulation which lies in Kansas and to the southward of the transcontinental triangulation was executed during the years 1899–1902, and now appears in print for the first time. This work was completed in 1902 by the occupation of three stations near the Kansas-Oklahoma line, which served to finish the connection with the Anthony base. The party which occupied these three stations continued the ninety-eighth meridian triangulation more than 400 miles, or 6 degrees of latitude, farther south to the Lampasas Base in Texas, during the season of 1902. This triangulation to the southward of the Kansas-Oklahoma line not being ready for publication at this time will be presented in a later report.

The reconnaissance from the thirty-ninth parallel triangulation southward to stations Arlington and Sunflower was made by Assistant William Eimbeck in the summer of 1899. At those stations it joined the reconnaissance carried northward from the vicinity of El Reno, Okla., by Assistant Stehman Forney during the same season.

Many different members of the Computing Division have taken part in the preparation of this appendix. Special acknowledgment seems proper for the services of Mr. M. H. Doolittle, who made the least square adjustment of the primary triangulation along the ninety-eighth meridian in Kansas, and to Mr. A. L. Baldwin, who has supervised the minor computations and the compilation of the results.

THE METHODS AND INSTRUMENTS USED IN THE MEASUREMENT OF HORIZONTAL ANGLES.

All of the angle measures were made by the direction method. Each series of observations consists of successive pointings on the various stations in order, from left to right, with corresponding readings of the horizontal circle with three micrometer microscopes followed immediately by pointings on the same stations in the reverse order after reversing the position of the telescope by transiting it through the wyes and turning the alidade 180° in azimuth, each pivot remaining in contact with the same wye as before. Each observation of an angle consists, therefore, of two pointings on each station involved, one in each position of the telescope, together with the corresponding micrometer readings, 24 in all, both a forward and a backward reading of each micrometer being made in each of its positions.

At each station along the transcontinental triangulation from the Kansas-Missouri state line as far westward as the stations Big Creek and Schmidt, except at the four stations mentioned below in the Salina base net, the observations were taken by Assistant F. D. Granger, assisted occasionally by a second observer, during the years 1885 and 1886–93. Theodolite No. 10 was used in seventeen positions and two series of observations were taken in each position, making the total number of measures of each angle 34. The horizontal circle of this theodolite is 35 centimeters in diameter and carries a 10′ graduation read directly by three micrometer microscopes to single seconds. The telescope has a clear aperture of 5.4 centimeters (2⅛ inches), a focal length of 61.6 centimeters (24¼ inches), and a magnifying power of 36. As a rule the observations were made during the afternoon hours of every favorable day. The signals employed were poles 20 feet long and 4 inches in diameter, heliotropes being rarely used except on the long lines during smoky weather. The theodolite was elevated at nearly every station east of the Salina Base, the average height above the ground being about 8 meters (26 feet). At a number of stations its elevation was approximately 17 meters (56 feet). At one station, Hughes, the elevation of the instrument was approximately 32 meters (105 feet). At a number of stations west of the Salina Base the telescope was used at the ordinary height of the eye.

At the four stations, Iron Mound, North Pole Mound, Salina East Base, and Salina West Base, the observations were made by Assistant F. D. Granger in 1896, using theodolite No. 118 in seventeen positions, two series of observations being taken in each position, or thirty-four measures in all. The horizontal circle of this theodolite is 30^{cm} in diameter, is graduated to 5′ spaces, and is read directly to single seconds by three micrometer microscopes. The telescope has a clear aperture of 6^{cm}, a focal length of 58^{cm}, and a magnifying power of 35. The height of instrument above ground at these stations varied from 2 to 11 meters.

At the stations westward from Big Creek–Schmidt to the Colorado state line the observations were made by Assistant F. W. Perkins and W. B. Fairfield, observer, in 1891 and 1892. Assistant Perkins used Gambey repeating theodolite No. 16, having a horizontal circle 30^{cm} (12 inches) in diameter. The focal length of the telescope was 75^{cm} (30 inches) and the clear aperture of the objective was 5.3^{cm} (2⅛ inches). The horizontal circle is graduated to 5′ and is read by two verniers to three seconds. The numbering of the graduation on the horizontal circle increases from right to left. Mr. Fairfield used Gambey repeating theodolite No. 74, having a horizontal circle 25^{cm} (10 inches) in diameter, graduated from right to left and read by two verniers to five seconds. The focal length of the telescope was 38^{cm} (15 inches) and the aperture of the objective 38^{mm} (1½ inches). Each measurement of an angle consisted of six repetitions, three direct and three reversed, on the angle, these being followed immediately by three direct and three reversed on the explement in order to eliminate in part at least the effect of drag or overrun in the clamp. Usually, three or four such measurements were made of each primary angle.

The measurements of angles on the portion of the ninety-eighth meridian triangulation north of the transcontinental triangulation to the Kansas-Nebraska border were made in 1897–98 by Assistant F. D. Granger, with theodolite No. 118, described above. During 1897, commencing at station Waldo and ending at station Lebanon, the theodolite was used in eleven positions and two series of observations were taken in each position, or twenty-two measures in all, and the instrument was less than 6 meters (20 feet) above the ground at each station. During the season of 1898, commencing with station Brown, the theodolite was used in thirteen positions, two series being taken in each position, or twenty-six measures in all. At the stations Brown and Cooper the instrument was about 21 meters above the ground.

On the triangulation southward from the thirty-ninth parallel the stations Bossing, Sherman, and Loder were occupied by Assistant William Eimbeck in 1899, using theodolite No. 145* in twenty-four positions, one measurement being made in each

* For a full description of this instrument see Appendix 8 of the Report for 1894, Notes on Some Instruments Recently Made by the Instrument Division of the Coast and Geodetic Survey.

position. Theodolite No. 145 carries a horizontal circle 30^{cm} (12 inches) in diameter graduated to 5′ spaces and read directly by three micrometer microscopes to single seconds. The clear aperture of the telescope is 61^{mm} (2.4 inches) and its focal length 74^{cm} (29 inches).

The stations on the southward extension of the ninety-eighth meridian triangulation, commencing with the three stations, Iron Mound, Heath, and Wilson, on the southern border of the thirty-ninth parallel triangulation and extending southward to the stations Little River and Chase, were occupied by Assistant A. T. Mosman with theodolite No. 167 in 1900, with the exception of the three stations referred to in the preceding paragraph. In 1901, Assistant Mosman occupied the remaining stations southward to the Anthony base net, ending with Rutherford and the two ends of the base. Only eight positions, one-half the usual number, were observed, however, at Anthony Southeast Base.

During the season of 1902, Assistants William Bowie and O. W. Ferguson occupied the stations Anthony Southeast Base, Miller, and Fowler, using theodolites Nos. 167 and 168.

Theodolites Nos. 167 and 168, used by Assistants Mosman, Bowie, and Ferguson, are similar to theodolite No. 145 described above. The approximate height at which the instrument was supported at each station is shown in the table under the heading, "Programme of occupation of stations," which follows. It is important to note, however, that the superstructure which carried the heliotropes was much higher than the instrument in two cases, viz, at Arlington about 31.4 meters (104 feet), and at Kingman 36.6 meters (120 feet) while at each of these stations the instrument was less than 21 meters (69 feet) above the ground. Commencing with the season of 1900 only sixteen positions of the circle were used and one observation taken in each position. In 1900 the observations were made on both heliotropes and poles, and in 1901 mainly upon heliotropes. In 1902 observations were taken in the afternoon upon heliotropes and at night upon acetylene lights. Commencing with 1901 the observer took more chances, so to speak, of error by observing upon heliotropes of which the images appeared larger and more tremulous than were formerly considered safe to observe upon. The parties in 1901 also took similar chances. The exhibit of the accuracy of the work given later will indicate whether the accuracy of the observations is thereby appreciably reduced.

During the seasons of 1900, 1901, and 1902 the observers were acting under the following instructions:

In making the measurements of horizontal directions, you will measure each direction in the primary scheme sixteen times, a direct and a reverse reading being considered one measurement, and sixteen positions of the circle are to be used, corresponding approximately to the following readings upon the initial signal:

Position.	Reading on initial.			Position.	Reading on initial.		
	°	′	″		°	′	″
No. 1	0	00	40	No. 9	128	00	40
2	15	01	50	10	143	01	50
3	30	03	10	11	158	03	10
4	45	04	20	12	173	04	20
5	64	00	40	13	192	00	40
6	79	01	50	14	207	01	50
7	94	03	10	15	222	03	10
8	109	04	20	16	237	04	20

When a broken series is observed the missing signals are to be observed later in connection with the chosen initial, or with some other one, and only one, of the stations already observed in that series. In selecting the conditions under which to observe, you should proceed upon the assumption that the maximum speed consistent with the requirement that the closing error of a triangle in the primary scheme shall seldom exceed three seconds, and that the average closing error shall be but little greater than one second, is what is desired rather than a greater accuracy than that indicated.

In regard to the positions specified in these instructions, it is important to note three points:

1. In each of the four groups of four positions each, the readings of the three microscopes on the circle corresponding to pointings on the initial station will be nearly uniformly spaced at intervals of approximately 15° over the whole 360°, and therefore the mean values of the angles from each group of four positions will be but little affected by periodic errors of graduation. In connection with this statement it is necessary to keep in mind that, during each measure, the alidade is turned 180° between the direct and reverse readings when the position of the telescope is changed, and therefore the three microscopes which are at intervals of 120° furnish readings at nearly uniform intervals of 60° during each measure.

2. In each group of four positions the micrometer readings corresponding to the initial station, and therefore those corresponding to each station, are nearly uniformly distributed over the 5′ interval covered by the micrometer. The effect of this is to insure that if a correction for run is applied, the algebraic sum of such corrections for each micrometer corresponding to pointings on each station will be nearly zero. In other words, the mean value of any angle from observations in four positions uncorrected for run is almost independent of the run. An examination in detail of the observations at two or three stations showed that it was entirely unnecessary to apply any correction for run to observations made under these instructions, and considerable time was thereby saved in making the computation.

3. No microscope ever returns for pointings on a given station to any position on the circle which it has formerly occupied. When the observations in sixteen positions have been completed, the circle has been read at ninety-six points, scattered at intervals of three or four degrees over the whole circumference for each station observed. This insures that the mean value of each angle from sixteen positions is still more completely freed from the effect of periodic errors than are the means from the separate groups of four positions each.

The preceding statements apply to observations at the primary stations only. In determining points by intersections from primary stations, these points being for convenience called tertiary stations, the observations were usually taken in from one to three positions of the instrument, though there were occasionally wide variations from this standard.

PROGRAMME OF OCCUPATION OF STATIONS.

In the following table the stations occupied on the southward extension of the ninety-eighth meridian triangulation are arranged in the order in which they were occupied. The second column indicates the days on which observations on primary stations were taken, the third column the number of such days, and the fourth column gives the approximate height of the instrument above the ground. In general, the pole, heliotrope, or light observed upon was but little, if any, higher than the instrument. The two most extraordinary exceptions to this rule have already been mentioned, namely, at Arlington and Kingman. The average height of the signals must be considered in connection with the rate of progress of a triangulation, both because the work may be delayed in waiting for the building of signals, and because there is likely to be more delay on account of wind when observing from a high signal than when observing from a low one.

Station.	Days on which observations of primary horizontal angles were made.	Number of days.	Height of instrument above ground.
			Meters.
Bossing	1899 August 9, 11–13, 19–24, 27–29, September 2–8, 10–12.	23	12
Sherman	1899 September 22–23, 26, 28–29, October 3–8.	11	13
Loder	1899 October 20–23, 28–30.	7	5
Iron Mound	1900 July 21–24, 26–27.	6	5
Heath	1900 August 3, 6–10.	6	9
Wilson	1900 August 17–19, 22–24.	6	9
Central	1900 August 31–September 4.	5	10
Little River	1900 October 8–12.	5	21
Chase	1900 October 18–19, 22–25.	6	20
Savage	1901 June 10, 12–14.	4	20
Gilmore	1901 June 21–25.	5	5
Partridge	1901 July 1–3.	3	12
Arlington	1901 July 8–12.	5	21
Sunflower	1901 July 19–21.	3	12
Pretty Prairie	1901 July 26, 29–31, August 1.	5	21
Kingman	1901 August 5–8.	4	21
Cheney	1901 August 14–15.	2	14
Belmont	1901 August 20–22.	3	14
Prairie	1901 August 24–26.	3	21
Sumner	1901 August 30–31, September 2–5.	6	21
Quarry	1901 September 10–12.	3	12
Rutherford	1901 September 15, 17–18.	3	21
Anthony Northwest Base	1901 September 20–21.	2	8
Anthony Southeast Base*	1901 September 22.	1	8
Anthony Southeast Base	1902 August 13–15.	3	8
Fowler	1902 August 8–9, 11–12.	4	21
Miller	1902 August 9, 11–13.	4	7

*This station is in the following discussion treated as being occupied in 1902.

The following summary shows the essential facts in regard to the length of occupation of each station in the southward extension of the ninety-eighth meridian triangulation, together with similar imformation with respect to triangulation in adjacent areas.

Years and locality.	Number observations.	Total number days of observation.	Number stations.	Average number days of observation at station.	Maximum number days of observation at any station.	Minimum number days of observation at any station.
1890, 1891, 1892, 1896, thirty-ninth parallel, Kansas*	34	168	16	10.5	18	5
1897, 1898, 1899, ninety-eighth north, Kansas and Nebraska	24	204	29	7.0	11	3
1900–1901, ninety-eighth north, Nebraska	16	62	12	5.2	7	3
1899, ninety-eighth south, Kansas	24	41	3	13.7	23	7
1900, ninety-eighth south, Kansas	16	34	6	5.7	6	5
1901, ninety-eighth south, Kansas	16	51	14	3.6	6	2
1902, ninety-eighth south, Kansas	16	12	3	4.0	4	3

*From Salina Base to the stations Meades Ranch and Waldo.

The weather conditions are not widely different in the various parts of the comparatively small area to which this summary refers, and comparison of the programmes of different seasons is therefore of special interest.

The saving in time which has been made by reducing the number of observations is shown in part by the fact that for the 16 stations at which 34 observations were made the average number of observing days at each station was 10.5; for the 32 stations at which 24 observations of each direction were made, 7.7 days; and for the 35 stations at which 16 observations were made, 4.5 days. This takes no account of the fact that the observer, while waiting for a day of additional observations to complete his programme, may be delayed by bad weather. It has already been shown* that the ratio of the number of observing days at a station to the total number of days at the station, exclusive of the time before the first observation and after the last observation, was for the stations under consideration along the thirty-ninth parallel and to the northward 0.78, and that therefore every observing day saved was equivalent, upon an average, to a saving of one and one-fourth days for the party. The total number of days on which observations were made on the triangulation to the southward in 1900, 1901, and 1902 was 97, and the total number of days spent at the stations from the first to the last days of observation, inclusive, was 113, and the ratio 0.86. On this work, then, either there must have been fewer bad days than on the work to the northward, or else the observer must have taken more apparent chances of error by observing on days which would by the observer on the northward triangulation have been condemned as unfit for observations. It is probable that the change of the ratio from 0.78 to 0.86 was due in part to both causes. This ratio had remained 0.78, upon an average, for several years

*See Appendix 6 of the Report for 1901, page 368.

along the thirty-ninth parallel and on the ninety-eighth meridian to the northward. The same observer was at the instrument year after year.

Everything being considered, it seems that the reduction in the number of observations from 34 to 16 has saved about 6 days for the party at each station, and the reduction from 24 to 16 about 3 days at each station. The question whether this large saving in time and cost has been accompanied by a decrease in the accuracy of the triangulation will be treated later.

The season of triangulation in 1901 by Assistant A. T. Mosman was not only remarkable for the small average number of days of observation at each station (3.6) and for the small percentage of delay from bad weather, but also for quick moves made between stations. Between June 10, when the first observations were taken at Savage, and September 21, when the last observations were taken at Anthony Northwest Base, an interval of 104 days, all the observations were taken at 14 stations, and 13 moves were made from station to station. The average length of stay at each station, from the first observation to the last, was 4.0 days, and the average interval from the last primary observation at one station to the first at the next, including Sundays, delays on account of bad weather, packing up and unpacking, the move between stations, and the delays due to the failure of heliotropes to show at once, was 3.7 days. The total time of the party per station, after observing had once commenced, was, therefore, upon an average 7.7 days. This is, so far as the writer knows, the most rapid primary triangulation up to 1901.

The best former season's record on this grade of triangulation known to the writer was made by Assistant F. D. Granger in 1900 in Nebraska on the northward extension of the ninety-eighth meridian triangulation. Eleven stations were occupied with an average interval from the first to the last primary observation at each station of 6.3 days, and an average interval between such observations of 7.2 days, or a total of 13.5 days per station. The longer time required on an average by Assistant Granger to move from station to station and prepare for observations was due in part to the fact that his signals were erected by the observing party, or men detailed from it, whereas in Assistant Mosman's work the signals were erected by a signalman and party operating almost independently of the observing party.

STATEMENT OF ADJUSTMENTS.

For the stations involved in the triangulation along the thirty-ninth parallel, local adjustments were made.

For the remaining stations, all in the ninety-eighth meridian triangulation, the computer made local adjustments at a few stations where the proportion of broken series was greatest, these being the cases in which the local adjustment will in general produce the greatest changes in the angles. These extraordinary cases being carefully studied indicated that the effect of the local adjustment at the remaining stations would in general be simply to change the angles in the hundredths of seconds, the tenths being seldom affected. It was therefore considered that the time would not be well spent in making these local adjustments, the effects of which would be so small as to be entirely masked by the corrections inevitably applied in the figure adjustments. For the greater number of stations the directions used in the figure adjustments are therefore those resulting directly from the observations after the mere taking of means. It should be noted that with the system of observations used since 1900, in which the missing signals in a broken series are observed later in connection with the chosen initial, or with some other one and only one of the signals already observed in that series, a local adjustment will change the result very little, much less than when two or more of the signals already observed are included with the missing signal.

The figure adjustments for the triangulation in Kansas were made in five sections: First, the Salina base net; second, from the Salina base net to the Versailles base net in Missouri; third, from the Salina base net to the El Paso base net in Colorado; fourth, from the line Meades Ranch–Waldo, on the thirty-ninth parallel triangulation, to the Shelton base net; fifth, from the lines Iron Mountain–Heath and Heath–Wilson, on the thirty-ninth parallel triangulation, to the Anthony Base. Adjustments of the first three sections are published fully in Special Publication No. 4, The Transcontinental Triangulation. The adjustment of the fourth section is published in full in Appendix No. 6 of the Report for 1901, Triangulation Northward Along the Ninety-eighth Meridian.

In the adjustment (see illustration No. 5) of the triangulation southward from the lines Iron Mountain–Heath and Heath–Wilson of the thirty-ninth parallel triangulation, which had previously been fixed in length and direction, to the Anthony Base, which is fixed in length* by the base measures, there are 121 directions connected by 50 rigid conditions, as indicated below, of which 35 refer to closures of triangles, 14 to ratios of sides, and the last condition is that the length of the Anthony Base, as carried from the line Wilson–Heath, must agree with its measured length.

The length of the Anthony Base, as reduced to sea level, is 6 034.7048 meters (logarithm 3.7806560). This corresponds exactly to the published length of the base in Appendix 3 of 1901. The reduction to sea level as there printed was computed upon the supposition that the elevation of the bench mark at Anthony Southeast Base was 419.9346 meters. The best elevation now available for this bench mark is 419.9081 meters. This change in the assigned elevation is so small as not to affect the reduction to the sea level by as much as a tenth of a millimeter.

It is important to note that the length equation extends to the base itself instead of stopping at the border line of the base net, as had been the practice of this Survey up to 1901.

In the following condition equations the numbers assigned to the directions correspond to those shown in illustration No. 5. The number of a direction inclosed in parenthesis, thus (1), means the required correction to that direction.

CONDITION EQUATIONS.

Thirty-ninth parallel triangulation to Anthony Base.

No.	
1	0 = −1.44 − (1) + (2) − (3) + (4) − (25) + (26)
2	0 = +1.53 − (4) + (5) − (22) + (23) − (24) + (25)
3	0 = +0.05 − (5) + (7) − (9) + (10) − (21) + (22)
4	0 = +1.06 − (6) + (7) − (9) + (11) − (12) + (13)
5	0 = +0.28 − (10) + (11) − (12) + (14) − (20) + (21)
6	0 = +1.15 − (14) + (16) − (19) + (20) − (27) + (28)
7	0 = +0.73 − (18) + (19) − (28) + (29) − (34) + (36)
8	0 = +0.94 − (15) + (17) − (33) + (35) − (37) + (39)
9	0 = +0.60 − (16) + (17) + (27) − (30) − (37) + (38)

*See pages 270–273 of Appendix 3 of the Report for 1901, On the Measurement of Nine Bases Along the Ninety-eighth Meridian.

CONDITION EQUATIONS—Continued.

Thirty-ninth parallel triangulation to Anthony Base—Continued.

No.	
10	$0=-0.84-(29)+(30)-(33)+(34)-(38)+(39)$
11	$0=+0.22-(32)+(33)-(39)+(41)-(42)+(43)$
12	$0=-0.77-(31)+(32)-(43)+(44)-(49)+(51)$
13	$0=+0.14-(40)+(41)-(42)+(44)-(49)+(50)$
14	$0=+0.38-(44)+(45)-(48)+(49)-(53)+(54)$
15	$0=+0.27-(45)+(46)-(52)+(53)-(56)+(57)$
16	$0=+0.88-(47)+(48)-(54)+(55)-(64)+(65)$
17	$0=+0.13+(52)-(55)-(57)+(58)-(63)+(64)$
18	$0=-0.07-(58)+(59)-(62)+(63)+(66)-(69)$
19	$0=-0.61-(59)+(60)-(68)+(69)-(70)+(71)$
20	$0=+0.56-(61)+(62)-(66)+(67)-(78)+(79)$
21	$0=+1.75-(67)+(68)-(71)+(72)-(77)+(78)$
22	$0=+0\ 73-(72)+(73)-(76)+(77)-(80)+(81)$
23	$0=+0.75-(73)+(74)+(80)-(83)-(84)+(85)$
24	$0=-0.92-(75)+(76)-(81)+(82)-(92)+(93)$
25	$0=-0.72-(82)+(83)-(85)+(86)-(91)+(92)$
26	$0=+1.95-(86)+(87)-(90)+(91)-(96)+(97)$
27	$0=-0.31-(87)+(88)-(94)+(96)-(100)+(102)$
28	$0=+0.37-(94)+(95)-(101)+(102)-(106)+(108)$
29	$0=-0.96-(101)+(103)-(107)+(108)-(111)+(112)$
30	$0=+0.82+(95)-(99)-(106)+(107)-(112)+(113)$
31	$0=+0.27+(89)+(90)-(97)+(98)-(117)+(118)$
32	$0=+1.17+(94)-(98)-(102)+(104)-(115)+(117)$
33	$0=+0.78-(98)+(99)+(109)-(113)-(116)+(117)$
34	$0=-1.98-(104)+(105)-(114)+(115)-(119)+(123)$
35	$0=-1.79-(109)+(110)-(114)+(116)-(121)+(123)$
36	$0=+1.9+2.91(1)-2.91(2)-3.12(9)+3.12(10)+2.16(21)-3.18(22)+1.02(23)+0.03(24)$ $+0.10(25)-0.13(26)$
37	$0=+1.8-1.73(5)+3.44(6)-1.71(7)-1.26(9)+4.48(10)-3.22(11)-3.26(20)+3.92(21)$ $-0.66(22)$
38	$0=-7.7-2.15(14)+15.75(15)-13.60(16)-3.02(18)+4.70(19)-1.68(20)-7.63(34)+8.36(35)$ $-0.73(36)$
39	$0=+1.3-2.15(14)+3.71(16)-1.56(17)-3.02(18)+4.70(19)-1.68(20)-2.40(33)+3.13(34)$ $-0.73(36)-2.10(37)+8.45(38)-6.35(39)$
40	$0=-2.5-1.53(31)+3.60(32)-2.07(33)-0.95(39)+3.56(40)-2.61(41)-3.32(49)+3.94(50)$ $-0.62(51)$
41	$0=-9.5-1.44(44)+5.59(45)-4.15(46)-1.93(47)+3.45(48)-1.52(49)-2.13(56)+3.44(57)$ $-1.31(58)-3.69(63)+5.93(64)-2.24(65)$
42	$0=-2.3-3.52(58)+5.38(59)-1.86(60)-1.28(61)+3.73(62)-2.45(63)-2.50(70)+5.21(71)$ $-2.71(72)-1.54(77)+3.35(78)-1.81(79)$
43	$0=+1.1-2.18(72)+3.36(73)-1.18(74)-2.50(75)+5.48(76)-2.98(77)-2.05(84)+4.40(85)$ $-2.35(86)-1.93(91)+4.04(92)-2.11(93)$
44	$0=+4.7+6.60(94)-3.86(95)-2.74(99)-3.41(101)+5.39(102)-1.98(103)-0.89(111)$ $+1.76(112)-0.87(113)$
45	$0=-2.0-1.55(86)+4.13(87)-2.58(88)-2.75(89)+4.94(90)-2.19(91)-1.51(100)+3.58(102)$ $-2.07(104)-2.84(115)+4.64(117)-1.80(119)$
46	$0=-37.9-5.83(94)-0.44(98)+6.27(99)-4.45(102)+10.19(103)-5.74(104)$ $-15.48(115)+19.30(116)-3.82(117)$
47	$0=0.0-0.44(98)+0.44(99)+2.52(110)-2.52(113)-1.38(114)+5.20(116)$ $-3.82(117)-7.37(121)+7.82(122)-0.45(123)$
48	$0=-10.0-5.83(94)+5.83(99)-4.45(102)+6.09(103)-1.64(105)-2.52(110)$ $+2.52(113)-5.45(119)+13.27(121)-7.82(122)$
49	$0=+19.21-0.198(101)+0.362(103)-0.164(105)+0.093(107)-0.093(108)$ $+2.715(110)-2.715(112)-0.545(119)+10.206(120)-9.661(121)$
50	$0=-5.7-1.73(5)+1.73(6)-1.26(9)+1.26(11)+0.77(12)-0.77(13)-1.16(15)$ $+1.16(17)-0.13(18)+0.79(20)-0.66(22)-1.53(31)+1.53(32)+1.38(35)$ $-1.38(36)+1.05(37)-2.00(39)+0.95(41)+0.81(42)-0.81(43)-1.44(44)$ $+1.44(45)-1.93(47)+1.93(48)+0.62(49)-0.62(51)-0.08(52)+0.76(53)-0.76(54)$ $+0.08(55)+1.31(57)-1.31(58)-1.86(59)+1.86(60)-2.45(62)+2.45(63)$ $+2.24(64)-2.24(65)+0.70(66)-0.06(67)+0.06(68)-0.70(69)+2.50(70)-2.50(71)$ $-1.18(73)+1.18(74)-2.98(76)+4.52(77)-1.54(78)-0.40(80)+0.40(81)$ $+0.02(82)-0.02(83)+2.05(84)-2.05(85)-2.58(87)+2.58(88)-2.19(90)$ $+4.12(91)-1.93(92)+5.83(94)+0.29(96)-0.29(97)-5.83(99)+1.51(100)$ $-1.98(101)-1.51(102)+1.98(103)+0.93(107)-0.93(108)-2.09(111)+2.09(113)$

ACCURACY AS INDICATED BY CORRECTIONS TO OBSERVED DIRECTIONS.

The corrections to observed directions, resulting from the figure adjustment of the triangulation from the thirty-ninth parallel triangulation southward to Anthony Base, are as follows (the numbers of the directions refer to illustration No. 5):

Thirty-ninth parallel triangulation to Anthony Base.

Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.
	″		″		″		″
1	0.000	34	+0.236	65	−0.571	96	+0.339
2	0.000	35	+0.123	66	+0.089	97	−0.322
3	−0.310	36	−0.363	67	+0.221	98	+0.099
4	+0 465	37	+0.361	68	−0.416	99	+0.077
5	−0.160	38	−0.234	69	+0.106	100	+0.433
6	+0.005	39	−0.234	70	+0.280	101	+0.258
9	+0.099	40	+0.176	71	+0.447	102	−0.188
10	−0.169	41	−0.069	72	−0.217	103	+0.580
11	+0.071	42	+0.148	73	−0.198	104	−1.378
12	+0.406	43	−0.078	74	−0.312	105	+0.295
13	−0.313	44	+0.054	75	+0.039	106	+0.231
14	+0.276	45	+0.281	76	+0.388	107	−0.126
15	+0.223	46	−0.405	77	+0.246	108	−0.105
16	−0.348	47	+0.120	78	−0.204	109	−0.118
17	−0.244	48	+0.225	79	−0.470	110	+0.069
18	+0.195	49	−0.279	80	+0.167	111	−0.232
19	+0.245	50	−0.079	81	−0.438	112	+0.388
20	+0.047	51	+0.012	82	+0.115	113	−0.107
21	−0.341	52	−0.105	83	+0.156	114	−0.433
22	+0.027	53	+0.105	84	+0.451	115	−0.269
23	−0.172	54	+0.001	85	−0.195	116	+0.908
24	+0.250	55	−0.001	86	+0.400	117	+0.156
25	−0.458	56	+0.130	87	−0.473	118	−0.363
26	+0.207	57	+0.335	88	−0.184	119	+0.536
27	+0.182	58	−0.229	89	+0.350	120	−1.392
28	−0.148	59	−0.077	90	+0.178	121	+0.411
29	−0.323	60	−0.158	91	−0.239	122	−0.232
30	+0.289	61	+0.359	92	−0.152	123	+0.677
31	−0.178	62	−0.067	93	−0.137		
32	+0.171	63	−0.131	94	−0.303		
33	+0.010	64	+0.410	95	+0.109		

The maximum correction to any direction is 1″.39, to the direction to Anthony Northwest Base as observed from Miller.*

The probable error of an observed direction, or direction resulting from a local adjustment, is

$$d = 0.674\sqrt{\frac{\Sigma v^2}{c}}$$

in which Σv^2 is the sum of the squares of the corrections to the directions, and c is the number of conditions.

The probable error of an observed direction is for the triangulation adjusted in this group ±0″.35, derived from 121 directions.

*The line of sight from Miller to the heliotrope at Anthony Northwest Base passed under the branches of a tree. The line of sight at night may possibly have been among the leaves of the tree.

For the purpose of comparison with other triangulation in Kansas and Nebraska under the same general conditions as to climate, topography, and length of line, the following values of *d* may be cited:

Salina base net	± 0''.44 from	30 directions.
Salina base net to El Paso base net	± 0''.50 from	225 directions.
Salina base net to Versailles base net	± 0''.35 from	188 directions.
Meades Ranch–Waldo to Shelton base net	± 0''.27 from	76 directions.
Shelton base net	± 0''.33 from	26 directions.
Shelton base net to Page Base	± 0''.29 from	96 directions.

As measured by this standard the southward triangulation under consideration is intermediate in accuracy between the triangulation northward on the ninety-eighth meridian and the triangulation along the thirty-ninth parallel in Missouri, Kansas and Colorado.

For a comparison covering a large part of the United States and necessarily involving varied conditions as to climate, topography and length of line, it may be noted that in the 21 sections* into which the thirty-ninth parallel triangulation was divided the maximum value of *d* was ±0''.82 in the American Bottom base net; the minimum value was ±0''.23 in the Nevada-California series of triangles; and the average value was ±0''.44. On but 8 of the 21 sections was *d* less than ±0''.35, its value on the triangulation southward along the ninety-eighth meridian. On the 19 sections† into which the triangulation along Eastern Oblique Arc was divided the maximum value of *d* was ±0''.79 in the first section west of the Atlanta Base in Georgia and Alabama; its minimum value was ±0''.26, occurring on two sections, one in New England and the other at Dauphin Island base net. The average value of *d* for this whole arc was ±0''.51 and on but 4 sections out of 19 was it less than ±0''.35.

By inspection of the formula for the probable error, *d*, of an observed direction given above, it may be seen that if the ratio of the number of directions to the number of conditions is the same in two groups of adjusted triangles, the values of d^2 are proportional to the average values of v^2. Under these conditions, then, the average value of the correction to a direction may be used as a rough means of comparing the accuracy of any one group or part of a group with some other group, since the probable error of an observed direction will be nearly proportional to the average value of corrections to directions in such groups.

The values of the ratio of the number of directions divided by the number of conditions in the five groups of adjusted triangles westward from the Salina Base to the El Paso base net and northward to the Page Base varied from 2.2 to 2.6. It is 2.4 in the first adjusted group of triangles southward from the thirty-ninth parallel triangulation, which is now under consideration. Hence, the mean value of the correction to a direction may be used throughout these groups as an approximate measure of the relative accuracy of different parts of the triangulation. It is especially desirable to determine whether the accuracy has been affected appreciably by the reduction in the number of observations of each direction, accompanied as it is by a considerable reduction in the number of days on which observations were taken. In the following table

*The Transcontinental Triangulation, page 613.

†The Eastern Oblique Arc of the United States, page 235.

the first three groups refer to triangulation westward and northward from the Salina Base,* and the last four to triangulation to the southward.

Groups.	Years.	Number of observations of each direction.	Average number of days of observation.	Number of directions.	Average correction to a direction without regard to sign.	Maximum correction to a direction.
					"	"
Group No. 1, Kansas.	1890, 1891, 1892, 1896.	34	10.5	76	0.42	1.37
Group No. 2, Kansas and Nebraska.	1897, 1898, 1899.	22–26	7.0	135	0.22	0.88
Group No. 3, Nebraska.	1900, 1901.	16	5.2	57	0.27	0.87
Group No. 4, Kansas.	1899.	24	13.7	15	0.25	0.46
Group No. 5, Kansas.	1900.	16	5.7	24	0.18	0.46
Group No. 6, Kansas.	1901.	16	3.6	67	0.25	1.38
Group No. 7, Kansas.	1902.	16	4.0	15	0.42	1.39

For the whole group of triangles from the thirty-ninth parallel triangulation southward to the Anthony Base, involving observations from 1899 to 1902, the total number of directions is 121, the average correction to a direction 0".26, and the maximum correction 1".39.

The evidence here shown indicates that the great increase in rapidity of the triangulation has not been accompanied by any reduction in accuracy.

ACCURACY AS INDICATED BY CORRECTIONS TO ANGLES AND CLOSURES OF TRIANGLES.

The correction to each angle is the algebraic difference of the corrections to two directions. In order to make it possible to study the corrections to separate angles, they are shown in the following table for every triangle in the primary scheme from the thirty-ninth parallel triangulation southward to the Anthony Base, together with the closure of the triangles, the corrected spherical angles, and the spherical excess. The plus sign prefixed to the error of closure of the triangle indicates that the sum of the angles is less than 180° plus the spherical excess. The spherical excess is a convenient indication of the size of the triangulation, since it is proportional to the area.

Stations.	Corrections to angles.	Error of closure of triangle.	Corrected spherical angles.			Spherical excess.
	"	"	°	'	"	"
Loder	+0.67		93	19	01.84	
Heath	+0.77	+1.44	50	47	22.10	2.54
Iron Mound	0.00		35	53	38.60	
Sherman	+0.37		44	18	21.04	
Wilson	−0.27	−0.05	34	03	22.61	2.89
Heath	−0.15		101	38	19.24	
Sherman	−0.20		64	22	01.42	
Heath	−0.62	−1.53	26	13	28.93	0.94
Loder	−0.71		89	24	30.59	

*Appendix 6 of the Report for 1901, p. 376.

Stations.	Corrections to angles.	Error of closure of triangle.	Corrected spherical angles.			Spherical excess.
	"	"	°	′	"	"
Bossing	−0.72		69	52	54.10	
Wilson	−0.03	−1.06	59	12	34.41	2.62
Heath	−0.31		50	54	34.11	
Bossing	+0.59		56	43	18.34	
Heath	+0.16	+0.73	50	43	45.13	2.09
Sherman	−0.02		72	32	58.62	
Bossing	−0.13		126	36	12.44	
Wilson	+0.24	−0.28	25	09	11.80	1.82
Sherman	−0.39		28	14	37.58	
Central	−0.33		84	01	57.52	
Bossing	−0.62	−1.15	44	27	50.84	1.12
Sherman	−0.20		51	30	12.76	
Little River	−0.60		70	52	57.32	
Central	−0.18	−0.73	74	12	33.07	0.59
Sherman	+0.05		34	54	30.20	
Chase	0.00		18	20	10.78	
Central	+0.61	+0.84	120	27	00.08	0.67
Little River	+0.23		41	12	49.81	
Little River	−0.49		56	44	13.09	
Bossing	−0.06	−0.71	36	51	05.41	1.45
Sherman	−0.16		86	24	42.95	
Chase	−0.59		63	27	46.58	
Bossing	−0.46	−0.94	61	10	41.72	2.33
Little River	+0.11		55	21	34.03	
Bossing	+0.10		53	33	56.29	
Central	−0.11	−0.60	81	18	29.32	1.41
Chase	−0.59		45	07	35.80	
Gilmore	+0.09		45	30	40.04	
Chase	+0.41	+0.68	35	03	23.07	2.20
Little River	+0.18		99	25	59.09	
Savage	−0.23		68	54	55.41	
Chase	+0.17	−0.22	65	39	46.71	1.93
Little River	−0.16		45	25	19.81	
Central	−0.50		158	14	30.60	
Bossing	−0.57	−1.18	7	36	45.42	0.25
Little River	−0.11		14	08	44.23	
Gilmore	+0.29		73	40	56.37	
Savage	+0.13	+0.77	52	18	26.11	1.77
Little River	+0.35		54	00	39.29	
Savage	−0.10		121	13	21.52	
Chase	−0.24	−0.14	30	36	23.64	1.49
Gilmore	+0.20		28	10	16.33	
Partridge	−0.11		70	10	21.51	
Savage	+0.23	−0.38	55	46	16.29	1.34
Gilmore	−0.50		54	03	23.54	
Arlington	+0.21		44	41	52.49	
Savage	−0.69	−0.27	26	52	38.57	0.85
Partridge	+0.21		108	25	29.79	

Stations.	Corrections to angles.	Error of closure of triangle.	Corrected spherical angles.			Spherical excess.
	″	″	°	′	″	″
Sunflower	−0.98		43	10	18.59	
Partridge	0.00	−0.88	89	17	49.74	1.57
Gilmore	+0.10		47	31	53.24	
Arlington	−0.56		58	09	49.21	
Partridge	−0.11	−0.13	92	06	18.95	0.99
Sunflower	+0.54		29	43	52.83	
Pretty Prairie	−0.02		108	24	36.52	
Arlington	+0.15	+0.07	30	50	30.57	0.82
Sunflower	−0.06		40	44	53.73	
Kingman	+0.17		40	00	34.93	
Arlington	−0.08	+0.61	48	33	17.78	1.29
Pretty Prairie	+0.52		91	26	08.58	
Cheney	−0.27		49	18	00.80	
Pretty Prairie	+0.13	−0.56	71	57	42.38	0.73
Sunflower	−0.42		58	44	17.55	
Kingman	−0.66		37	52	32.72	
Pretty Prairie	−0.64	−1.75	88	11	32.51	1.14
Cheney	−0.45		53	55	55.91	
Belmont	−0.61		100	44	26.73	
Kingman	+0.02	−0.73	44	04	30.45	0.94
Cheney	−0.14		35	11	03.76	
Prairie	−0.65		45	48	30.13	
Kingman	−0.11	−0.75	60	37	26.86	0.92
Belmont	+0.01		73	34	03.93	
Sumner	+0.02		44	51	43.63	
Belmont	+0.55	+0.92	95	03	13.49	1.05
Cheney	+0.35		40	05	03.93	
Sumner	+0.09		47	27	04.63	
Prairie	+0.59	+0.72	41	54	40.59	1.06
Belmont	+0.04		90	38	15.84	
Quarry	−0.66		82	23	13.81	
Prairie	−0.87	−1.95	53	41	16.97	1.21
Sumner	−0.42		43	55	30.43	
Rutherford	−0.62		54	19	09.75	
Prairie	+0.29	+0.31	39	09	33.10	0.82
Quarry	+0.64		86	31	17.97	
Anthony Southeast Base	+0.12		134	47	36.43	
Rutherford	+0.76	+0.50	25	20	59.24	0.13
Quarry	−0.38		19	51	24.46	
Anthony Northwest Base	−0.33		140	56	17.13	
Quarry	+0.41	−0.37	17	41	44.05	0.11
Rutherford	−0.45		21	21	58.93	
Anthony Southeast Base	+0.62		67	09	14.24	
Rutherford	+0.32	+0.96	46	42	58.18	0.11
Anthony Northwest Base	+0.02		66	07	47.69	
Anthony Northwest Base	−0.36		74	48	29.43	
Quarry	+0.03	−0.82	37	33	08.51	0.14
Anthony Southeast Base	−0.49		67	38	22.20	

Stations.	Corrections to angles.	Error of closure of triangle.	Corrected spherical angles.			Spherical excess.
	″	″	°	′	″	″
Fowler	−0.52		49	23	26.64	
Quarry	+0.42	−0.27	93	10	36.24	1.14
Sumner	−0.17		37	25	58.26	
Fowler	+0.42		36	35	36.37	
Rutherford	−1.19	−1.17	45	29	32.41	0.76
Quarry	−0.40		97	54	51.98	
Anthony Southeast Base	−0.01		73	05	33.23	
Quarry	−0.02	−0.78	78	03	27.52	0.45
Fowler	−0.75		28	50	59.70	
Anthony Southeast Base	−0.12		152	06	50.33	
Fowler	+1.18	−0.90	7	44	36.68	0.17
Rutherford	−1.96		20	08	33.16	
Miller	+0.14		98	57	05.86	
Rutherford	+1.67	+1.98	31	56	04.62	0.71
Fowler	+0.17		49	06	50.23	
Miller	+0.26		77	49	49.73	
Anthony Southeast Base	+0.19	+1.79	45	18	43.95	0.58
Fowler	+1.34		56	51	26.90	
Anthony Southeast Base	−0.30		106	48	06.39	
Miller	−0.12	−0.70	21	07	16.13	0.31
Rutherford	−0.28		52	04	37.79	
Miller	−0.77		42	48	08.62	
Rutherford	+0.48		77	25	37.03	0.79
Quarry	....		59	46	15.14	
Miller	+0.91		56	08	57.24	
Quarry	....		38	08	36.84	0.68
Fowler	+0.59		85	42	26.60	
Anthony Southeast Base	+0.18		118	24	17.18	
Quarry	....		39	54	50.67	0.35
Miller	−0.64		21	40	52.50	
Anthony Northwest Base	....		61	41	47.14	
Miller	−1.93		19	30	37.28	0.39
Rutherford	+0.04		98	47	35.97	
Anthony Southeast Base	+0.32		173	57	20.63	
Miller	+1.80		1	36	38.84	0.03
Anthony Northwest Base	....		4	26	00.56	

The maximum correction to any angle is $-1''.96$, to the angle at Rutherford, between Anthony Southeast Base and Fowler, measured in 1901.

The triangulation shows 14 closing errors of the plus sign and 28 of the minus sign. The average closing error for this triangulation without regard to sign is $0''.79$ (42 triangles). For a comparison it may be noted that the average closing error for the whole transcontinental triangulation is $1''.06$, and that the average closing error for the 21 sections into which that triangulation was divided varies from a minimum of $0''.57$ in the Nevada–California section to a maximum of $2''.22$ in the American Bottom base net (see "The Transcontinental Triangulation," p. 613). There are but 3 sections out of the 21 on whicht he average closing error is less than $0''.79$. The average closing error for the triangulation from the Salina Base westward and northward to the Page Base was $\pm 0''.68$.

The mean error of an angle, $a=\sqrt{\frac{\Sigma \Delta^2}{3n}}$ (in which $\Sigma \Delta^2$ is the sum of the squares of the closing errors of the triangles and n is the number of triangles) is for this triangulation $\pm 0''.54$.

For a comparison with other triangulation, principally in Kansas and Nebraska, under the same general conditions as to climate, topography, and length of line, the following mean error of an angle may be cited.*

Salina base net	$\pm 0''.75$
Salina base net to Versailles base net	$\pm 0''.60$
Salina base net to El Paso base net	$\pm 0''.75$
Meades Ranch–Waldo to Shelton base net	$\pm 0''.35$
Shelton base net	$\pm 0''.45$
Shelton base net to Page Base	$\pm 0''.44$

As measured by this standard the southward triangulation under consideration is intermediate in accuracy between the triangulation northward from the thirty-ninth parallel and the triangulation along the thirty-ninth parallel in Missouri, Kansas and Colorado.

For a comparison covering a large part of the United States, and necessarily involving varied conditions as to climate, topography, and length of line, it may be noted that in the 21 sections into which the thirty-ninth parallel triangulation was divided† the maximum value for the mean error of an angle was $\pm 1''.59$ in the American Bottom base net; the minimum value was $\pm 0''.42$ in the Nevada–California series of triangles; and the average value was $\pm 0''.77$. There are but two sections out of 21 for which it is less than $\pm 0''.54$. Similarly, in the 19 sections into which the triangulation along the Eastern Oblique Arc is divided† the maximum value of the mean error of an angle was $\pm 1''.31$, in Virginia and North Carolina; its minimum value was $\pm 0''.49$, in the Fire Island base net; and its mean value $\pm 0''.82$. There are but 3 sections out of 19 for which it is less than $\pm 0''.54$.

The mean error of an angle as thus computed from the triangle closures may be rendered comparable with the probable error of an observed direction by multiplying it by $\sqrt{1/2}$, to take account of the fact that an angle is the difference of two directions, and by the factor 0.674 to reduce from a mean error to a probable error.

The mean error of an angle, a, for the triangulation now under consideration, from the thirty-ninth parallel triangulation to the Anthony Base, viz, $\pm 0''.54$, when reduced to the probable error of an observed direction, d, is $\pm 0''.26$, whereas the probable error of an observed direction derived from the figure adjustment is $\pm 0''.35$. The excess of the second of these values over the first is an indication of the magnitude of the errors which were put in evidence by the rigid conditions relating to the ratios of the sides and the accord in length between bases and which do not appear from the triangle closures alone.

To secure still further evidence as to whether the accuracy of the triangulation has been appreciably affected by the reduction of the number of observations and the

*See Transcontinental Triangulation, page 613; Appendix 6, 1901, page 384.

†See Transcontinental Triangulation, page 613; The Eastern Oblique Arc, page 235.

number of days of observation at each station, the following table has been compiled. Certain triangles belong to two different seasons. In such cases the triangle has been credited to the season during which two of its three stations were occupied.

Groups 1, 2, and 3 refer to triangulation along the thirty-ninth parallel from the Salina Base to Meades Ranch–Waldo, and along the ninety-eighth meridian from Meades Ranch–Waldo to the Page Base. Groups 4–5 and 6–7 refer to triangulation southward from the thirty-ninth parallel to the Anthony Base.

	Number of observations of each direction.	Average number of days of observations.	Years.	Number of triangles.	Average closing error.	Maximum closing error.
					"	"
Group No. 1	34	10.5	1890–91–92, 96	37	0.83	2.37
Group No. 2	22 to 26	7.0	1897–98–99	50	0.59	2.07
Group No. 3	16	5.2	1900–01	28	0.63	1.77
Groups No. 4–5	24 to 16	8.3	1899–1900	15	0.81	1.53
Groups No. 6–7	16	3.7	1901–02	27	0.78	1.98

This evidence indicates that an increase in accuracy rather than a decrease has accompanied the increase in the rapidity of the triangulation.

No attempt has been made here to set forth the agreement of the separate measures of each direction as a criterion of accuracy, since it is well known that it is of little value for that purpose. A close agreement of the separate measures of a given direction is of little consequence, since such measures are usually subject to constant errors of considerable size which become evident as soon as the closures of the triangles are studied or an attempt is made to adjust the figure.

THE ACCORD OF BASES.

There are five bases which serve to fix the lengths of triangulation lines in Kansas, namely, the Salina Base in central Kansas, Versailles Base in Missouri, El Paso Base in Colorado, Shelton Base in Nebraska, and Anthony Base in southern Kansas. The accord in length between each of these bases as measured and its value as computed from the triangulation through the adjacent triangles furnishes a valuable test of the accuracy of the triangulation.

In solving the normal equations of the figure adjustment between the Salina base net and the Versailles base net the length equation was, as usual, assigned to the last place, so that the discrepancy in length, after all the conditions relating to closures of triangles and ratios of length had been satisfied, became known. It thus became evident that the Versailles Base as computed from the Salina Base was one part in 25 700 shorter than its measured length (represented by 169 in the seventh place of logarithms). Similarly the El Paso Base as computed from the Salina Base was found to be one part in 47 000 shorter than its measured length (represented by 92.3 in the seventh place of logarithms). So also, the Shelton Base as computed from the line Meades Ranch–Waldo, a line intermediate between the Salina and El Paso bases of the thirty-ninth parallel triangulation, was found to be shorter by one part in 58 000 than its measured length (represented by 75 in the seventh place of logarithms). The

Anthony Base, computed from the line Wilson–Heath of the thirty-ninth parallel triangulation in the vicinity of the Salina Base, was found to be one part in 107 000 less than its measured length (or 41 units in the seventh place of logarithms).

In view of the fact that the triangulation southward to the Anthony Base was done very rapidly and economically, it is important to note that the discrepancy developed on the Anthony Base is smaller than the other three similar discrepancies quoted above for triangulation under the same conditions as to climate, topography and length of line.

It is also important to note that of the nine similar discrepancies developed on the thirty-ninth parallel triangulation there are but three which are smaller than this discrepancy between the Anthony and Salina bases, namely, between the Olney and American Bottom bases, Kent Island and St. Albans bases, and St. Albans and Holton bases.*

ACCURACY AND ECONOMY.

In fixing the methods of triangulation along the ninety-eighth meridian an aim has constantly been to hold the accuracy up to the standard fixed by the best half of the transcontinental triangulation and the triangulation along the Eastern Oblique Arc, a standard of accuracy which compares very favorably with that actually attained in any country. With equal constancy there has been kept in view the desirability of reducing the cost of the triangulation and the time required for it as much as possible, while holding the accuracy up to this high standard.

The success attained in increasing the speed of the triangulation is measured roughly by the fact that the average number of observing days at a station has been reduced since 1896 to much less than one-half the former number, and the speed of the triangulation, including all delays for moving, etc., has been fully doubled. This increase in speed has been accompanied by a corresponding reduction in cost. The cost of building signals, provided they are built by the observing party, is not influenced appreciably by the rate at which the triangulation is done. The remaining expenses of the party are roughly proportional to the time spent in the field for a party of given size, and therefore any increase in speed is accompanied by a nearly proportional decrease in cost per station. In the later years heliotropes have been used rather than poles, and this has tended to increase the cost per station. After all the elements of cost are taken into account it must be conceded that there has been a very large reduction in the cost per station since 1896.

That the accuracy has been kept up to the selected standard is put in evidence in detail in the foregoing pages by the corrections to directions, closures of triangles, and accord between bases. The detailed comparisons which have been given show that the gradual change of methods has certainly not been accompanied by any decrease in accuracy. The comparisons given on the preceding pages show that the accuracy of the latest section of the triangulation, namely, from the thirty-ninth parallel southward to the Anthony Base, is such as to place it about the middle of the first third of the triangulation along the thirty-ninth parallel and the Eastern Oblique Arc, if the various sections of triangulation are placed in order of accuracy.

* See The Transcontinental Triangulation, page 614.

EXPLANATION OF POSITIONS, LENGTHS, AND AZIMUTHS, AND OF THE UNITED STATES STANDARD DATUM.

The lengths, as already fully explained in connection with the adjustments, all depend upon the Shelton, Salina, Versailles, Anthony, and El Paso bases.

The positions—that is, the latitudes, longitudes, and the azimuths—need a special explanation.

All of the positions and azimuths have been computed upon the Clarke spheroid of 1866, which has been in use in the Coast and Geodetic Survey for many years.

After a spheroid has been adopted and all the angles and lengths in a triangulation have been fully fixed, it is still necessary, before the computation of latitudes, longitudes, and azimuths can be made, to adopt a standard latitude and longitude for a specified station and a standard azimuth of a line from that station. For convenience let the adopted standard position (latitude and longitude) of a given station, together with the adopted standard azimuth of a line from that station, be called the *geodetic datum*.

The primary triangulation in the United States was commenced at various points, and existed at first as a number of detached portions in each of which the geodetic datum was necessarily dependent only upon the astronomic stations connected with that particular portion. As examples of such detached portions of triangulation there may be mentioned the early triangulation in New England and along the Atlantic coast, a detached portion of the transcontinental triangulation centering on St. Louis and another portion of the same triangulation in the Rocky Mountain region, and three separate portions of triangulation in California in the latitude of San Francisco, in the vicinity of Santa Barbara Channel, and in the vicinity of San Diego. With the lapse of time these separate pieces have expanded until they have touched or overlapped.

The transcontinental triangulation, of which the office computation was completed in 1899, joins all of the detached portions mentioned and makes them one continuous triangulation. As soon as this took place the logical necessity existed of discarding the old geodetic data used in these various pieces and substituting one datum for the whole country, or at least for as much of the country as is covered by continuous triangulation. To do this is a very heavy piece of work, and involved much preliminary study to determine the best datum to be adopted. On March 13, 1901, the Superintendent adopted what is now known as the United States Standard Datum, and it was decided to reduce the positions to that datum as rapidly as possible. The datum adopted was that formerly in use in New England, and therefore its adoption will not affect the positions which have been used for geographic purposes in New England* and along the Atlantic coast to North Carolina, or those in the States of New York, Pennsylvania, New Jersey, and Delaware. The adopted datum does not agree, however, with that used in "The Transcontinental Triangulation" and in "The Eastern Oblique Arc of the United States," publications which deal primarily with the purely scientific problem of the determination of the figure of the earth.

As the adoption of such a standard datum is a matter of considerable importance, it is in order here to explain the desirability of this step more fully.

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*Many such positions are published in Appendix No. 8, Report for 1885, Appendix No. 8, for 1888, and Appendix No. 10, for 1894.

The main objects to be attained by the geodetic operations of the Coast and Geodetic Survey are, first, the control of the charts published by the Survey; second, the furnishing of geographic positions (latitudes and longitudes), of accurately determined elevations, and of distances and azimuths to engineers connected with the Coast and Geodetic Survey and to other organizations; third, the determination of the figure of the earth. The first two of these objects are purely practical; the third is purely scientific. For the first and second objects it is not necessary that the reference spheroid should be accurately that which most closely fits the geoid within the area covered, nor that the adopted geodetic datum should be absolutely the best that can be derived from the astronomic observations at hand. It is simply desirable that the reference spheroid and the geodetic datum adopted shall be, if possible, such a close approximation to the truth that any correction which may hereafter be derived from the observations which are now or may become available shall not greatly exceed the probable errors of such corrections. It is, however, very desirable that one spheroid and one geodetic datum be used for the whole country. In fact, this is absolutely necessary if a geodetic survey is to perform fully the function of accurately coordinating all surveys within the area which it covers. This is the most important function of a geodetic survey. To perform this function it is also highly desirable that when a certain spheroid and geodetic datum have been adopted for a country they should be rigidly adhered to without change for all time, unless shown to be largely in error.

In striving to attain the third object, the determination of the figure of the earth, the conditions are decidedly different. This problem concerns itself primarily with astronomic observations of latitude, longitude and azimuth, and with the geodetic positions of the points at which the astronomic observations were made, but is not concerned with the geodetic positions of other points fixed by the triangulations. The geodetic positions (latitudes and longitudes) of comparatively few points are therefore concerned in this problem. However, in marked contrast to the statements made in preceding paragraphs, it is desirable in dealing with this problem that, with each new important accession of data, a new spheroid fitting the geoid with the greatest possible accuracy, and new values of the geodetic latitudes, longitudes and azimuths of the highest degree of accuracy, should be derived.

The United States Standard Datum was adopted with reference to positions furnished for geographic purposes, but has no reference to the problem of the determination of the figure of the earth. It is adopted with reference to the engineer's problem of furnishing standard positions, and does not affect the scientist's problem of the determination of the figure of the earth.

The principles which guided in the selection of the datum to be adopted were: First, the adopted datum should not differ widely from the ideal datum for which the sum of the station errors in latitude, longitude, and azimuth should each be zero; second, it was desirable that the adopted datum should produce minimum changes in the publications of the Survey, including its charts; and third, it was desirable, other things being equal, to adopt that datum which allowed the maximum number of positions already in the office registers to remain unchanged, and therefore necessitated a minimum amount of new computation. These considerations led to the adoption as the United States Standard of the datum which had been in use for many years in the northeastern group of States and along the Atlantic coast as far as North Carolina.

An examination of the approximate station errors available on the United States Standard Datum at 204 latitude stations, 68 longitude stations, and 126 azimuth stations, scattered widely over the United States from Maine to Louisiana and to California, indicated that this datum approaches closely the ideal with which the algebraic sum of the station errors of each class would be zero. How closely it approaches that ideal will be set forth in a later publication.

The adopted United States Standard Datum, upon which the positions and azimuths given in this publication depend, may be defined in terms of the position of the station Meades Ranch, as follows:

$$\begin{array}{ll} & \circ \quad ' \quad '' \\ \varphi & =39\ 13\ 26.686 \\ \lambda & \ \ 98\ 32\ 30.506 \\ \alpha \text{ to Waldo} & =75\ 28\ 14.52 \end{array}$$

The positions here published on the United States Standard Datum therefore differ considerably from those given in "The Transcontinental Triangulation" (pp. 854–865), which depend upon a special geodetic datum which was adopted for the special purpose of that publication, and which was based upon the astronomic observations connected with that triangulation alone.

The position given for the station Meades Ranch, in "The Transcontinental Triangulation" (p. 862), is—

$$\begin{array}{ll} & \circ \quad ' \quad '' \\ \varphi & =39\ 13\ 25.006 \\ \lambda & =98\ 32\ 30.469 \\ \alpha \text{ to Waldo} & =75\ 28\ 16.52 \end{array}$$

The corrections to reduce this position to the United States Standard Datum are—

$$\begin{array}{l} \quad '' \\ \Delta\varphi=+1.680 \\ \Delta\lambda=+0.037 \\ \Delta\alpha=-2.00 \end{array}$$

Such corrections to reduce a position from one datum to another are not constant, but vary slightly from station to station.

Index to positions, descriptions, and elevations.

Index to positions, descriptions, and elevations—Continued.

Index to positions, descriptions, and elevations—Continued.

Index to positions, descriptions, and elevations—Continued.

Index to positions, descriptions, and elevations—Continued.

Index to positions, descriptions, and elevations—Continued.

TABLE OF POSITIONS, AZIMUTHS, AND LENGTHS.

The following tables give the positions of all points, and the azimuths and lengths of all lines, fixed by Coast and Geodetic Survey triangulation in Kansas.

These tables may be conveniently consulted by using as finders the five sketches at the end of this appendix and the preceding index. In the third column of the index will be found for each point, a reference to the page on which its description is given, and in the fourth column the page on which its elevation above sea level may be found.

The azimuth and length of every line over which observations have been made in one or both directions are given in the list in connection with the position of one end only of the line.

The positions of all points for which the latitudes and longitudes are given to thousandths of seconds have been fixed by a complete adjustment of the triangulation concerned, so as to make all the triangles close and remove all discrepancies between lengths, azimuths, and positions. Such adjustments are of a very high degree of accuracy, as indicated in the preceding pages, for points on the primary scheme, of a less degree of accuracy for secondary points, and of a still more approximate character for tertiary points determined by intersections only. In each class all discrepancies are removed to the limit given by the decimal place shown. The statements in regard to the various degrees of accuracy refer to the manner in which the discrepancies were removed.

If less than three decimal places are given in the latitudes and longitudes the point in question has not been fixed by fully adjusted triangulation, or is fixed in such a way as to furnish no check on its position, and the accuracy with which its position is known is indicated in part by the number of decimal places given.

The seconds in meters are given for the convenience of draftsmen.

In the column giving azimuths, distances, and logarithms of distances various numbers of decimal places are given, the intention being to indicate the accuracy to a certain extent, it being understood that in each quantity two doubtful figures are given. In some cases there is very little doubt of the correctness of the second figure from the right, and in a few cases some doubt may be cast upon the third figure.

The following tables give the positions of 94 primary stations and 176 subordinate stations, or 270 in all. Of these 23 primary and 45 subordinate stations are reprinted from Appendix 6 of 1901. The number of new stations is, therefore, 202, of which 71 are primary stations and 131 subordinate stations.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Bowler (Mo.)	38 53 16.076	495.7					
	94 23 39.564	953.6					
Fulton (Mo.)	38 38 43.589	1344.0	164 42 34.07	344 39 22.96	Bowler	27894.67	4.4455213
	94 18 34.346	830.6					
Berry (Mo.)	38 49 13.996	431.6	242 25 32.30	62 31 45.02	Bowler	16154.20	4.2082854
	94 33 33.688	812.7	311 44 47.67	131 54 10.38	Fulton	29150.23	4.4646420
Marty	38 59 22.786	702.6	295 09 51.59	115 20 17.24	Bowler	26508.27	4.4233814
	94 40 15.041	362.0	332 42 35.51	152 46 47.57	Berry	21117.51	4.3246428
Haskin	38 44 23.610	728.0	182 33 56.07	2 34 28.46	Marty	27755.18	4.4433441
	94 41 06.663	160.9	230 38 40.88	50 43 24.59	Berry	14132.49	4.1502186
			287 40 09.79	107 54 15.18	Fulton	34322.37	4.5355773
Thomas	38 50 24.485	755.0	229 20 38.19	49 29 03.40	Marty	25514.39	4.4067853
	94 53 39.299	947.8	301 25 36.89	121 33 28.39	Haskin	21302.06	4.3284216
Eckman	39 02 32.453	1000.8	281 25 47.64	101 38 17.61	Marty	29251.15	4.4661429
	95 00 06.343	152.5	337 24 57.90	157 29 01.17	Thomas	24306.52	4.3857228
Bebe Mound	38 46 17.298	533.4	189 38 49.87	9 41 03.37	Eckman	30503.42	4.4843486
	95 03 38.898	939.1	242 09 56.57	62 16 12.33	Thomas	16352.87	4.2135939
			276 00 38.19	96 14 44.70	Haskin	32838.77	4.5163869
Kanwaka	38 59 34.317	1058.2	260 44 17.28	80 59 10.97	Eckman	34589.86	4.5389488
	95 23 45.895	1104.5	310 05 07.68	130 17 45.34	Bebe Mound	38084.37	4.5807468
Simmons	38 47 04.633	142.9	188 11 23.33	8 12 50.13	Kanwaka	23356.48	4.3684075
	95 26 04.148	100.1	232 32 44.64	52 49 03.18	Eckman	47193.29	4.6738803
			272 27 24.02	92 41 26.56	Bebe Mound	32505.09	4.5119514
Elevation	38 58 59.096	1822.2	267 55 10.50	88 08 57.84	Kanwaka	31667.31	4.5006112
	95 45 40.887	984.2	307 44 11.39	127 56 30.08	Simmons	35914.14	4.5552655
Mabon	38 47 49.467	1525.3	185 53 46.17	5 54 41.79	Elevation	20759.06	4.3172077
	95 47 09.485	228.9	237 09 14.77	57 23 56.09	Kanwaka	40206.37	4.6042949
			272 28 55.25	92 42 07.96	Simmons	30569.15	4.4852834
Powell	38 55 29.610	913.0	245 52 48.70	65 59 06.33	Elevation	15840.40	4.1997662
	95 55 41.548	1000.8	318 55 42.33	139 01 03.61	Mabon	18808.38	4.2743513
Adams	39 02 40.968	1263.4	284 06 23.15	104 18 10.39	Elevation	27882.08	4.4453252
	96 04 24.369	586.0	316 32 36.71	136 38 05.62	Powell	18310.77	4.2627067
Clark	38 51 58.932	1817.1	191 44 22.91	11 46 10.48	Adams	20222.41	4.3058329
	96 07 15.463	372.8	247 19 32.56	67 33 05.94	Elevation	33769.40	4.5285234
			248 42 31.97	68 49 47.68	Powell	17940.16	4.2538262
			284 42 27.90	104 55 04.09	Mabon	30088.62	4.4784023

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and Longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Meyer	38 55 39.622	1221.7	236 56 16.07	57 04 59.27	Adams	23862.87	4.3777226
	96 18 15.984	385.0	293 05 27.32	113 12 22.08	Clark	17311.18	4.2383260
Zean Dale	39 05 12.309	379.6	279 00 31.91	99 13 14.44	Adams	29460.77	4.4692440
	96 24 34.322	824.9	314 16 55.26	134 27 48.71	Clark	34984.13	4.5438711
			332 41 49.39	152 45 47.52	Meyer	19868.16	4.2981577
Reinhard	38 52 07.050	217.4	208 59 07.70	29 04 58.95	Zean Dale	27695.45	4.4424084
	96 33 52.731	1271.2	253 43 33.72	73 53 21.94	Meyer	23506.17	4.3711818
			270 13 59.70	90 30 42.02	Clark	38508.21	4.5855534
Humboldt	39 01 22.730	701.0	249 59 00.28	70 07 31.48	Zean Dale	20753.56	4.3170925
	96 38 05.666	136.3	340 24 32.34	160 27 11.34	Reinhard	18185.77	4.2597316
Erricssen	39 11 26.067	803.9	293 41 09.77	113 52 37.18	Zean Dale	28582.29	4.4560970
	96 42 43.382	1041.1	340 14 43.99	160 17 39.15	Humboldt	19765.85	4.2959155
			340 18 01.98	160 23 36.14	Reinhard	37951.60	4.5792301
Robbins	38 58 52.001	1603.4	197 48 15.01	17 51 31.23	Erricssen	24426.90	4.3878683
	96 47 54.600	1314.3	251 47 23.32	71 53 33.96	Humboldt	14914.17	4.1735990
			301 32 57.75	121 41 46.70	Reinhard	23815.96	4.3768681
White City	38 48 10.474	323.0	163 06 35.66	343 03 58.96	Robbins	20676.60	4.3154790
	96 43 45.022	1086.4	242 53 48.14	62 59 59.56	Reinhard	16040.36	4.2052142
Taylor	38 52 58.442	1802.0	238 52 40.38	59 00 32.71	Robbins	21133.79	4.3249775
	97 00 26.243	632.6	290 06 14.37	110 16 42.32	White City	25727.07	4.4103902
Wilmer	39 07 16.239	500.8	254 39 47.46	74 52 11.45	Erricssen	29320.84	4.4671764
	97 02 21.636	519.8	306 38 24.05	126 47 30.29	Robbins	26008.78	4.4151200
			353 59 50.81	174 01 03.43	Taylor	26597.23	4.4248364
Frey	39 01 27.169	837.9	227 02 53.63	47 07 57.26	Wilmer	15810.36	4.1989417
	97 10 23.355	561.9	317 26 30.49	137 32 45.89	Taylor	21279.66	4.3279647
Vine Creek	39 06 06.360	196.1	265 49 07.83	86 02 22.85	Wilmer	30355.62	4.4822391
	97 23 21.914	526.6	294 37 55.17	114 46 05.79	Frey	20603.29	4.3139366
			306 09 15.54	126 23 41.14	Taylor	41065.97	4.6134821
Iron Mound	38 48 29.935	923.0	197 57 47.76	18 02 24.16	Vine Creek	34253.50	4.5347049
	97 30 41.549	1002.5	230 39 26.35	50 52 11.60	Frey	37891.44	4.5785411
			259 07 55.01	79 26 53.62	Taylor	44553.42	4.6488811
Thompson	39 04 14.794	456.3	264 41 30.14	84 58 07.67	Vine Creek	38181.14	4.5818489
	97 49 44.067	1059.3	316 32 17.01	136 44 15.08	Iron Mound	40075.82	4.6028824
North Pole Mound	38 57 09.869	304.3	228 51 50.08	49 00 07.11	Vine Creek	25183.03	4.4011081
	97 36 31.235	752.1	332 14 15.85	152 17 55.35	Iron Mound	18113.49	4.2580021
			124 33 21.07	304 25 02.01	Thompson	23142.19	4.3644044
Salina East Base	38 52 25.110	774.2	345 46 19.74	165 47 07.53	Iron Mound	7481.14	3.8739678
	97 31 57.754	1392.2	143 08 26.59	323 05 34.80	North Pole Mound	10978.18	4.0405304
Salina West Base	38 51 07.674	236.6	177 28 56.39	357 28 43.58	North Pole Mound	11179.66	4.0484285
	97 36 10.840	261.4	248 36 22.26	68 39 01.06	Salina E. Base	6552.446	3.8164035
			301 27 14.28	121 30 40.75	Iron Mound	9313.81	3.9691274
Heath	38 50 40.442	1247.0	217 13 08.57	37 21 27.91	Thompson	31563.71	4.4991880
	98 02 58.247	1404.7	243 16 03.32	63 40 57.94	Vine Creek	63934.06	4.8057323
			252 25 45.16	72 42 21.71	North Pole Mound	40084.51	4.6029766
			274 45 16.98	95 05 31.22	Iron Mound	46890.33	4.6710833
Lincoln	39 05 29.183	900.0	275 31 24.62	95 41 37.30	Thompson	23471.89	4.3705480
	98 05 55.923	1344.0	351 06 48.79	171 08 40.53	Heath	27737.76	4.4430713
Golden Belt	38 58 42.872	1321.9	235 05 58.82	55 13 50.26	Lincoln	21934.92	4.3411360
	98 18 24.488	589.4	255 57 27.70	76 15 30.98	Thompson	42631.89	4.6297346
			303 36 26.15	123 46 07.94	Heath	26820.24	4.4284626
Wilson	38 51 50.913	1569.9	230 56 08.33	51 02 57.34	Golden Belt	20182.61	4.3049773
	98 29 15.508	373.8	233 02 42.57	53 17 22.94	Lincoln	42091.26	4.6241919
			273 07 57.76	93 24 27.25	Heath	38094.10	4.5808577
Meades Ranch	39 13 26.686	823.0	290 53 50.41	111 10 37.33	Lincoln	41019.97	4.6129954
	98 32 30.506	731.7	314 30 36.47	134 49 12.64	Heath	59933.30	4.7776682
			323 12 24.56	143 21 18.14	Golden Belt	34001.33	4.5314959
			353 17 21.81	173 19 24.64	Wilson	40232.35	4.6045754
Bunker Hill	38 52 16.436	506.8	199 51 29.13	19 57 40.79	Meades Ranch	41661.11	4.6197308
	98 42 20.476	493.6	272 18 47.22	92 26 59.81	Wilson	18940.56	4.2773929

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and Longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Waldo	39 09 55.645	1716.1	255 17 17.52	75 28 14.52	Meades Ranch	25783.11	4.4113352
	98 49 50.128	1203.4	318 17 14.47	138 30 11.69	Wilson	44734.45	4.6506421
			341 38 12.02	161 42 55.11	Bunker Hill	34407.64	4.5366549
Blue Hill	38 58 57.310	1767.1	228 48 22.76	48 58 32.79	Waldo	30876.87	4.4896332
	99 05 57.933	1394.4	240 45 31.84	61 06 37.98	Meades Ranch	55185.00	4.7418210
			289 46 43.15	110 01 33.78	Bunker Hill	36312.86	4.5600604
Allen	38 49 35.689	1100.5	131 19 58.31	311 11 23.81	Blue Hill	26260.11	4.4192965
	98 52 18.705	451.2	185 24 58.50	5 26 32.00	Waldo	37789.35	4.5773694
			250 59 06.05	71 05 21.30	Bunker Hill	15253.90	4.1833810
Fairmount	38 40 30.165	930.1	166 28 22.67	346 24 48.69	Blue Hill	35118.51	4.5455361
	99 00 16.656	402.6	214 24 45.88	34 29 45.05	Allen	20400.25	4.3096355
			229 55 59.62	50 07 13.57	Bunker Hill	33900.07	4.5302006
Hays	38 54 51.841	1598.5	243 01 04.68	63 07 33.69	Blue Hill	16714.45	4.2230921
	99 16 16.771	404.0	285 34 52.00	105 49 54.48	Allen	36012.55	4.5564539
			318 49 37.10	138 59 38.64	Fairmount	35254.18	4.5472107
La Crosse	38 35 37.940	1169.8	179 44 21.19	359 44 16.98	Hays	35581.72	4.5512270
	99 16 10.050	243.2	198 50 46.88	18 57 10.34	Blue Hill	45609.74	4.6590576
			248 34 25.45	68 44 20.70	Fairmount	24757.55	4.3937077
Smoky Hill	38 43 35.088	1081.9	228 57 51.50	49 08 16.44	Hays	31841.32	4.5029910
	99 32 53.677	1296.6	276 42 19.46	97 02 43.10	Fairmount	47632.97	4.6779076
			301 08 32.08	121 18 59.04	La Crosse	28377.88	4.4529799
Trego	38 53 55.551	1712.9	266 45 32.75	86 59 21.24	Hays	31832.07	4.5028649
	99 38 15.907	383.4	337 51 28.51	157 54 50.48	Smoky Hill	20651.83	4.3149585
Skaggs	38 39 28.137	867.6	200 40 39.93	20 45 02.37	Trego	28595.98	4.4563050
	99 45 14.932	361.0	246 54 24.08	67 02 07.46	Smoky Hill	19465.48	4.2892652
			279 23 41.06	99 41 50.27	La Crosse	42800.85	4.6314524
Big Creek	38 55 39.410	1215.2	277 44 46.75	97 54 53.89	Trego	23506.36	4.3711854
	99 54 22.466	541.1	336 08 43.13	156 14 26.16	Skaggs	32735.53	4.5150194
Schmidt	38 41 46.499	1433.8	206 37 25.96	26 43 01.10	Big Creek	28741.66	4.4585118
	100 03 17.173	415.0	238 02 54.36	58 18 35.01	Trego	42636.72	4.6297838
			279 10 07.27	99 21 23.59	Skaggs	26506.08	4.4233455
Indian Creek	38 52 02.084	64.3	262 05 47.61	82 27 14.97	Big Creek	49857.68	4.6977321
	100 28 32.632	786.8	297 17 39.75	117 33 28.97	Schmidt	41210.93	4.6150124
Canyon	38 39 25.361	782.0	171 53 25.86	351 51 59.51	Indian Creek	23570.52	4.3723691
	100 26 14.715	355.8	236 46 35.11	57 06 33.14	Big Creek	55062.79	4.7408582
			262 26 03.59	82 40 24.45	Schmidt	33581.99	4.5261065
Beaver	38 43 24.662	760.4	244 31 00.94	64 45 34.82	Indian Creek	37249.48	4.5711202
	100 51 47.401	1145.0	281 07 58.72	101 23 56.82	Canyon	37769.80	4.5771447
Monument	38 53 56.464	1741.0	275 32 42.05	95 48 06.69	Indian Creek	35677.84	4.5523986
	100 53 05.604	135.0	304 29 46.46	124 46 35.38	Canyon	47260.10	4.6744946
			354 27 40.96	174 28 29.97	Beaver	19573.42	4.2916666
Gopher	38 59 27.457	846.6	293 12 36.32	113 22 55.03	Monument	25808.33	4.4117600
	101 09 29.915	720.0	319 06 57.25	139 18 03.85	Beaver	39214.45	4.5934461
Sheridan	38 51 33.573	1035.2	229 18 21.19	49 25 45.37	Gopher	22439.94	4.3510218
	101 21 16.871	406.8	263 41 01.64	83 58 43.22	Monument	41004.30	4.6128294
			289 17 26.11	109 35 54.66	Beaver	45287.33	4.6559767
Teeters Hill	39 04 23.182	714.9	288 12 28.94	108 24 30.55	Gopher	29030.44	4.4628536
	101 28 35.773	859.9	335 57 40.12	156 02 16.13	Sheridan	25978.37	4.4146119
Wallace Bluffs	38 50 56.391	1738.8	200 14 17.43	20 18 17.41	Teeters Hill	26521.59	4.4235996
	101 34 57.4[illegible]6	1384.8	246 40 59.06	66 56 58.70	Gopher	40031.20	4.6023986
			266 36 43.34	86 45 18.11	Sheridan	19819.08	4.2970835
Turtle	39 01 17.931	553.0	256 40 32.90	76 51 09.15	Teeters Hill	24950.36	4.3970768
	101 45 25.759	619.7	297 11 07.66	117 26 18.31	Sheridan	39272.57	4.5940893
			321 39 01.79	141 45 36.66	Wallace Bluffs	24420.75	4.3877590
Curlew	38 50 26.101	804.8	186 12 37.93	6 13 35.07	Turtle	20219.25	4.3057651
	101 46 56.687	1367.1	225 39 53.92	45 51 26.11	Teeters Hill	36999.63	4.5681974
			266 51 18.26	86 58 49.39	Wallace Bluffs	17370.82	4.2398204
McLane	39 01 54.398	1677.6	273 31 56.74	93 39 44.96	Turtle	17921.88	4.2533836
	101 57 49.345	1186.9	301 26 04.88	121 40 27.15	Wallace Bluffs	38773.86	4.5885391
			323 25 07.96	143 31 58.13	Curlew	26411.95	4.4218004

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Arapahoe (Colo.)	38 46 01.519	46.8	201 13 23.16	21-18 21.15	McLane	31530.13	4.4987257
	102 05 43.882	1059.4	225 59 04.46	46 11 49.31	Turtle	40747.11	4.6100968
			253 12 17.04	73 24 03.41	Curlew	28396.26	4.4532612
Monotony (Colo.)	39 01 44.752	1380.1	269 13 17.61	89 24 05.78	McLane	24759.27	4.3937378
	102 14 58.626	1410.2	297 10 24.66	117 28 01.66	Curlew	45596.54	4.6589319
			335 16 03.18	155 21 51.53	Arapahoe	32010.98	4.5052989
Independence Court-House, high cupola or tower (Mo.)	39 05 32.741	1009.7	355 15 58.35	175 16 47.46	Bowler	22794.0	4.3578212
	94 24 57.613	1384.6	22 25 22.42	202 19 57.94	Berry	32639.3	4.5137405
			62 44 18.46	242 34 40.59	Marty	24838.7	4.3951284
Kansas City Catholic Cathedral, Eleventh street, between Broadway and Washington (Mo.)	39 06 03.118	96.2	273 31 36.5	93 38 09.4	Independence C.H.	14996.2	4.175980
	94 35 20.437	491.1	324 26 47.9	144 34 08.9	Bowler	29051.1	4.463162
			355 16 08.7	175 17 16.1	Berry	31224.1	4.494490
			29 52 35.9	209 49 30.3	Marty	14233.6	4.153315
			79 49 21.0	259 33 44.4	Eckman	36306.0	4.559978
Kansas City Second Presbyterian Church, spire (Mo.)	39 05 55.813	1721.2	272 41 54.75	92 48 23.10	Independence C.H.	14816.3	4.1707387
	94 35 13.448	323.2	30 55 25.85	210 52 15.87	Marty	14124.3	4.1499661
			80 13 08.76	259 57 27.81	Eckman	36432.3	4.5614868
Westport, College of Redemptorist Fathers (Mo.)	39 04 01 546	47.7	319 41 24.6	139 48 44.9	Bowler	26078.4	4.416281
	94 35 19.549	470.0	354 40 08.6	174 41 15.2	Berry	27487.7	4.439138
			39 36 41.0	219 33 34.9	Marty	11154.1	4.047434
Kansas City Astronomic Station 1882 (Mo.)	39 05 50.40	1554.1					
	94 35 22.16	532.7					
Harrisonville Cumberland Presbyterian Church, spire (Mo.)	38 39 14.918	460.0	108 11 29.0	287 58 55.0	Haskin	30660.1	4.486573
	94 21 00.613	14.8	135 30 36.2	315 22 45.0	Berry	25924.2	4.413706
			171 35 54.9	351 34 15.4	Bowler	26220.0	4.418633
			285 15 49.6	105 17 21.0	Fulton	3666.5	3.564256
State Line 3, stake	38 46 20.761	640.2	61 36 44.4	241 33 51.4	Haskin	7592.3	3.880372
	94 36 30.102	725.7	167 20 53.5	347 18 32.3	Marty	24716.8	4.392993
			218 32 17.7	38 34 08.4	Berry	6830.8	3.834472
Belton South Methodist Church, spire (Mo.)	38 48 32.756	1010.0	60 17 46.1	240 11 57.4	Haskin	15481.2	4.189806
	94 31 49.882	1203.5	116 55 47.0	296 54 41.9	Berry	2808.8	3.448518
			148 46 25.9	328 41 08.7	Marty	23451.5	4.370170
			233 29 49.6	53 34 57.2	Bowler	14701.4	4.167359
			313 19 22.9	133 27 40.6	Fulton	26444.8	4.422341
Missouri and Kansas State Line 3, stone	38 46 02.85	87.9	179 59 23	359 59 23	State Line 3	552.16	2.74207
	94 36 30.10	726.7					
State Line 1	38 53 01.80	55.5	328 59 26	149 01 16	Berry	8194.7	3.913532
	94 36 28.69	691.6	22 47 35	202 44 41	Haskin	17329.3	4.238782
Missouri and Kansas State Line 1, stone (Mo.)	38 53 01.56	48.1	117 32 54	297 32 54	State Line 1	15.82	1.19931
	94 36 28.11	677.6					
Base 1*	38 59 27.48	847.3	345 31 14	165 33 21	Berry	19536.9	4.290856
	94 36 56.18	1352.1	88 17 00	268 14 55	Marty	4788.2	3.680172
Base 2*	38 59 19.15	590.5	198 43 06	18 43 08	Base 1	271.24	2.43336
	94 36 59.80	1439.3					
State Line 2	38 59 10.30	317.6	110 31 44	290 31 25	Base 2	778.2	2.89111
	94 36 29.52	710.5	129 32 31	309 32 14	Base 1	832.2	2.92022
Missouri and Kansas State Line 2, stone	38 59 10.39	320.4	11 08 31	191 08 31	State Line 2	2.90	0.4617
	94 36 29.49	709.8					
Section Line 1	38 59 35.04	1080.4	37 55 13	217 55 05	Marty	479.0	2.68034
	94 40 02.81	67.6					
Section Line 2	38 59 08.84	272.6	145 45 51	325 45 43	Marty	520.4	2.71630
	94 40 02.88	69.3					
Martys House, lightning rod*	38 59 36.27	1118.4	275 46 38	95 46 48	Section Line 1	377.8	2.57727
	94 40 18.43	443.4	348 54 34	168 54 36	Marty	423.8	2.62720
Lenexa Methodist Episcopal Church, spire	38 57 45.236	1394.8	44 44 50.7	224 39 00.1	Thomas	19120.6	4.281502
	94 44 21.174	509.8	111 21 36.3	291 11 41.5	Eckman	24407.0	4.387514
			243 03 39.0	63 06 13.9	Marty	6644.7	3.822478
			315 14 10.6	135 20 57.2	Berry	22181.8	4.345997

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Olathe High School	38 52 41.989	1294.7	323 24 34.3	143 29 30.2	Haskin	19130.0	4.281716
	94 48 58.821	1417.9	57 56 13.4	237 53 17.4	Thomas	7982.0	3.902110
			138 37 26.6	318 30 26.9	Eckman	24286.6	4.385367
Olathe Methodist Episcopal Church, spire*	38 52 50.54	1558.4	55 26 07	235 23 17	Thomas	7934.1	3.899495
	94 49 08.39	202.2	226 40 38	46 46 14	Marty	17644.2	4.246603
Olathe Deaf and Dumb Asylum, new chimney*	38 52 58.95	1817.8	60 11 00	240 01 40	Bebe Mound	24850.1	4.395329
	94 48 45.78	1103.4	137 14 38	317 07 30	Eckman	24108.8	4.382176
Dennis Barn, cupola 1885	38 51 58.426	1801.5	61 20 45.8	241 18 28.2	Thomas	6037.4	3.780849
	94 49 59.624	1437.4	143 17 06.3	323 10 44.9	Eckman	24406.6	4.387508
			225 43 48.6	45 49 55.9	Marty	19648.1	4.293320
Ochiltree Church, cupola* 1885	38 46 06.78	209.1	285 26 04	135 31 02	Haskin	11923.0	4.076387
	94 49 02.54	61.3	90 57 15	270 48 06	Bebe Mound	21158.9	4.325493
Spring Hill Methodist Church, spire	38 44 34.316	1058.1	152 02 34.8	332 00 05.9	Thomas	12226.7	4.087310
	94 49 41.630	1005.4	98 59 59.2	278 51 15.1	Bebe Mound	20464.2	4.310994
			271 28 32.6	91 33 54.9	Haskin	12441.3	4.094866
Spring Hill Presbyterian Church, spire	38 44 36.424	1123.0	151 46 13.6	331 43 43.9	Thomas	12184.1	4.085792
	94 49 40.340	974.2	271 46 46.8	91 52 08.3	Haskin	12412.0	4.093842
			98 48 24.9	278 39 39.6	Bebe Mound	20484.9	4.311434
Gardner Methodist Church, spire	38 48 33.600	1036.0	70 26 37.5	250 21 31.1	Bebe Mound	12530.0	4.097951
	94 55 29.799	719.0	165 34 57.9	345 32 04.1	Eckman	26711.4	4.426697
			217 55 46.4	37 56 55.7	Thomas	4335.5	3.637042
Gardner Catholic Church, spire*	38 48 33.74	1040.3	70 09 18	250 04 16	Bebe Mound	12368.7	4.092323
	94 55 36.97	892.0	219 43 26	39 44 40	Thomas	4440.5	3.647435
Hesper Schoolhouse, belfry*	38 53 56.45	1740.6	199 53 30	19 56 01	Eckman	16923.9	4.228501
	95 04 05.78	139.3	293 20 48	113 27 22	Thomas	16426.6	4.216341
Edgerton Presbyterian Church, spire*	38 45 54.76	1688.5	99 20 31	279 18 41	Bebe Mound	4288.9	3.632345
	95 00 43.59	1052.4	230 52 25	50 56 51	Thomas	13190.9	4.120275
Blue Mound 1887	38 54 15.821	487.8	117 57 02.5	297 48 57.9	Kanwaka	21000.6	4.322232
	95 10 55.056	1326.6	225 30 07.4	45 36 55.4	Eckman	21872.5	4.339898
			285 51 15.4	106 02 05.2	Thomas	25967.9	4.414436
			324 28 36.6	144 33 10.1	Bebe Mound	18121.6	4.258196
Lawrence, Kansas State University, north dome, anemometer	38 57 25.632	790.4	40 54 07.8	220 46 56.8	Simmons	25312.6	4.403337
	95 14 37.467	902.1	106 46 41.6	286 40 56.6	Kanwaka	13785.2	4.139414
			245 37 53.7	65 47 01.9	Eckman	22998.7	4.361704
			293 04 38.3	113 17 48.3	Thomas	32983.4	4.518295
			322 19 51.2	142 26 44.4	Bebe Mound	26016.0	4.415240
Lawrence Water Tower, pole	38 57 38.912	1199.8	40 32 30.2	220 25 15.5	Simmons	25714.5	4.410177
	95 14 31.646	761.9	104 59 01.9	284 53 13.2	Kanwaka	13808.0	4.140129
			246 25 41.7	66 34 46.3	Eckman	22704.2	4.356107
			323 07 12.8	143 14 02.4	Bebe Mound	26257.0	4.419245
Carson	38 54 22.062	680.3	43 26 37.4	223 21 05.7	Simmons	18564.0	4.268672
	95 17 15.260	367.7	135 42 10.5	315 38 04.9	Kanwaka	13461.2	4.129083
			238 30 15.5	58 41 02.8	Eckman	29019.8	4.462694
			307 08 07.2	127 16 39.3	Bebe Mound	24720.7	4.393060
Le Compton, U.S.G.S.*	39 00 01.38	42.6	313 04 00	133 04 24	Kanwaka	1221.9	3.087018
	95 24 22.99	553.3	5 49 14	185 48 11	Simmons	24075.8	4.381581
Big Springs Windmill	39 00 41.02	1265.0	285 56 03	105 59 11	Kanwaka	7480.5	3.873928
	95 28 44.78	1077.4	82 45 51	262 35 12	Elevation	24653.1	4.391872
Roberts Windmill	38 59 58.242	1795.8	85 08 45.9	264 59 33.2	Elevation	21220.0	4.326746
	95 31 02.426	58.2	273 58 45.3	94 03 20.0	Kanwaka	10530.9	4.022467
			343 12 16.0	163 15 23.3	Simmons	24914.9	4.396460
Kellams House, chimney	38 56 22.630	697.8	54 41 39.8	234 31 59.9	Mabon	27325.9	4.436574
	95 31 45.398	1093.3	103 33 40.1	283 24 54.7	Elevation	20686.3	4.315682
			242 50 36.9	62 55 38.4	Kanwaka	12969.4	4.112920
			334 24 52.8	154 28 26.9	Simmons	19072.4	4.280406

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Stenger	38 49 53.636	1653.8	36 47 53.0	216 46 38.6	Mabon	4781.0	3.679516
	95 45 10.815	260.9	97 00 42.9	276 46 52.1	Clark	32176.1	4.507534
			124 19 35.6	304 12 59.7	Powell	18397.9	4.264768
			177 32 09.2	357 31 50.5	Elevation	16835.6	4.226229
			239 50 33.8	60 04 01.0	Kanwaka	35763.3	4.553438
			280 34 03.0	100 46 01.7	Simmons	28153.7	4.449536
Carbondale School-house, (stone) cupola	38 49 07.096	218.8	74 26 59.4	254 23 16.4	Mabon	8911.9	3.949969
	95 41 13.707	330.7	104 06 21.7	284 03 52.9	Stenger	5896.9	3.770627
			119 29 24.8	299 20 20.1	Powell	24017.0	4.380518
			160 35 47.8	340 33 00.0	Elevation	19357.3	4.286844
			279 40 59.3	99 50 29.2	Simmons	22270.7	4.347733
Prominent Windmill*	38 47 38.68	1192.7	92 06 22	272 02 24	Mabon	9191.6	3.96339
	95 40 48.85	1178.9	123 23 03	303 20 19	Stenger	7567.3	3.87894
Scranton Schoolhouse, south end cupola*	38 46 54.18	1670.6	110 05 51	290 03 50	Mabon	4965.2	3.69594
	95 43 56.26	1357.9	161 59 54	341 59 07	Stenger	5818.8	3.76483
Knox Knob, top	39 00 34.696	1070.0	36 19 18.6	216 18 21.9	Elevation	3658.6	3.563311
	95 44 10.854	261.1	64 37 23.1	244 22 52.9	Clark	36946.1	4.567568
			97 42 15.5	277 29 31.4	Adams	29448.8	4.469067
Martins Hill 1888	39 03 47.946	1478.6	0 04 35.1	180 04 34.8	Elevation	8907.3	3.949747
	95 45 40.394	971.4	55 04 26.9	234 50 52.3	Clark	38081.1	4.580709
			85 43 41.4	265 31 53.1	Adams	27105.0	4.433049
Topeka Insane Asylum, cupola*	39 03 54.40	16 77.7	25 44 00	205 42 05	Elevation	10107.9	4.00466
	95 42 38.56	927.2	87 24 28	267 22 33	Martins Hill	4376.2	3.64110
Topeka Methodist Episcopal Church, spire*	39 03 09.46	291.7	43 14 44	223 11 34	Elevation	10594.2	4.02507
	95 40 39.33	945.7	99 20 23	279 17 13	Martins Hill	7335.6	3.86543
Topeka First Presbyterian Church, spire	39 02 57.12	1761.6	44 10 17	224 07 11	Elevation	10228.2	4.00980
	95 40 44.78	1076.8	89 17 21	269 02 27	Adams	34141.3	4.53328
			102 27 56	282 24 50	Martins Hill	7278.8	3.86206
Topeka, State House, west wing, flagstaff*	39 02 53.71	1656.4	44 50 03	224 46 55	Elevation	10197.65	4.00850
	95 40 42.17	1014.1	103 09 19	283 06 11	Martins Hill	7363.1	3.86706
Topeka, State House, west wing, cupola*	39 02 53.52	1650.5	44 55 16	224 52 08	Elevation	10204.7	4.00880
	95 40 41.51	998.2	103 10 18	283 07 10	Martins Hill	7380.1	3.86806
Stone House, center	38 59 12.18	375.6	53 09 15	233 05 16	Powell	11436.4	4.05829
	95 49 21.62	520.4	62 46 42	242 35 26	Clark	29112.5	4.46408
			106 35 29	286 26 01	Adams	22652.7	4.35512
			274 19 17	94 21 35	Elevation	5328.6	3.72661
White House on hill, center chimney	38 50 57.68	1778.5	95 29 53	275 21 16	Clark	19973.8	4.30046
	95 53 30.79	742.5	159 24 53	339 23 31	Powell	8957.98	3.95221
			217 17 19	37 22 14	Elevation	18669.4	4.27113
			279 15 29	99 20 43	Stenger	12219.1	4.08704
Burlingame Schoolhouse, cupola	38 45 11.86	365.7	117 15 23	297 04 48	Clark	27491.0	4.43919
	95 50 21.75	525.2	220 47 13	40 50 29	Stenger	11481.0	4.05998
			223 39 46	43 41 48	Mabon	6720.3	3.82739
Eskridge Schoolhouse, cupola*	38 51 26.14	806.0	123 39 43	303 39 03	Clark	1824.4	3.26112
	96 06 12.48	300.9	243 40 04	63 46 40	Powell	16958.2	4.22938
Small House	38 53 26.56	819.0	256 41 26	76 48 26	Powell	16553.9	4.21890
	96 06 50.29	1212.1	12 39 40	192 39 24	Clark	2769.4	3.44239
			251 20 51	71 34 09	Elevation	32247.1	4.50849
			191 35 52	11 37 23	Adams	17453.8	4.24189
Buffalo Mound, azimuth mark	39 03 42.898	1323.0	359 48 30.6	179 48 30.8	Adams	1909.8	3.280982
	96 04 24.634	592.3	95 31 20.5	275 18 38.0	Zean Dale	29209.3	4.465521
St. Marys Catholic Church, spire	39 11 31.100	959.1	311 16 54.2	131 28 24.8	Elevation	35082.1	4.545085
	96 03 56.199	1348.7	2 22 22.6	182 22 04.8	Adams	16362.1	4.213838
			68 39 42.5	248 26 41.0	Zean Dale	31947.1	4.504432
Moss Springs, Morgans barn, ventilator	38 53 30.74	947.8	46 51 29	226 50 18.	Reinhard	3773.4	3.57673
	96 31 58.52	1410.4	206 15 26	26 20 05	Zean Dale	24131.8	4.38259
			258 35 21	78 43 58	Meyer	20213.0	4.30563
Newbury Catholic Church, spire*	39 05 05.40	166.5	297 00 42	117 04 31	Adams	9795.8	3.99104
	96 10 27.28	653.3	90 40 25	270 31 31	Zean Dale	20359.2	4.30876

*No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Abernathys Windmill	38 51 26.33	811.9	70 03 24	249 56 11	White City	17655.1	4.24687
	96 32 17.23	415.4	118 36 38	298 35 37	Reinhard	2622.7	3.41875
			203 35 20	23 40 11	Zean Dale	27801.6	4.44407
			248 51 28	69 00 16	Meyer	21726.5	4.33699
United Brethren	38 56 33.71	1039.4	1 58 04	181 57 57	Reinhard	8227.9	3.91529
Church, cupola*	96 33 41.00	987.4	144 28 03	324 25 17	Humboldt	10954.9	4.03961
Dwight Windmill*	38 50 55.71	1717.9	67 41 04	247 35 42	White City	13393.7	4.12690
	96 35 11.53	278.0	220 48 40	40 49 29	Reinhard	2906.6	3.46339
Dwight M. E. Church,	38 50 42.58	1312.9	68 21 04	248 15 58	White City	12690.0	4.10346
cupola*	96 35 36.22	873.3	223 45 36	43 46 41	Reinhard	3606.8	3.55712
White City School-	38 47 49.350	1521.7	111 51 07.0	291 40 46.1	Taylor	25703.7	4.409995
house, cupola	96 43 56.459	1362.6	164 19 54.7	344 17 25.2	Robbins	21224.5	4.326838
			202 57 31.7	22 57 38.7	White City	707.5	2.849703
			241 19 33.7	61 25 52.2	Reinhard	16589.0	4.219821
White City Baptist	38 47 36.948	1139.3	112 51 05.4	292 40 51.0	Taylor	25618.5	4.408553
Church, spire	96 44 06.791	163.9	165 14 38.0	345 12 15.0	Robbins	21528.1	4.333006
			206 56 03.1	26 56 16.6	White City	1159.6	3.064311
			240 35 47.0	60 42 12.0	Reinhard	16992.6	4.230261
Fort Riley Reservoir,	39 04 14.644	451.6	3 32 56.1	183 32 39.9	Robbins	9968.4	3.998626
top	96 47 28.965	696.3	41 58 09.2	221 50 00.3	Taylor	28015.5	4.447399
			104 42 31.7	284 33 08.8	Wilmer	22170.7	4.345779
			207 15 00.4	27 18 00.6	Erricssen	14968.4	4.175175
			291 19 26.3	111 25 21.2	Humboldt	14546.4	4.162756
Hollingers House,	38 53 57.96	1787.2	58 28 17	238 26 59	Taylor	3508.8	3.545154
cupola*	96 58 22.16	534.1	166 50 50	346 48 19	Wilmer	25281.8	4.402808
Grand View School-	39 01 07.733	238.5	353 37 05.3	173 37 17.7	Robbins	4211.6	3.624446
house, belfry	96 48 14.047	338.0	49 30 30.7	229 22 50.6	Taylor	23205.9	4.365599
			119 13 22.8	299 04 28.6	Wilmer	23330.4	4.367923
			202 35 29.4	22 38 58.0	Erricssen	20657.1	4.315069
			268 08 12.2	88 14 35.5	Humboldt	14642.8	4.165624
Abilene Catholic Col-	38 56 35.246	1086.8	59 54 10.5	239 43 00.6	Iron Mound	29759.4	4.473624
lege, cupola	97 12 54.453	1311.4	139 27 22.7	319 20 47.6	Vine Creek	23194.8	4.365391
			201 59 07.4	22 00 42.4	Frey	9708.9	3.987171
			290 16 58.5	110 24 48.3	Taylor	19226.4	4.283898
German Lutheran	38 42 53.948	1663.5	61 07 44.1	241 04 16.3	Fairmount	9174.0	3.962559
Church, spire	98 54 44.315	1070.7	195 49 44.5	15 51 15.7	Allen	12877.1	4.109818
			200 57 59	21 01 17	Russell NW. Base	21236.8	4.327088
			215 02 53	35 07 40	Russell SE. Base	19156.9	4.282325
Salina West Base	38 51 07.67	236.6	90 00	270 00	Salina W. Base	7.87	0.89597
Latitude Station	97 36 10.51	253.5					
Ellsworth Water Tow-	38 44 10.400	320.7	29 10 10.5	209 06 53.0	Bossing	15689.1	4.195598
er, pole	98 13 55.321	1336.2	122 40 45.2	302 31 08.7	Wilson	26357.4	4.420903
			232 45 53.2	52 52 44.8	Heath	19903.1	4.298921
			311 52 07.0	132 00 50.4	Sherman	27231.7	4.435074
Ellsworth Astronomic	38 43 48.76	1503.5	159 29 28.4	339 29 21.9	Ellsworth W. Tower	712.5	2.85280
Station	98 13 44.98	1086.5					
Ellsworth North Base	38 43 57.51	1773.3	29 09 59	209 09 55	Ellsworth Astr. Sta.	309.2	2.49018
	98 13 38.74	935.7	134 47 34	314 47 24	Ellsworth W. Tower	564.0	2.75132
Ellsworth South Base	39 43 52.21	1609.9	9 06 17	189 06 16	Ellsworth Astr. Sta.	107.7	2.03232
	98 13 44.28	1069.5	219 14 25	39 14 29	Ellsworth N. Base	211.23	2.32475
			154 34 30	334 34 23	Ellsworth W. Tower	621.2	2.79320
Ellsworth Schoolhouse,	38 43 50.06	1543.6	27 16 26	207 16 25	Ellsworth Astr. Sta.	45.0	1.65358
cupola	98 13 44.13	1065.8	176 54 02	356 54 02	Ellsworth S. Base	66.4	1.82239
			209 29 16	29 29 19	Ellsworth N. Base	264.1	2.42185
Salina, Phillips House,	38 50 20.26	624.7	140 15 11	320 05 51	Thompson	33508.0	4.525148
dome	97 34 52.83	1274.2	299 16 49	119 19 26	Iron Mound	6951.0	3.842046
			91 01 27	270 43 50	Heath	40652.0	4.609082
Salina, St. Johns Mili-	38 51 45.51	1403.3	140 29 58	320 21 39	Thompson	29974.0	4.476745
tary College, vane	97 36 30.95	746.2	305 33 30	125 37 09	Iron Mound	10362.8	4.015479
on tower			87 08 15	266 51 39	Heath	38327.1	4.583506

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Soldier Cap Mound*	38 42 58.46	1802.6	176 04 43	356 03 32	Thompson	39450.5	4.596052
	97 47 51.84	1252.5	247 34 20	67 45 05	Iron Mound	26893.2	4.429643
Sugar Loaf Mound, rock pile	38 49 28.37	874.8	102 10 52	282 06 23	Heath	10564.5	4.023851
	97 55 50.04	1207.1	153 50 19	333 43 57	Lincoln	33025.4	4.518848
			197 50 17	17 54 07	Thompson	28720.0	4.458185
			272 42 11	92 57 57	Iron Mound	36437.5	4.561549
Lincoln College, cupola	39 01 59.80	1844.1	337 54 14	157 57 55	Heath	22604.8	4.354201
	98 08 50.84	1222.8	66 18 09	246 12 08	Golden Belt	15079.6	4.178391
			121 58 19	301 43 23	Meades Ranch	40143.6	4.603616
Turkey Point	38 56 17.33	534.4	112 09 00	292 04 11	Golden Belt	11923.9	4.076417
	98 10 45.68	1100.2	202 15 04	22 18 06	Lincoln	18390.1	4.264583
			244 00 57	64 14 11	Thompson	33739.1	4.528134
			312 38 26	132 43 19	Heath	15324.1	4.185374
Small Peak	39 15 22.39	690.5	300 44 08	120 57 35	Lincoln	35677.0	4.552388
	98 27 11.91	285.6	337 36 24	157 41 57	Golden Belt	33325.4	4.522776
			3 55 00	183 53 42	Wilson	33627.4	4.639759
			64 59 46	244 56 24	Meades Ranch	8432.6	3.925961
Lone Tree (cottonwood)*	39 03 36.31	1119.8	71 27 54	251 16 11	Golden Belt	28321.5	4.452116
	97 59 48.92	1176.2	111 33 53	291 30 01	Lincoln	9483.7	3.976979
Bunker Hill Water Tower	38 52 15.48	477.3	50 13 06	230 01 51	Fairmount	33923.6	4.530502
	98 42 18.17	438.0	71 15 37	251 09 20	Allen	15296.8	4.184600
			110 02 26	289 47 34	Blue Hill	36374.2	4.560794
			161 38 32	341 33 48	Waldo	34453.2	4.537229
			272 13 51	92 22 02	Wilson	18883.7	4.276088
Bunker Hill Methodist Church, spire	38 52 34.29	1057.3	69 32 01	249 25 38	Allen	15712.1	4.196234
	98 42 08.46	203.9	160 57 45	340 52 54	Waldo	33978.7	4.531207
			274 02 17	94 10 22	Wilson	18681.8	4.271418
Bunker Hill Schoolhouse, cupola	38 52 34.81	1073.4	69 41 51	249 35 24	Allen	15878.8	4.200817
	98 42 01.34	32.3	160 40 52	340 35 57	Waldo	34020.0	4.531734
			199 31 27	19 37 27	Meades Ranch	40878.1	4.612491
			274 07 34	94 15 35	Wilson	18511.9	4.267450
Bunker Hill Flouring Mill, iron chimney	38 52 30.80	949.7	49 27 24	229 16 13	Fairmount	34119.8	4.533007
	98 42 24.02	579.0	69 25 06	249 18 53	Allen	15322.8	4.185338
			161 37 02	341 32 21	Waldo	33960.4	4.530973
Russell Tripod	38 54 39.51	1218.3	294 51 35	114 55 43	Bunker Hill	10481.0	4.020404
	98 48 54.96	1324.2	27 41 08	207 39 00	Allen	10578.2	4.024410
			177 19 01	357 18 26	Waldo	28282.3	4.451514
Russell High School, cupola, pole	38 53 19.51	601.6	116 50 25	296 41 26	Blue Hill	23131.2	4.364199
	98 51 40.44	974.6	184 55 44	4 56 53	Waldo	30832.4	4.489008
			216 30 10	36 42 15	Meades Ranch	46371.3	4.666249
			278 09 03	98 14 54	Bunker Hill	13636.2	4.134714
			7 37 04	187 36 40	Allen	6963.1	3.842802
			27 45 17	207 39 54	Fairmount	26796.6	4.428079
Russell Northwest Base	38 53 36.93	1138.7	283 28 32	103 33 01	Bunker Hill	10623.1	4.026250
	98 49 29.00	698.9	28 49 37	208 47 50	Allen	8490.0	3.928910
			112 36 52	292 26 30	Blue Hill	25785.5	4.411376
			179 02 16	359 02 03	Waldo	30185.0	4.479791
Russell Southeast Base	38 51 22.30	687.6	66 20 03	246 16 48	Allen	8181.2	3.912819
	98 47 08.07	194.6	117 22 07	297 10 17	Blue Hill	30622.8	4.486045
			140 43 05	320 41 36	Russell NW. Base	5364.4	3.729521
			173 32 05	353 30 24	Waldo	34553.0	4.538486
			256 26 19	76 29 20	Bunker Hill	7132.0	3.853213
Russell North School, tall cupola	38 53 53.99	1664.7	280 02 45	100 04 02	Russell NW. Base	3012.9	3.478980
	98 51 32.10	773.5	282 42 03	102 47 49	Bunker Hill	13631.5	4.134543
			306 17 30	126 20 15	Russell SE. Base	7898.5	3.897543
			184 43 12	4 44 18	Waldo	29755.7	4.473570
Blue Hill, U. S. G. S.	39 20 29.64	914.0	325 49 25	145 57 41	Lincoln	33537.2	4.525527
	98 18 59.83	1432.8	358 47 26	178 47 49	Golden Belt	40306.9	4.605379
Russell SE. Base Astr. Sta.	38 51 22.30	687.6	90	270	Russell SE. Base	6.16	0.78958
	98 47 07.81	188.3					
Salina Paper Mill, tall brick chimney	38 50 54.29	1674.1	138 41 38	318 41 28	Salina West Base	549.4	2.739881
	97 35 55.80	1345.6	175 47 13	355 46 51	North Pole Mound	11612.9	4.064941
			300 23 43	120 27 00	Iron Mound	8790.7	3.944022

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
New Cambria Church	38 52 44.04	1358.0	2 57 18	182 57 07	Iron Mound	7846.2	3.894658
(stone), white spire*	97 30 24.78	597.3	132 54 30	312 50 40	North Pole Mound	12047.2	4.080887
Section 31, T. 13, R. 12,	38 52 15.02	463.2	232 53 37	52 53 39	Bunker Hill	72.6	1.86096
SW. cor., stone	98 42 22.88	551.6					
Section 13, T. 11, R. 1,	39 06 52.08	1606.0	352 19 48	172 19 48	Vine Creek	142.2	2.15305
NW. cor., stone	97 23 22.70	545.4					
Section 22, T. 14, R. 14,	38 49 38.06	1173.6	302 27 11	122 27 14	Allen	136.2	2.13413
NW. cor., stone	98 52 23.47	566.1					
Gorham Elevator	38 52 52.690	1624.7	33 59 48.9	213 50 33.2	La Crosse	38450.7	4.584904
	99 01 21.654	522.0	99 44 40.2	279 35 18.4	Hays	21881.3	4.340073
			149 24 17.1	329 21 23.6	Blue Hill	13065.4	4.116122
			294 50 38.5	114 56 19.1	Allen	14432.8	4.159351
			356 04 27.5	176 05 08.2	Fairmount	22950.1	4.360784
Walker Schoolhouse,	38 52 09.717	299.6	29 03 33.8	208 56 14.7	La Crosse	34965.4	4.543639
cupola	99 04 28.276	681.7	106 22 52.6	286 15 27.8	Hays	17791.6	4.250216
			170 15 28.2	350 14 31.9	Blue Hill	12753.0	4.105613
			285 02 38.7	105 10 16.4	Allen	18223.3	4.260628
Hertzog Catholic	38 51 23.044	710.5	19 35 58.3	199 31 30.1	La Crosse	30928.1	4.490353
Church, tower	99 09 01.355	32.7	121 34 04.1	301 29 30.8	Hays.	12312.2	4.090335
			197 29 30.0	17 31 25.3	Blue Hill	14688.5	4.166976
			327 46 30.2	147 51 58.8	Fairmount	23785.9	4.376320
Katherinestadt Catholic Church, spire	38 55 38.213	1178.3	7 07 05.0	187 05 05.5	La Crosse	37297.5	4.571680
	99 12 59.075	1423.0	73 18 18.8	253 16 14.6	Hays	4972.6	3.696586
			238 46 14.9	58 50 39.7	Blue Hill	11854.3	4.073877
			290 23 30.7	110 36 29.2	Allen	31920.7	4.504073
			326 37 36.3	146 45 34.1	Fairmount	33503.8	4.525094
Victoria, Stable cupola	38 50 48.995	1510.7	131 15 45.3	311 12 02.7	Hays	11361.6	4.055439
west of	99 10 22.285	537.4	202 54 11.3	22 56 57.3	Blue Hill	16349.4	4.213503
			322 29 04.9	142 35 24.0	Fairmount	24040.4	4.380941
Ellis Schoolhouse,	38 55 58.59	1806.6	274 36 35	94 47 28	Hays	25118.3	4.399990
tower*	99 33 35.98	866.6	60 39 46	240 36 50	Trego	7738.1	3.888633
Round Top Mound	38 54 59.078	1821.6	93 15 46.3	273 06 02.8	Big Creek	22406.7	4.350378
	99 38 53.768	1295.4	270 16 21.8	90 30 34.2	Hays	32693.7	4.514464
			335 01 33.5	155 01 57.3	Trego	2161.0	3.334647
State Forestry Station,	38 59 37.31	1150.8	316 26 22	136 30 43	Trego	14534.6	4.162404
large windmill*	99 44 11.55	278.0	61 06 07	241 00 21	Big Creek	15157.8	4.180637
Wakeeney Court-	39 01 34.37	1060.0	303 34 30	123 43 45	Trego	25532.1	4.407086
House, cupola*	99 52 58.66	1411.1	10 26 58	190 26 05	Big Creek	11130.3	4.046505
Ransom Schoolhouse,	38 38 03.97	122.5	123 14 51	303 10 20	Schmidt	12527.9	4.097878
cupola*	99 56 03.62	87.3	260 33 01	80 39 46	Skaggs	15900.4	4.201409
Ransom Gristmill,	38 37 59.50	1834.6	123 43 34	303 39 03	Schmidt	12619.3	4.101036
smokestack*	99 56 02.86	69.3	260 02 57	80 09 41	Skaggs	15905.6	4.201551
Castle Rock	38 51 23.309	718.7	46 38 38.4	226 28 32.4	Canyon	32196.7	4.507812
	100 10 06.518	157.2	92 39 48.6	272 28 14.5	Indian Creek	26695.5	4.426438
			250 46 31.5	70 56 24.2	Big Creek	24083.3	4.381716
			330 54 36.3	150 58 52.7	Schmidt	20346.8	4.308497
Bluff	38 51 32.604	1005.3	42 35 52.3	222 26 59.0	Canyon	30427.5	4.483267
	100 12 02.959	71.4	92 16 05.1	272 05 44.0	Indian Creek	23878.1	4.378000
			253 19 29.3	73 30 35.1	Big Creek	26666.6	4.425967
			324 52 33.0	144 58 02.3	Schmidt	22084.3	4.344083
Hill	38 40 11.113	342.7	100 34 45.5	280 20 49.4	Beaver	32863.9	4.516719
	100 29 30.088	727.4	126 48 22.0	306 33 35.4	Monument	42602.9	4.629439
			183 36 54.3	3 37 30.3	Indian Creek	21967.2	4.341775
			286 36 41.2	106 38 43.3	Canyon	4929.7	3.692816
Russell Springs School-	38 54 48.32	1490.1	68 18 57	248 12 25	Sheridan	16214.6	4.209906
house, cupola*	101 10 51.96	1252.0	192 55 13	12 56 04	Gopher	8831.4	3.946028
Russell Springs Court-	38 54 44.63	1376.2	68 48 51	248 42 16	Sheridan	16262.2	4.211180
House, cupola*	101 10 47.99	1156.1	192 09 27	12 10 16	Gopher	8921.7	3.950449
Russell Springs	38 54 58.24	1795.8	68 23 49	248 16 55	Sheridan	17098.7	4.232963
Church, spire*	101 10 17.52	422.1	187 51 26	7 51 56	Gopher	8380.5	3.923271

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Winona Old School-	39 03 43.46	1340.2	317 41 29	137 44 37	Gopher	10670.4	4.028181
house, cupola*	101 14 28.36	681.8	93 30 56	273 22 01	Teeters Hill	20409.2	4.309826
Winona New School-	39 03 45.255	1395.6	22 48 00.7	202 43 53.5	Sheridan	24469.0	4.388617
house, tower	101 14 43.599	1048.2	93 25 07.1	273 16 22.6	Teeters Hill	20040.1	4.301899
			316 28 01.4	136 31 18.9	Gopher	10960.5	4.039831
Sheridan Butte	39 00 36.155	1115.0	45 28 37.4	225 20 44.3	Wallace Bluffs	25466.8	4.405974
	101 22 24.477	589.0	128 07 46.6	308 03 52.7	Teeters Hill	11346.7	4.054871
			276 25 00.0	96 33 07.6	Gopher	18758.6	4.273200
			354 26 07.7	174 26 50.2	Sheridan	16810.5	4.225581
McAllaster School-	38 59 54.485	1680.0	45 20 53.4	225 13 36.5	Wallace Bluffs	23584.7	4.372630
house, spire	101 23 21.667	521.4	137 40 13.1	317 36 55.3	Teeters Hill	11212.9	4.049719
			348 58 35.2	168 59 53.6	Sheridan	15736.2	4.196901
Pond	38 58 52.098	1606.4	17 09 10.5	197 07 05.1	Curlew	16328.0	4.212932
1891	101 43 37.018	891.0	105 24 13.4	285 15 16.9	McLane	21264.6	4.327658
			149 48 58.9	329 47 50.3	Turtle	5203.0	3.716250
			244 42 10.7	64 51 38.0	Teeters Hill	23962.7	4.379535
			292 36 34.3	112 50 36.1	Sheridan	35002.4	4.544098
			319 28 42.1	139 34 08.4	Wallace Bluffs	19284.4	4.285206
Wallace Latitude Sta-	38 54 44.343	1367.3	64 19 09.6	244 11 59.5	Curlew	18336.0	4.263304
tion 1885	101 35 31.504	759.1	123 12 16.2	303 07 11.0	Pond	13966.7	4.145095
			285 51 50.6	106 00 47.1	Sheridan	21422.0	4.330860
			353 19 54.3	173 20 15.7	Wallace Bluffs	7077.0	3.849851
Wallace Railway Of-	38 54 43.870	1352.7	64 17 42.8	244 10 34.0	Curlew	18286.6	4.262132
fice (stone), chimney	101 35 33.490	806.9	123 21 43.4	303 16 39.4	Pond	13934.8	4.144100
1891			130 29 24.7	310 23 12.2	Turtle	18734.3	4.272637
			285 47 28.7	105 56 26.5	Sheridan	21464.1	4.331713
			352 55 56.5	172 56 19.1	Wallace Bluffs	7068.3	3.849313
Wallace Church, spire	38 54 56.931	1755.4	63 08 31.8	243 01 23.5	Curlew	18447.8	4.265945
	101 35 34.283	826.0	121 59 55.9	301 54 52.4	Pond	13701.2	4.136759
			129 34 39.8	309 28 27.8	Turtle	18460.6	4.266245
			286 48 20.7	106 57 19.0	Sheridan	21595.4	4.334362
			353 10 02.2	173 10 25.3	Wallace Bluffs	7470.4	3.873343
Wallace Schoolhouse,	38 55 03.962	122.2	62 36 20.5	242 29 11.0	Curlew	18584.9	4.269160
cupola,	101 35 32.500	783.0	121 07 48.1	301 02 43.5	Pond	13624.3	4.134313
1891			128 58 15.1	308 52 02.0	Turtle	18356.5	4.263790
			287 23 21.4	107 32 18.6	Sheridan	21618.2	4.334819
			353 40 41.0	173 41 03.0	Wallace Bluffs	7681.0	3.885415
Sharon Springs School-	38 54 01.285	39.6	21 49 33.4	201 48 24.3	Curlew	7147.4	3.854147
house, cupola	101 45 06.505	156.7	178 01 46.9	358 01 34.9	Turtle	13472.8	4.129457
			193 30 19.4	13 31 15.8	Pond	9223.0	3.964874
			277 24 17.9	97 39 15.3	Sheridan	34759.8	4.541077
			291 10 08.6	111 16 30.9	Wallace Bluffs	15750.5	4.197295
Sharon Springs	38 53 49.837	1536.7	24 00 31.9	203 59 19.1	Curlew	6876.9	3.837395
Church, spire	101 45 00.667	16.1	192 11 21.3	12 12 13.9	Pond	9535.9	3.979363
			276 51 21.6	97 06 15.2	Sheridan	34576.4	4.538780
			290 08 26.1	110 14 44.5	Wallace Bluffs	15494.4	4.190174
Kansas and Colorado	38 55 31.028	956.7	13 56 03.8	193 54 10.5	Arapahoe	18092.7	4.257504
Boundary Mark 73½	102 02 43.411	1045.7	123 08 09.8	303 00 27.3	Monotony	21119.0	4.324674
			210 53 07.9	30 56 12.9	McLane	13779.1	4.139220
			292 18 43.8	112 28 38.1	Curlew	24680.3	4.392351
Weskan Schoolhouse,	38 51 56.666	1747.3	46 05 44.0	226 00 48.8	Arapahoe	15780.5	4.198122
cupola	101 57 52.929	1276.0	133 23 01.4	313 19 59.0	Kans. and Colo. 73½	9628.0	3.983537
			126 22 31.4	306 11 46.6	Monotony,	30642.5	4.486324
			226 02 53.8	46 10 43.4	Turtle	24966.5	4.397358
			279 57 05.0	100 03 56.7	Curlew	16068.6	4.205978
Kansas and Colorado	39 00 22.642	698.3	98 13 44.5	278 06 02.7	Monotony	17828.4	4.251113
Boundary Mark 68	102 02 45.062	1084.2	248 17 04.7	68 20 10.9	McLane	7656.1	3.884009
			308 45 28.5	128 55 24.4	Curlew	29331.1	4.467329
Kansas and Colorado	38 51 30.148	929.6	23 22 26.0	203 20 32.3	Arapahoe	11038.3	4.042902
Boundary Mark 78	102 02 42.489	1024.5	136 58 33.1	316 50 50.4	Monotony	25951.1	4.414155
			179 49 41.7	359 49 41.1	Kans. and Colo. 73½	7427.9	3.870864
Kansas and Colorado	38 47 09.287	286.4	64 35 15.6	244 33 21.6	Arapahoe	4866.9	3.687254
Boundary Mark 83	102 02 41.793	1008.8	179 51 20.0	359 51 19.0	Kans. and Colo. 73½	15471.8	4.189541
			255 00 49.8	75 10 42.1	Curlew	23596.0	4.372838

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Dial	39 15 03.832	118.2	278 37 23.35	98 46 00.02	Meades Ranch	19817.10	4.2970402
	98 46 07.314	175.4	29 22 38.29	209 20 17.44	Waldo	10904.29	4.0375973
Kill Creek	39 16 51.330	1583.0	286 31 07.37	106 36 01.72	Dial	11631.36	4.0656305
	98 53 52.373	1255.2	335 35 37.51	155 38 10.69	Waldo	14074.56	4.1484348
Lawrence 2	39 31 13.088	403.6	345 35 22.00	165 38 45.23	Dial	30858.07	4.4893688
	98 51 27.586	659.0	7 26 23.19	187 24 51.29	Kill Creek	26800.75	4.4281469
Old Well 2	39 36 42.774	1319.1	357 12 09.17	177 13 04.86	Meades Ranch	43105.42	4.6345318
	98 33 58.209	1388.6	23 35 17.61	203 27 34.51	Dial	43689.32	4.6403753
			68 00 02.01	247 48 53.58	Lawrence 2	27034.11	4.4319121
Brown	39 46 37.160	1146.0	327 00 59.85	147 06 18.22	Old Well 2	21842.53	4.3393029
	98 42 16.680	397.0	24 47 36.18	204 41 44.66	Lawrence 2	31380.06	4.4966538
Lipps	39 59 40.677	1254.5	331 25 06.55	151 31 01.13	Brown	27505.66	4.4394220
	98 51 29.619	702.6	359 56 49.80	179 56 51.10	Lawrence 2	52663.94	4.7215133
Lebanon	39 49 41.533	1280.9	7 58 23.47	187 56 53.36	Old Well 2	24251.31	4.3847352
	98 31 37.195	884.5	69 33 43.46	249 26 54.10	Brown	16240.88	4.2106096
Cooper	39 58 41.987	1294.9	342 04 23.34	162 06 48.79	Lebanon	17517.19	4.2434644
	98 35 23.929	567.7	23 43 35.68	203 39 11.05	Brown	24412.03	4.3876039
			94 36 12.19	274 25 51.63	Lipps	22983.18	4.3614101
Herrick (Nebr.)	40 14 55.800	1721.2	335 19 24.94	155 25 39.49	Cooper	33040.00	4.5190400
	98 45 05.248	124.0	17 54 24.71	197 50 17.02	Lipps	29656.35	4.4721177
Blue Hill (Nebr.)	40 17 33.261	1025.9	11 05 42.51	191 02 36.64	Cooper	35553.50	4.5508824
	98 30 35.592	840.7	42 00 50.97	221 47 22.49	Lipps	44447.50	4.6478473
			76 46 45.95	256 37 23.80	Herrick	21113.72	4.3245648
Lawrence, U. S. G. S.	39 31 13.081	403.4	93 27	273 27	Lawrence 2	3.377	0.52853
	98 51 27.445	655.6					
Old Well, U. S. G. S.	39 36 42.824	1320.7	67 58 10.7	247 47 03.2	Lawrence, U. S. G. S	27003.1	4.431413
	98 33 59.502	1419.4	272 52 31	92 52 32	Old Well 2	30.875	1.48961
Tipton, U. S. G. S.	39 21 33.77	1041.4	3 07 33	183 07 12	Meades Ranch	15043.1	4.177338
	98 31 56.31	1348.1	59 32 42	239 23 43	Dial	23671.8	4.374231
			122 38 05	302 25 41	Lawrence 2	33222.6	4.521433
			174 04 40	354 03 22	Old Well 2	28184.4	4.450009
Medicine Peak	39 21 37.40	1153.4	47 51 36	227 45 42	Dial	18072	4.25701
	98 36 48.44	1159.7	70 18 29	250 07 40	Kill Creek	26066	4.41607
Covert	39 21 40.58	1251.4	23 17 00	203 14 41	Dial	13318.0	4.124439
	98 42 27.77	664.8	61 31 02	241 23 48	Kill Creek	18668.3	4.271104
			143 52 31	323 46 48	Lawrence 2	21871.7	4.339882
			203 35 32	23 40 56	Old Well 2	30371.5	4.482466
Sec. 16, T. 5, R. 11, SE. corner	39 36 39.57	1220.3	102 14 44	282 14 32	Old Well 2	466.0	2.66839
	98 33 39.12	933.3					
Hardilee, U. S. G. S.	39 50 52.82	1629.1	205 48 53	25 52 26	Lipps	18089.5	4.257426
	98 57 01.67	39.7	290 27 21	110 36 48	Brown	22478.6	4.351769
			347 37 40	167 41 13	Lawrence 2	37244.5	4.571063
Smith Center Standpipe	39 46 39.90	1230.6	163 46 41	343 43 33	Lipps	25082.2	4.399366
	98 46 34.26	815.3	270 46 05	90 48 50	Brown	6130.4	3.787487
			13 46 29	193 43 22	Lawrence 2	29426.6	4.468740
Smith Center Court-House, cupola.*	39 46 33.57	1035.3	164 54 01	344 51 04	Lipps	25146.7	4.400481
	98 46 53.49	1273.0	269 00 48	89 03 45	Brown	6588.5	3.818786
Lebanon Methodist Church, spire	39 48 36.36	1121.3	2 34 44	182 34 17	Old Well 2	22030.1	4.343017
	98 33 16.66	396.3	74 04 50	253 59 04	Brown	13364.1	4.125940
			229 38 22	49 39 26	Lebanon	3104.2	3.491949
Lebanon Schoolhouse, cupola*	39 48 38.39	1183.9	73 41 18	253 35 35	Brown	13274.3	4.123012
	98 33 21.35	507.9	231 48 59	51 50 05	Lebanon	3151.0	3.498443
Kansas and Nebraska State Line A	40 00 08.37	258.2	198 19 13	18 23 20	Herrick	28838.4	4.459971
	98 51 28.78	682.7	276 33 08	96 43 28	Cooper	23045.1	4.362579
			1 20 05	181 20 05	Lipps	854.21	2.931566
Kansas and Nebraska State Line B	40 00 08.42	259.7	195 28 36	15 32 03	Herrick	28403.2	4.453367
	98 50 25.93	615.1	277 01 14	97 10 54	Cooper	21564.8	4.333746
			60 28 54	240 28 12	Lipps	1736.4	3.239661

*No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Kansas and Nebraska State Line 1*	40 00 08.38 98 50 20.86	258.5 494.8	277 03 27 90 33 17	97 13 04 270 33 14	Cooper K.-N. State Line B	21445.2 120.4	4.331331 2.08061
Kansas and Nebraska State Line 2*	40 00 08.37 98 50 29.88	258.2 708.8	276 59 08 269 07 12	97 08 51 89 07 14	Cooper K.-N. State Line B	21657.8 93.8	4.335614 1.97218
Kansas and Nebraska State Line C*	40 00 08.67 98 34 30.28	267.4 718.2	25 27 51 151 16 10	205 27 17 331 09 21	Cooper Herrick	2960.9 31220.4	3.471423 4.494438
Bossing 1899	38 36 46.004 98 19 11.381	1418.5 275.4	152 26 50.21 222 19 44.31	332 20 32.17 42 29 53.14	Wilson Heath	31487.96 34850.98	4.4981445 4.5422149
Sherman 1899	38 34 20.138 97 59 57.623	620.9 1394.9	99 15 02.35 127 29 39.93 171 48 00.97	279 03 02.65 307 11 20.37 351 46 08.01	Bossing Wilson Heath	28281.91 53416.88 30541.55	4.4515087 4.7276785 4.4848911
Loder 1899	38 38 23.587 97 52 14.058	727.3 340.0	56 14 51.64 145 39 22.22 238 58 24.06	236 10 02.39 325 32 39.08 59 11 52.62	Sherman Heath Iron Mound	13496.77 27537.23 36392.80	4.1302298 4.4399202 4.5610154
Central 1900	38 27 05.342 98 10 05.636	164.7 136.6	143 36 33.46 227 38 30.99	323 30 53.49 47 44 49.59	Bossing Sherman	22255.31 19918.32	4.3474336 4.2992526
Little River 1900	38 23 38.660 98 03 03.368	1192.1 81.7	121 55 26.48 136 04 10.71 192 48 23.80	301 51 04.06 315 54 08.06 12 50 19.39	Central Bossing Sherman	12063.89 33757.25 20285.38	4.0814874 4.5283670 4.3071831
Chase 1900	38 20 43.445 98 25 26.859	1339.6 652.4	197 00 56.14 242 08 31.94 260 28 42.72	17 04 49.78 62 18 04.14 80 42 36.67	Bossing Central Little River	31043.82 25266.07 33058.37	4.4919752 4.4025377 4.5192814
Savage 1901	38 09 23.350 98 15 49.341	720.0 1201.3	146 14 26.98 215 09 22.38	326 08 29.43 35 17 16.86	Chase Little River	25236.97 32281.98	4.4020371 4.5089601
Gilmore 1901	38 10 00.941 97 57 12.395	29.0 301.7	87 39 18.63 115 49 34.96 161 20 15.00	267 27 48.49 295 32 05.79 341 16 37.57	Savage Chase Little River	27216.56 45713.62 26616.88	4.4348333 4.6600456 4.4251572
Partridge 1901	37 59 14.373 98 06 14.834	443.1 361.9	143 19 59.05 213 30 20.56	323 14 04.78 33 35 55.09	Savage Gilmore	23422.96 23920.62	4.3696418 4.3787725
Arlington 1901	37 52 33.788 98 12 07.349	1041.7 179.6	170 09 00.08 214 50 52.56	350 06 43.35 34 54 29.26	Savage Partridge	31594.11 15054.83	4.4996061 4.1776758
Sunflower 1901	37 51 40.281 97 51 28.036	1241.8 685.4	93 13 22.53 122 57 15.35 166 07 33.94	273 00 41.77 302 48 10.31 346 04 01.85	Arlington Partridge Gilmore	30336.13 25789.68 34959.49	4.4819601 4.4114460 4.5435651
Pretty Prairie 1901	37 46 16.111 98 00 19.195	496.7 469.7	123 58 26.60 232 23 03.13	303 51 12.34 52 28 28.80	Arlington Sunflower	20869.57 16391.28	4.3195135 4.2146129
Cheney 1901	37 40 37.449 97 49 56.508	1154.5 1384.7	124 27 06.51 173 45 07.31	304 20 45.51 353 44 11.25	Pretty Prairie Sunflower	18481.30 20557.84	4.2667325 4.3129776
Kingman 1901	37 35 10.420 98 09 12.615	321.2 309.5	172 26 17.04 212 26 51.97 250 19 24.70	352 24 30.12 32 32 18.02 70 31 10.60	Arlington Pretty Prairie Cheney	32450.63 24332.28 30087.32	4.5112232 4.3861829 4.4783835
Belmont 1901	37 31 13.481 97 58 18.214	415.6 447.3	114 30 34.01 215 15 00.74	294 23 55.15 35 20 06.84	Kingman Cheney	17645.70 21301.93	4.2466390 4.3284190
Prairie 1901	37 22 27.627 98 07 49.381	851.7 1215.0	175 02 12.66 220 50 42.79	355 01 22.01 40 56 30.08	Kingman Belmont	23604.86 21445.70	4.3730014 4.3313402
Sumner 1901	37 24 25.061 97 48 15.243	772.6 374.9	82 57 16.37 130 24 21.00 175 16 04.63	262 45 23.38 310 18 14.24 355 15 02.91	Prairie Belmont Cheney	29108.62 19445.12 30080.90	4.4640217 4.2888105 4.4782908
Quarry 1901	37 14 28.323 97 58 19.839	873.2 489.0	136 32 25.54 218 55 39.35	316 26 40.35 39 01 45.93	Prairie Sumner	20372.70 23664.42	4.3090486 4.3740959
Rutherford 1901	37 08 57.928 98 06 31.618	1785.9 780.2	175 37 00.52 229 56 10.27	355 36 13.44 50 01 07.57	Prairie Quarry	25034.68 15837.98	4.3985420 4.1996998
Anthony Northwest Base 1901	37 12 35.542 98 04 03.454	1095.7 85.2	247 39 23.75 28 35 40.88	67 42 51.62 208 34 11.34	Quarry Rutherford	9156.81 7639.49	3.9617440 3.8830644
Anthony Southeast Base 1901	37 10 00.285 98 01 34.433	8.8 849.6	75 20 09.03 142 29 23.27 210 07 45.46	255 17 09.52 322 27 53.20 30 09 43.11	Rutherford Anthony NW. Base Quarry	7580.75 6034.705 9555.29	3.8797122 3.7806560 3.9802437

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Miller	37 02 20.963	646.3	127 28 17.95	307 21 47.30	Rutherford	20139.64	4.3040518
1902	97 55 43.908	1085.1	146 58 55.23	326 53 53.75	Anthony NW. Base	22605.47	4.3542135
			148 35 34.07	328 32 02.64	Anthony SE. Base	16595.38	4.2199872
			170 16 26.57	350 14 52.43	Quarry	22750.30	4.3569871
Fowler	37 07 35.852	1105.3	46 29 33.16	226 25 23.81	Miller	14090.87	4.1489378
1902	97 48 50.372	1243.4	95 36 23.39	275 25 42.68	Rutherford	26314.85	4.4202009
			103 21 00.06	283 13 18.69	Anthony SE. Base	19374.42	4.2872287
			132 11 59.76	312 06 15.59	Quarry	18947.06	4.2775418
			181 35 26.40	1 35 47.67	Sumner	31123.76	4.4930920
German Church, spire	38 49 15.480	477.3	12 17 22.1	192 15 12.0	Bossing	23650.9	4.373847
1899–1900	98 15 43.310	1044.8	103 49 13.9	283 40 44.5	Wilson	20165.4	4.304607
			261 51 10.1	81 59 09.7	Heath	18638.4	4.270408
Oxide	38 41 26.501	817.1	44 22 00.2	224 18 21.9	Bossing	12092.5	4.082515
1899–1900	98 13 21.890	529.1	129 59 36.9	309 49 39.7	Wilson	30010.1	4.477267
			280 18 57.8	100 32 09.9	Loder	31166.1	4.493683
			303 58 53.4	124 07 15.6	Sherman	23479.2	4.370683
Heaths Barn, cupola	38 50 37.396	1153.1	42 09 59.3	221 59 59.7	Bossing	34542.4	4.538352
1899	98 03 12.974	312.9	324 49 29.9	144 56 22.3	Loder	27662.9	4.441897
			351 04 50.8	171 06 53.0	Sherman	30501.6	4.484322
Geneseo Schoolhouse, tower	38 31 04.324	133.3	5 55 28.0	185 55 08.4	Central	7408.4	3.869724
1899–1900	98 09 34.100	826.1	127 03 36.9	306 57 37.0	Bossing	17502.2	4.243092
			194 44 43.8	14 48 51.1	Heath	37507.0	4.574112
			246 33 42.7	66 39 41.9	Sherman	15210.2	4.182135
			325 22 57.2	145 27 00.2	Little River	16691.0	4.222482
Lyons Salt Works, tower	38 21 20.324	626.7	86 51 03.0	266 42 26.4	Chase	20237.5	4.306157
1899–1900	98 11 34.738	843.5	158 50 42.3	338 45 58.0	Bossing	30613.4	4.485912
			191 28 47.8	11 29 43.1	Central	10855.7	4.035658
			250 59 30.1	71 04 47.4	Little River	13125.3	4.118108
Butte, highest point	38 39 59.633	1838.7	79 16 18.0	259 09 36.4	Loder	15828.0	4.199426
1891–1900	97 41 31.048	750.6	122 33 29.5	302 20 03.7	Heath	36830.4	4.566206
			224 51 14.8	44 58 01.6	Iron Mound	22218.9	4.346722
Sterling College, tower	38 13 16.422	506.4	34 23 38.7	214 21 33.8	Savage	8707.0	3.939867
1900	98 12 27.324	664.7	215 29 06.4	35 34 56.0	Little River	23576.2	4.372473
			285 04 09.1	105 13 34.8	Gilmore	23065.3	4.362960
Hutchinson Salt Works, largest stack	38 02 25.241	778.3	65 53 51.6	245 48 20.2	Partridge	14384.7	4.157900
1900	97 57 16.755	408.6	180 25 58.0	0 26 00.7	Gilmore	14050.7	4.147697
			336 47 30.1	156 51 04.5	Sunflower	21631.0	4.335076
Table Mountain, cairn	38 37 03.120	96.2	86 22 24.6	266 18 51.5	Bossing	8277.6	3.917904
1899	98 13 29.931	724.0	265 17 34.4	85 30 50.9	Loder	30961.4	4.490820
			284 16 12.4	104 24 39.1	Sherman	20290.2	4.307286
Marquette Church, spire*	38 32 47.05	1450.8	101 05 48	280 59 29	Sherman	14984.2	4.175633
1899	97 49 50.21	1215.9	161 28 03	341 26 33	Loder	10945.5	4.039235
Langley Church,* spire	38 32 43.67	1346.5	134 25 42	314 24 24	Sherman	4249.9	3.628380
1899	97 57 52.25	1265.3	217 57 23	38 00 54	Loder	13298.2	4.123792
White Cliffs, cairn*	38 41 06.52	201.0	288 03 10	108 09 47	Loder	16164.3	4.208556
1899	98 02 49.52	1196.9	341 37 43	161 39 30	Sherman	13202.5	4.120657
North Sherman, cairn*	38 36 20.30	625.9	253 13 31	73 18 58	Loder	13207.3	4.120813
1899	98 00 56.91	1377.0	338 49 25	158 50 02	Sherman	3973.2	3.599140
Kanopolis Salt Works, center hoist*	38 42 59.76	1842.7	320 57 33	141 03 08	Sherman	20615.4	4.314192
1899	98 08 54.03	1305.4	52 22 49	232 16 23	Bossing	18857.2	4.275477
Bushton Elevator*	38 30 53.46	1648.4	211 06 29	31 09 18	Bossing	12699.5	4.103788
1899–1900	98 23 42.58	1031.6	289 29 11	109 37 39	Central	21012.9	4.322487
Frederic Elevator*	38 30 54.09	1667.8	157 06 39	337 04 41	Bossing	11780.0	4.071144
1899–1900	98 16 02.00	48.4	309 12 16	129 15 58	Central	11151.7	4.047340
Windom Water Tower*	38 23 14.47	446.2	93 29 18	273 24 01	Little River	12415.6	4.093968
1900	97 54 32.70	793.6	167 32 28	287 22 48	Central	23725.2	4.375210

* No check on this position.

Table of positions, azimuths, and lengths—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithms.
	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Loders House, chimney* 1899	38 38 18.14 97 55 03.76	559.3 90.9	267 38 22 44 07 17	87 40 08 224 04 14	Loder Sherman	4107.6 10218.4	3.613588 4.009384
Hutchinson Court-House* 1901	38 02 57.18 97 55 52.05	1763.1 1269.1	342 48 51 65 43 16	162 51 33 245 36 52	Sunflower Partridge	21842.3 16672.1	4.339298 4.221991
Harper Standpipe 1901–2	37 17 09.642 98 01 49.375	297.3 1216.3	21 22 12 24 40 57 313 54 31 341 45 01 358 24 16	201 20 51 204 38 06 133 56 38 161 48 42 178 24 25	Anthony NW. Base Rutherford Quarry Miller Anthony SE. Base	9073.0 16679.3 7168.6 28841.4 13241.2	3.957750 4.222177 3.855435 4.460016 4.121926
Anthony Baptist Church, spire 1902	37 09 18.684 98 01 46.746	576.0 1153.5	193 19 36.9 279 19 43.0 325 08 18.2	13 19 44.3 99 27 31.8 145 11 57.1	Anthony SE. Base Fowler Miller	1318.0 19421.6 15687.6	3.119913 4.288286 4.195556
Anthony Schoolhouse, tower 1901–2	37 09 02.176 98 01 35.377	67.1 873.0	88 59 55.5 150 58 03.8 180 44 41.1 205 36 28.[illegible] 277 57 29.8 324 54 37.4	268 56 56.6 330 56 34.4 0 44 41.7 25 38 26.5 98 05 11.7 144 58 09.5	Ruther ord Anthony NW. Base Anthony SE. Base Quarry Fowler Miller	7311.7 7523.7 1791.5 11151.0 19067.8 15109.8	3.864016 3.876433 3.253217 4.047314 4.280300 4.179259
Bluff City Schoolhouse, belfry 1902	37 04 14.280 97 52 34.900	440.2 862.1	53 13 10.1 128 43 56.9 221 43 24.1	233 11 16.2 308 38 31.3 41 45 39.5	Miller Anthony SE. Base Fowler	5832.0 17064.2 8327.9	3.765816 4.232085 3.920534
Anthony Elevator, stack 1901–2	37 09 10.398 98 02 10.228	320.6 252.4	86 36 39.4 156 10 51.6 209 52 00.0 210 04 59.3	266 34 01.4 336 09 43.2 29 52 21.6 30 07 18.5	Rutherford Anthony NW. Base Anthony SE. Base Quarry	6461.8 6913.3 1773.4 11328.6	3.810353 3.839686 3.248805 4.054178
Anthony Roller Mill, stack 1901–2	37 09 05.062 98 02 08.086	156.1 199.5	156 19 40.0 205 59 59.2 322 40 30.2	336 18 30.3 26 00 19.5 142 44 21.8	Anthony NW. Base Anthony SE. Base Miller	7085.2 1894.0 15658.6	3.850350 3.277392 4.194752
Freeport (gothic) Church, spire 1902	37 12 01.252 97 51 20.686	38.6 510.1	19 59 10.3 76 12 49.3 335 36 09.5	199 56 31.4 256 06 38.4 155 37 40.3	Miller Anthony SE. Base Fowler	19032.3 15591.5 8982.9	4.279492 4.192889 3.953417
Freeport, east spire 1902*	37 12 01.10 97 51 14.76	33.9 364.9	336 26 47 76 21 29	156 28 14 256 15 15	Fowler Anthony SE. Base	8919.2 15732.4	3.950326 4.196796
Bluff City Elevator (red), north gable* 1902	37 04 47.53 97 52 34.83	1465.3 860.3	125 56 31 226 52 08	305 51 05 46 54 23	Anthony SE. Base Fowler	16443.6 7592.4	4.215998 3.880378
Bluff City Mill, iron stack* 1902	37 04 46.54 97 52 25.62	1434.8 632.8	125 34 08 225 30 10	305 28 37 45 32 20	Anthony SE. Base Fowler	16646.1 7449.3	4.221312 3.872118
Hinton Elevator, north gable* 1902	37 10 01.08 97 55 24.74	33.3 610.3	294 40 11 89 52 37	114 44 09 269 48 54	Fowler Anthony SE. Base	10712.8 9121.0	4.029903 3.960044
Sec. 35, T. 18, R. 8 W., NW. corner	38 26 58.18 98 10 59.20	1793.9 1435.5	260 20 27	80 21 00	Central	1317.5	3.119751
Sec. 24, T. 19, R. 7 W., NW. corner	38 23 27.74 98 03 11.38	855.3 276.2	209 59 49	29 59 54	Little River	388.72	2.589637
Sec. 3, T. 20, R. 10 W., NW. corner	38 20 51.57 98 25 28.17	1590.1 684.2	352 46 07	172 46 08	Chase	252.6	2.402433
Sec. 36, T. 34, R. 6 W., SW. corner	37 02 14.18 97 55 44.82	437.2 1107.7	186 08 38	6 08 39	Miller	210.22	2.322674
Sec. 36, T. 33, R. 5 W., SW. corner	37 07 29.15 97 49 11.58	898.7 285.9	248 27 36	68 27 49	Fowler	562.98	2.750493

*No check on this position.

Seven points in Kansas, or very near the Kansas–Oklahoma boundary, which depend in part on triangulation in Oklahoma that had not been computed when this publication was prepared (November, 1902), will be published with the Oklahoma points.

DESCRIPTIONS OF STATIONS.

This list may be conveniently consulted by reference to the illustrations at the end of this appendix and the index on pages 238–242.

In each description the tense used is appropriate to the date at which the description was written.

All directions in the descriptions are given in the form of azimuths reckoned continuously from south around by west to 360°, west being 90°, north 180°, and east 270°. The azimuths are true, not magnetic.

In general, the surface and underground marks described are not in contact, so that a disturbance of the surface mark will not, in general, affect the underground mark. The underground mark should be resorted to only when there is evidence that the surface mark has been disturbed.

GENERAL NOTES IN REGARD TO STATION MARKS.

Note 1.—For each station referred to this note, unless otherwise stated, the underground mark is a bottle filled with ashes and buried from 2.5 to 3 feet below the surface. The surface mark is a marble post 6 inches square and 2 to 3 feet long, placed with its top flush with the ground and having two grooves at right angles and the letters U. S. C. S. cut in its top. The witness marks are two sandstone or limestone posts 5 or 6 inches square on top and 2 to 3 feet long, marked by a diagonal groove terminating in an arrowhead pointing to the station, and both placed in the meridian of the station, one to the northward and one to the southward of it, and 5 to 10 feet distant.

Note 2.—Around each station referred to this note a circular trench 4 to 8 feet in diameter, 9 to 18 inches deep, and 6 to 12 inches wide, was dug and partly filled with coal.

Note 3.—For each station referred to this note the marking is the same as that indicated in Note 1, except that the buried bottle is stated to be a stone bottle or jug.

Note 4.—For each station referred to this note the underground mark is a stone jug buried from 2 to 3 feet below the surface and marked with a cross and small drill hole in its bottom.

Note 5.—For each station referred to this note the underground mark is an earthenware crock buried bottom upward from 2 to 4 feet below the surface and marked with small drill hole and sometimes also with a cross.

Note 6.—For each station referred to this note the surface mark is a marble post 8 inches square and 2.3 to 2.6 feet long, placed with its top flush with the ground, and having two grooves at right angles and the letters U. S. C. S. cut in its top.

Note 7.—For stations referred to this note the underground mark is a bottle incased in concrete and buried with the mouth 2½ to 4 feet below the surface of the ground. The surface mark is a 6-inch drain tile pipe 2 feet long, filled with concrete and buried with flange end flush with surface of ground, the intersection of a cross on a bronze plate embedded in the concrete marking center of station. The bronze plate has a stem 76 millimeters long, which is securely fastened in the concrete by a wedge driven in the lower end. The top of the bronze mark is a shallow cup about 60 millimeters in diameter and 12 millimeters deep inside, with a flange or rim 10 millimeters thick. The marking plate is about 37 millimeters in diameter and raised about 3 millimeters above the bottom of the cup, where the letters U. S. C. & G. S. are cast.

Witness marks are placed 4½ to 7 feet north and south of the station, and consist of 4-inch drain tile pipes 2 feet long, filled with concrete and buried with top flush with ground. An iron nail is set in the concrete of each witness mark.

Note 8.—For each station referred to this note the underground mark is a stone jug buried upright, with mouth 3 to 4 feet below the surface of the ground, the center of mouth marking station. Above this is placed an earthenware jar, bottom up, 2 to 3 feet below the surface, a small drill hole in bottom marking station. The surface mark is a white-oak post 2 to 2½ feet long, a tack in top marking center of station.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, MISSOURI LINE TO ELEVATION—MABON, IN THE THIRTY-NINTH PARALLEL TRIANGULATION.

Bowler (Jackson County, Mo., F. D. Granger, 1884).—This station is in NW. ¼ of SW. ¼ sec. 18, T. 47 N., R. 31 W., on a small hill about one-third of a mile west of the dwelling house of Mr. J. O. Bowler, owner of the land, and about 2½ miles southwest of the town of Lees Summit. The geodetic point is about 20 yards south of an apple orchard. (See notes 1 and 6, p. 258.) Pieces of soft coal are mixed in the earth around it.

Fulton (Cass County, Mo., F. D. Granger, 1883).—This station is in NE. ¼ sec. 2, T. 44 N., R. 31 W., about 168.5 feet from northwest corner of quarter, 71.1 feet south of fence forming the northern boundary of Fulton's farm and separating it from main road, and 71.5 feet east from a small house. (See note 1, p. 258.) Central post bears F. D. G. 1883 on north face.

Berry (Cass County, Mo., F. D. Granger, 1884).—This station is in SW. ¼ sec. 10, T. 33 N., R. 46 W., about 1½ miles west of the town of Belton, near the east center of a cultivated field belonging to Mrs. R. C. Berry. A forked cottonwood tree, marked with cut triangle 3 feet from ground, on side toward station, bears 93° 23′, 279½ feet distant. (See notes 1 and 3, p. 258.) Earth around central post is mixed with charcoal.

Marty (Johnson County, Kans., F. D. Granger, 1884) —This station is in SE. ¼ sec. 19, T. 12 S., R. 25 E., about 4 miles northeast of the town of Lenexa. The geodetic point is in an open cultivated field about one-fourth mile south of Mr. John Marty's house, 12 yards north of a farm road, and 22 yards west of a hedge. (See notes 1 and 3, p. 258.) Central post is surrounded by charcoal.

Haskin (Johnson County, Kans., F. D. Granger, 1885).—This station is in SW. ¼ sec. 18, T. 15 S., R. 25 E., about 7½ miles east of the town of Spring Hill, 45½ feet northeast of Mr. U. A. Haskin's barn and nearly due south of his dwelling house. The corner of secs. 13, 18, 19, and 24 is 665½ feet distant, and the southeasterly tree in grove is 23½ feet distant. (See notes 1 and 3, p. 258.) Central post is surrounded by charcoal.

Thomas (Johnson County, Kans., F. D. Granger, 1885).—This station is in sec. 7, T. 14 S., R. 23 E., on Mr. Thomas' place about 2 miles south and 4 miles west of Olathe, 358½ feet west of a hedge fence which is one-eighth mile west of section line, and 64 feet north of middle of road. (See note 1, p. 258.) The azimuths and distances to certain points are: To southeast corner Thomas house, 92° 15′, 163 feet; to cottonwood tree near barn, 195° 41′, 84 feet; to cottonwood tree near fence, 240° 43′, 134 feet; to double tree near hedge, 267° 25′. Around the central post is a bed of charcoal 4 feet in diameter and 18 inches deep.

Eckman (Leavenworth County, Kans., F. D. Granger, 1885).—This station is about 502 feet south and 93 feet west of the northeast corner of sec. 6, T. 12 S., R. 22 E., in the immediate vicinity of Daisy post-office. (See note 1, p. 258.) The azimuths and distances to certain points are: To northeast corner of Daisy post-office and hotel, 355° 24′, 29 feet 1 inch; to northwest corner of post-office, 17° 46′, 77 feet 10 inches; to middle of road, east 93 feet 4 inches; to E. Martin's house, 292° 22′. Reoccupied in 1887. A bed of charcoal surrounds the central post 4 feet in diameter and 18 inches deep.

Bebe Mound (Douglas County, Kans., F. D. Granger, 1887).—This station is in Palmyra Township, one-fourth mile west of county line between Johnson and Douglas counties and 2¼ miles north of county line between Franklin and Douglas counties. The azimuths and distances to certain points are: To northwest corner of orchard, 305 feet; to northeast corner of orchard, 129 feet; to fence, south, 38 feet; to center of Mr. Dwyer's house, 7° 09′, 466 feet. (See notes 1 and 2, p. 258.) The center post tapers to 3 by 3 inches at bottom, and has F. D. G. 1887 cut on one side near the top.

Kanwaka (Douglas County, Kans., F. D. Granger, 1887).—This station is in the northeast corner of NW. ¼ of SE. ¼ sec. 22, T. 12 S., R. 18 E., Kanwaka Township, on land owned by Mr. Thomas Anderson, in a pasture 109 feet south of the "Old California Road," 10 miles northwest of Lawrence and about 5 miles south of Le Compton. Quarter section corner of sections 22 and 23 is 1 447.0 feet distant, north and east. Quarter section corner of sections 22 and 27 is 2 810.3 feet distant, south and west. George Anderson's house is 1 251.5 feet distant, north and west. (See notes 1, 2, and 3, p. 258.) The center post is also marked on south side near the top with F. D. G. 1887.

Simmons (Douglas County, Kans., F. D. Granger, 1887).—This station is near the center of SW. ¼ of SE. ¼ sec. 32, T. 14 S., R. 18 E., on the summit of a prominent hill about 14 miles west of Baldwin City, on land owned by P. A. Simmons, of Lapeer. The underground mark is a drill hole in the head of an iron bolt tightly wedged in a hole drilled into a ledge of limestone 2.3 feet below the surface of the ground. (See notes 1 and 2, p. 258.) The azimuths and distances to certain points are: To northwest corner stone wall, 272° 52′, 142.2 feet; to southeast corner stone sec. 32, 291° 36′, 2 176.5 feet; to northwest corner Simmons's house, 354° 50′, 287.3 feet. A farmyard gate bears about west, 73 feet.

Elevation (Shawnee County, Kans., F. D. Granger, 1887).—This station is near the southwest corner of north half of NW. ¼ south of Reserve line in sec. 28, T. 12 S., R. 15 E. "Elevation" is a well-known point about 10 miles southwest of Topeka; on its summit stands the Wesleyan Methodist Church, and on its south face or slope, about 60 yards from the church, stands the Elevation Schoolhouse. (See notes 1, 2, and 3, p. 258). The azimuths and distances to certain points are: To cupola Elevation Schoolhouse, 14° 28′, 288 feet; to stone northwest corner school acre, 35° 38′, 273.7 feet; to stone northwest corner sec. 28, 166° 32′, 701.1 feet; to northeast corner stone coal house, 339° 06′, 41 feet; to northwest corner Elevation Church, 22′, 59.1 feet; to tombstone of Phebe McCool, 111.5 feet. The center stone has F. D. G. 1887 cut on south face near the top.

Mabon (Osage County, Kans., F. D. Granger, 1887).—This station is near the south center of SW. ¼ of SE. ¼ sec. 30, T. 14 S., R. 15 E., on the summit of a small elevation, on land owned by James Mabon, about 7 miles southwest of Carbondale and 5 miles northeast of Burlingame. The azimuths and distances to certain points are: To stone southeast corner sec. 30, 276° 43′, 1 924.5 feet; to quarter-section stone, 70° 17′, 778.2 feet. (See notes 1, 2, and 3, p. 258.) The marble post has F. D. G. 1887 cut on south face near the top. The hill on which station is located is rocky and has never been cultivated.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, ELEVATION-MABON TO SALINA BASE NET, IN THE THIRTY-NINTH PARALLEL TRIANGULATION.

Powell (Shawnee County, Kans., F. D. Granger, 1887).—This station is in NE. ¼ sec. 14, T. 13 S., R. 13 E., on land owned by Messrs. Powell & Sage, 194 feet north of a new schoolhouse and 88 feet west of the center of the road. (See notes 1 and 3, p. 258.) The marble post has F.D.G.1887 cut on south side near top. The azimuths and distances to certain points are: To quarter-section stone, 356° 20′, 1 481.1 feet; to northeast corner of schoolhouse porch, 358° 56′, 194.4 feet; to chimney of schoolhouse, 9° 28′, 205.1 feet; to northwest corner of schoolhouse, 10° 22′, 193.5 feet; to stone northeast corner sec. 14, 184° 32′, 1 185.8 feet; to wire fence east, 60.5 feet.

Adams (Wabaunsee County, Kans., F. D. Granger, 1888).—This station is in SW. ¼ sec. 34, T. 11 S., R. 12 E., Maple Hill Township, on land owned by Frank Adams, of Maple Hill. It is on a high point 1.2 miles due south of Buffalo Mound, a prominent and well-known butte 4 miles southwest of Maple Hill. The summit of the hill is rough and the soil poor and rocky and suitable only for cattle grazing. About 150 yards west there is a good spring of water near the head of a ravine. Station is 207½ feet north of section-line fence, and 50 feet south and 44 feet east of brow of hill. A railroad tie was used as a pier for the artificial horizon and has not been removed. It is 6 feet 3 inches north of the center of the station. (See note 1, p. 258.) The marble post is marked F. D. G.1888 on south side near the top.

Clark (Wabaunsee County, Kans., F. D. Granger, 1888).—This station is in NE. ¼ sec. 6, T. 14 S., R. 12 E., Eskridge Township, on the summit of a high ridge, on land owned by Mr. John Clark, about 1 mile west-northwest from center of the town of Eskridge. To the west of station, 420 feet, is a public road which terminates at a road running north and south, the station being situated about 8 to 10 feet to the north of the prolongation of the south side of this road. About 2 000 feet east is a good spring. (See note 1, p. 258.) The marble post has F. D. G. 1888 cut on the south face.

Meyer (Wabaunsee County, Kans., F. D. Granger, 1888).—This station is in NE. ¼ sec. 16, T. 10 S., R. 13 E., on the crest of a large prairie about 6 miles south and 1 mile west from the town of Alma, on land owned by Mr. W. C. Meyer, of Fairview, and used as a cattle range. To the south about 600 feet is a public road, which at this point from being a north and south road turns abruptly to the east and runs again north and south about a mile east of the station. A private road runs about 250 feet to the west of the station and joins this road at the angle. About one-half mile down a deep ravine to the north-northwest of station is a good spring and horse pond. About 1 000 or more feet to the east of the station is a section-line fence. (See note 1, p. 258.) The center post has F. D. G. 1888 cut on south side.

Zean Dale (Riley County, Kans., F. D. Granger, 1888).—This station is 29 feet 3 inches southwest of intersection of secs. 15, 16, 21, and 22, and is also south of section fence to the north 23 feet 1 inch and west of section fence to the east 18 feet 9 inches. It is on the crest of a large broken prairie which at this point falls off abruptly to the valley of the Kaw River on the north, and is about 10 miles northwest of the town of Alma, Wabaunsee County, on land owned by Mr. C. W. Allandorph, of Topeka, and used as a cattle range. To the northeast and northwest are deep ravines and the hill top is very rocky. In a little ravine about one-half mile to the east is a well of good water. (See note 1, p 258.) On south face of center post is cut F. D. G. 1888.

Reinhard (Morris County, Kans., F. D. Granger, 1888).—This station is in W. ½ of NE. ¼ of NE. ¼ sec. 6, T. 14 S., R. 18 E., on the crest of a large prairie about 2½ miles northeast of the town of Dwight. It is about 215¼ feet north of the prolongation of the west side of the house of Mrs. L. C. Reinhard, on whose land it is, the land being used for grass and pasture. (See note 1, p. 258.) On the south face of center post is cut F. D. G. 1888. Northwest corner of Reinhard's house bears 353° 11′.

Humboldt (Geary County, Kans., F. D. Granger, 1889).—This station is 200 feet north and 880 feet west of southeast corner of NE. ¼ sec. 10, T. 12 S., R. 7 E., Winfield Township, on the dividing ridge between Humboldt and McDowell creeks, about 14 miles east of Junction City and 35 miles south of Westgate post-office, on land supposed to belong to the Union Pacific Railroad. The ridge runs in a northwesterly and southeasterly direction, varying in width from 1 500 feet to 1 mile, and falls off more abruptly on its eastern than on its western border. The station is on the highest point of the ridge, near its northeastern border. (See notes 1, 2, and 3, p. 258.) The distances and azimuths to certain points are: To southwest corner sec. 10, 57° 07′, 5 242 feet; to quarter-section stone, 87° 09′, 4 406 feet; to clump of trees at W. Roper's house, 109° 55′, about 1½ miles; stone pile on cone-shaped hill near Ogden, 158° 03′; to hill at end of range to northeast, 196°, about 8 miles; to hill east of station, 263° 35′, about 2.5 miles.

Erricssen (Riley County, Kans., F. D. Granger, 1889).—This station is in SE. ¼ of SW. ¼ sec. 12, T. 10 S., R. 6 E., about 9 miles west of Manhattan and 13 miles east of Milford, on the main road between these towns crossing Overalls Ridge, 479 feet north of the center of the road and 1 988 feet from stone marking the southwest corner of section 12, on land belonging to Hans Christopher. (See notes 1, 2, and 3, p. 258.) The azimuths and distances to certain points are: To stone at southwest corner sec. 12, 77° 07′, 1 988 feet; to northeast corner of Christopher's house, 76.5 feet.

Robbins (Geary County, Kans., F. D. Granger, 1889).—This station is in SE. ¼ of NE. ¼ sec. 30, T. 12 S., R. 6 E., at the south end of a cultivated field belonging to Mr. James Barnard. It is north of a small grove of cottonwood trees, 125 feet west of the main road and 15 feet north of the fence. West of the grove is a peach orchard and a ranch building, the whole surrounded by a wire fence. (See notes 1, 2, and 3,

p. 258.) The surface marks are in an east and west line 17.9 feet south of station. The arrows on the limestone witness posts point to the station. The azimuths and distances to the surface marks and certain other points are: To east limestone post (No. 1), 325° 00′, 21.93 feet; to marble post, 0° 00′, 17.90 feet; to west limestone post (No. 2), 35° 00′, 21.93 feet; to stone northeast corner sec. 30, 183° 19′, 1 823.3 feet; to quarter section stone, 192° 11′, 518.2 feet; to northeast cottonwood, 287° 38′, 76.6 feet; to northeast corner ranch building, 35° 11′, 200.6 feet.

White City (Morris County, Kans., F. D. Granger, 1888).—This station is in NE. ¼ of SE. ¼ sec. 26, T. 14 S., R. 6 E., on a level prairie, about one-half mile east-northeast of White City, about 1 750 feet east-northeast of crossing of Chicago, Rock Island and Pacific and Missouri, Kansas and Texas railways on land of Mr. Nelson Burnham, of Peoria, Ill. (Garret Inedeker, of White City, agent). (See notes 1 and 2, p. 258.) Marble post has F.D.G.1888 cut on south side. The azimuths and distances to certain points are: To cupola of schoolhouse at White City, 22° 58′; to west post (one-half mile to White City), 76° 14′, 1 025 feet; to north post (2 000 feet to Chicago, Rock Island and Pacific and Missouri, Kansas and Texas Railroad crossing) 157° 21′, 609 feet.

Taylor (Dickinson County, Kans., F. D. Granger, 1889).—This station is in NE. ¼ sec. 32, T. 13 S., R. 4 E., about 6 miles south and 1 mile east of Chapman, on land owned by Mr. Clarence Taylor. (See notes 1 and 2, p. 258.) The distances to certain points are: To north hedge, 925.5 feet; to line of east hedge, 47 feet; to west face of coal house, 137.1 feet; to north line of cherry trees, 54.6 feet; to northeast corner sec. 32, 2 096.9 feet; to large cottonwood, 67.3 feet.

Wilmer (Dickinson County, Kans., F. D. Granger, 1889).—This station is in SE. ¼ of SE. ¼ sec. 1, T. 11 S., R. 3 E., on land owned by Rudolph Wilmer, who lives three-fourths of a mile to the southwest. The nearest towns are Wakefield, about 8 miles to north-northeast, and Milford, 10 miles to the east-northeast, both on the Union Pacific Railroad. (See notes 1, 2, and 3, p. 258.) The azimuths and distances to certain points are: To southeast corner of sec. 1, 325° 24′, 1 283 feet; to wire fence east, 428 feet; to fence south, 1 060 feet.

Frey (Dickinson County, Kans., F. D. Granger, 1890).—This station is in the NW. ¼ of SE. ¼ sec. 11, T. 12 S., R. 2 E., about 8.5 miles north of Abilene, on land owned by Adam Frey, about 0.6 mile east-southeast from Frey's house and south of a hedge fence dividing Frey's and Chronister's farms. The underground mark is a stone bottle filled with charcoal and buried 20 inches below the surface of the ground. The surface marks, consisting of one marble and two limestone posts, each 6 inches square by 2.3 feet long, are in an east-and-west line in the hedge 8.91 feet to the north. The arrows on the limestone witness posts point to station. The azimuths and distances to surface marks and certain other points from the center of the station are: To west limestone post (No. 1), 138°, 11.93 feet; to marble post, 180°, 8.91 feet; to stone northeast corner sec. 11, 215° 06′; to east limestone post (No. 2), 222°, 12.01 feet; to stone northeast corner of W. ½ of SE. ¼ sec. 11, 268° 03′, 575 feet.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, SALINA BASE TO MEADES RANCH–WALDO, IN THE THIRTY-NINTH PARALLEL TRIANGULATION.

Vine Creek (Ottawa County, Kans., F. D. Granger, 1886).—This station is situated in NW. ¼ sec. 13, T. 11 S., R. 1 W. The nearest railroad stations are Vine Creek, 2½ miles to the northwest, and Manchester, 4 miles east, both on the Santa Fe Railroad. The geodetic point is marked by a bottle filled with ashes, buried 2.6 feet below the surface of the ground. Over this was placed a marble post, 6 inches square and 2.3 feet long, having two cross lines and the letters U. S. C. S. cut on its top surface, which was flush with the ground. As reference marks, two limestone posts, each 5 inches square and 2.5 feet long, with a single diagonal groove and arrowhead cut on top, were placed in the meridian of the station, one north and one south, each distant 10.01 feet from the central marble post. The azimuths and distances to additional reference marks are as follows: The northeast corner of McDade's house, 53° 30′, 270.5 feet; stone at northwest corner of sec. 13, 172° 19′, 466.7 feet; southwest corner of old stone stable, 263° 08′, 218.6 feet; stone on the sixth principal meridian at the southeast corner of the northeast quarter of sec. 13, 292° 48′, 5 680 feet, and the northwest corner of stone "dugout," 294° 29′, 124.6 feet.

Iron Mound (Saline County, Kans., F. D. Granger, 1886).—This station is situated on a prominent and well-known butte in the NW. ¼ sec. 26, T. 14 S., R. 2 W., about 7 miles southeast of Salina. The geodetic point is marked by a stone ink bottle, filled with ashes and buried 2.7 feet below the surface of the ground. Over this was placed a marble post 6 inches square and 2.3 feet long, with cross lines and the letters U. S. C. S. cut on its top surface, which was flush with the ground. As reference marks, two hard limestone posts, each 5 inches square and 2.3 feet long and having a single diagonal groove and arrowhead cut on the top, were placed in the meridian of the station, one north and one south of the central marble post. Recovered 1899, W. Eimbeck. Visited in 1900 by A. T. Mosman, who says that no witness marks could be found.

Salina West Base (Saline County, Kans., F. D. Granger, 1895).—This station is situated in the northeast part of Salina, east of the tanks of the Standard Oil Company. The geodetic point is marked by the intersection of cross lines on a copper bolt set in a limestone post, 6 inches square and 2 feet long, sunk 2.5 feet below the surface of the ground. About 5 inches of earth covers the top of the post. Above this, except for a space of 8 inches square over the post, is a layer of concrete 4 inches thick and 36 inches square, on which rests a limestone block 30 inches square and 10 inches high, supporting another limestone 30 inches square and 15 inches high, with beveled top and having a copper bolt with cross lines and a small drill hole sunk into its top as a surface mark. The two blocks are cemented together and are surrounded by a body of concrete several inches thick. The exposed top of the block bears the inscription U. S. C. & G. Survey, 1896. The following distances to reference marks are given: The geodetic point is 42.75 feet northwest of the line of telepraph poles which follow on the north side of and parallel to the track of the Union Pacific Railroad, and 10 feet east of a north and south fence which marks the eastern limit of ground owned by the Standard Oil Company, 79 feet northwest of the north rail of the main track of the Union Pacific Railroad. It is also 79.7 feet west of a telegraph pole and 35.2 feet a little east of north of the fence corner of the Standard Oil Company's property.

Salina East Base (Saline County, Kans., F. D. Granger, 1895).—This station is situated about 1 mile west of the village of New Cambria, on land owned by Mrs. Mary Marlin, Salina. The geodetic point is marked, both underground and at the surface, in practically the same manner as at West Base station, the only points of difference being that the underground post is 2.7 feet below the surface, with 8 inches of earth and 5 inches of concrete over it. The geodetic point is 78.8 feet a little south of west from a wire fence on the Marlin farm; 22.43 feet a little west of north of a wire fence alongside the railroad; 35.05 feet from the second telegraph pole, marked with a triangle, west of the gate entrance to the Marlin farm, and 70.3 feet in the same direction from the north rail of the Union Pacific Railroad track.

North Pole Mound (Saline County, Kans., F. D. Granger, 1890).—This station is situated on a prominent and well-known hill in the NW. ¼ sec. 1, T. 14 S., R. 3 W., and about 8.5 miles north of Salina. The geodetic point is marked by a bottle filled with ashes, buried 1 foot below the surface of the ground. Over this was placed a limestone block, 1 foot square by 5 inches thick, with two cross lines and the letters U. S. C. S. cut on its top surface, which was covered with several inches of earth.

Heath (Ellsworth County, Kans., F. D. Granger, 1890).—This station is situated in the SW. ¼ sec. 12, T. 14 S., R. 7 W., on land owned by William Heath, who lives in a stone house about one-third of a mile to the southwest. The nearest towns are Brookville, 14 miles to the southeast, and Ellsworth, 18 miles to the southwest, both on the Union Pacific Railroad. The geodetic point is marked by a glass bottle filled with ashes, the top being 3 feet below the surface of the ground. Over this was placed a marble post 6 inches square and 2.25 feet long, having two cross lines and the letters U. S. C. S. cut on its top surface, which was flush with the ground. As reference marks, two hard limestone posts, each 6 inches square and 2.25 feet long, with a single diagonal groove and arrowhead cut on top, were placed in the meridian of the station, one 7.51 feet south and one 7.16 feet north of the central marble post. Recovered 1899, W. Eimbeck; 1900, A. T. Mosman.

Thompson (Ottawa County, Kans., F. D. Granger, 1890).—This station is situated about 12 miles southwest of the town of Minneapolis, in the NW. ¼ sec. 25, T. 11 S., R. 5 W., on a prominent round-topped hill, belonging to Judge R. F. Thompson, of Minneapolis, Kans. The geodetic point is marked by a bottle filled with ashes, buried 3 feet below the surface of the ground. Over this was placed a marble post 6 inches square and 2.25 feet long, having two cross lines and the letters U. S. C. S. cut on its top surface, which was flush with the ground. As reference marks, two hard limestone posts, each 6 inches square and 2.25 feet long, with a single diagonal groove and arrowhead cut on top, were placed in the meridian of the station, one 13.18 feet north and one 14.10 feet south of the central marble post.

Lincoln (Lincoln County, Kans., F. D. Granger, 1891).—This station is located on the high prairie 3½ miles north and 3½ miles east of the town of Lincoln, and about 300 yards west and 40 yards north of the southeast corner of sec. 16, T. 11 S., R. 7 W., on land held by a mortgage and investment company of Lincoln. It is about 15 yards south of the main road from Lincoln to Barnard, and the nearest house, which is about one-half mile to the northeast on the Barnard road, is owned and occupied by Mr. Parks. The reference stones are 10.09 feet north and 11.41 feet south of the station. (See notes 1 and 2, p. 258.)

Golden Belt (Lincoln County, Kans., F. D. Granger, 1891).—This station is near the south end of the northernmost of two prominent hills situated in the SE. ¼ sec. 27, T. 12 S., R. 9 W., on land owned by Mr. Marshall, of Lincoln Center, and used as a cattle range. The station is 110 yards from the north end and 20 yards from the south end of the hill on which it stands. There is an old stone quarry on the west face of the hill about 55 yards southwest of the station, and another about 200 yards to the southeast of the station on the northwest face of the southernmost hill. The two reference marks are placed 9.55 feet north and 9.05 feet south of the station. (See note 1, p. 258.)

Wilson (Russell County, Kans., F. D. Granger, 1891).—This station is situated in the SE. ¼ sec. 1, T. 14 S., R. 11 W., about one-half mile west and 2½ miles north of the town of Wilson, Ellsworth County, Kans. A road running north along the line, separating Ellsworth and Russell counties, passes over the ridge within 100 yards to the west of the station. The two reference marks are placed one 8.03 feet north and the other 15.08 feet south of the station. (See note 1, p. 258.) Recovered 1899, W. Eimbeck; 1900, A. T. Mosman.

Bunker Hill (Russell County, Kans., F. D. Granger, 1891).—This station is situated in the SW. ¼ sec. 31, T. 13 S., R. 12 W., in the southwest part of the town of Bunker Hill, in an open lot west of the town water tower. The nearest corner of the water tower is 187.4 feet from the station and the stone marking the southwest corner of sec. 31, T. 13 S., R. 12 W., is 238.2 feet from the station. The two reference marks are 8 feet north and 8 feet south of the station. (See notes 2 and 3, p. 258.)

Allen (Russell County, Kans., F. D. Granger, 1892).—This station is situated in the NW. ¼ sec. 22, T. 14 S., R. 14 W., and about one mile west and 4 miles south of Russell, Russell County, Kans., on land owned by Mr. Montgomery, of Ohio, and under the management of Mr. Clements, who lives one mile south of the station. The azimuths and distances to certain points are: To stone marking the northwest corner of sec. 22, 122° 27′ 14″, 446.8 feet; to the north chimney of the house of Mr. H. A. Allen, who rents the land on which the station stands, 99° 36′, about 150 yards; to the north chimney of an old house, 158° 18′, and the southeast chimney of the house is 90 feet from the station. The station is 237 feet south of the center of the road. The reference marks are 9 feet north and 9 feet south of the station. (See notes 2 and 3, p. 258.)

Blue Hill (Ellis County, Kans., F. D. Granger, 1892).—This station is situated on a prominent ridge forming a part of the Blue Hills and in the S. ½ sec. 21, T. 12 S., R. 16 W. To reach the station from Walker, travel due north to the foot of the hills, thence to the northwest, passing to the eastward of a stone house and grove of small trees. Follow this road about 2 miles, and when well up on the ridge take the first trail bearing off to the west. This trail passes near the head of two deep canyons, which make up from the valley of the Saline River. After passing the head of the second canyon leave the trail and pass to the top of the ridge, which is narrow at the point and almost surrounded by ravines. There is a ravine in azimuth 63° 46′ and distant 112 feet; the head of a ravine in azimuth 133° 34′, distant 154 feet; the head of a ravine in azimuth 254° 25′, distant 213 feet; the head of a ravine in azimuth 288° 34′, distant 342 feet; and an old sod house in azimuth 340° 59′ from the station. The two reference marks are 8 feet north and 8 feet south of the station. (See notes 2 and 3, p. 258.)

Waldo (Osborne County, Kans., F. D. Granger, 1892).—This station is situated on the highest ground in the SE. ¼ sec. 24, T. 10 S., R. 14 W., and about 4.5 miles northwest of Waldo, Russell County, Kans., on land said to belong to the Union Pacific Railroad Company. A well-traveled road from Waldo ascends the hill from the southwest, and turning north passes some 20 yards to the east of the station. The two reference marks are 9 feet north and 9 feet south of the station. (See note 1, p. 258.) Note 2, p. 258, also applies, except that the circular trench is 11 feet in diameter and 1½ feet deep. Recovered 1897, F. D. Granger.

Meades Ranch (Osborne County, Kans., F. D. Granger, 1891).—This station is on the highest part of a prominent ridge in sec. 34, T. 9 S., R. 11 W., and about one-half mile northeast of Meade's ranch house. A good road passes up from the house and crosses the hill within 100 feet west of the station. The nearest town is Lucas, or Elbon, 12 miles to the south on the Union Pacific Railroad, Lincoln Branch. The azimuths and distances to certain points are: To the chimney of Meade's ranch house, 8° 36′, about one-half mile; to stone marking southwest corner of sec. 34, T. 9 S., R. 11 W., 34° 33′, 625 yards. The two reference marks are 8.70 feet north and 8.62 feet south of the station. (See notes 1 and 2, p. 258.) Recovered 1897, F. D. Granger.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, WALDO—ALLEN TO INDIAN CREEK—CANYON, THIRTY-NINTH PARALLEL TRIANGULATION.

Fairmount (Barton County, Kans., F. D. Granger, 1892).—This station is in NE. ¼ sec. 8, T. 16 S., R. 15 W., near the northeast corner of Fairmount Schoolhouse lot. (See notes 1, 2, and 3, p. 258.) The azimuths and distances to certain points are: To north line of schoolhouse lot, north, 29 feet; to northeast corner of schoolhouse lot, 225°, 41 feet; to east line of schoolhouse lot, east, 29 feet; to center of well, 353° 22′, 131.1 feet; to center of road, south, 238 feet; to northeast corner of schoolhouse, 20° 20′, 127.8 feet.

Hays (Ellis County, Kans., F. D. Granger, 1892).—This station is near the north center of sec. 24, T. 13 S., R. 18 W., just south of the road separating sections 24 and 13, and about 4 miles northeast of Hays City. The only house in the immediate vicinity is built of stone and is situated about 500 yards to the southwest. It is occupied by Mrs. Margaret Middlemeyer, who owns the land south of station. The land to the north is owned by Andrew Meyer. (See notes 1, 2, and 3, p. 258.) The distances to certain points are: To northwest corner of sec. 24, about 2 550 feet; to center of road, north, 29 feet; to end of hedge, east, 190 feet; to hedge, south, 12.5 feet.

La Crosse (Rush County, Kans., F. D. Granger, 1892).—This station is in the NW. ¼ sec. 12, T. 17 S., R. 18 W., on the highest point of a prominent hill in a pasture belonging to George Schwab. A stone house, formerly occupied by a Mr. Schmidt, stands on the summit of a prominent hill about 1 mile northwest of the station. The nearest town is La Crosse, about 5.5 miles to the southwest. The azimuths and distances to certain points are: To magnetic mark (chimney of house), 205° 50′.5, 2.5 miles; to highest point of ridge to southeast, 321° 35′; to well and windmill, 353° 05′, 633 feet; to fence on line to windmill, 405 feet; to fence west of station, 350 feet; to northwest corner sec. 12, 134° 55′. (See notes 1, 2, and 3, p. 258.)

Smoky Hill (Ellis County, Kans., F. D. Granger, 1893).—This station is in the south central part of sec. 21, T. 15 S., R. 20 W., on the highest point of a prominent hill overlooking the Smoky Hill River, about 14 miles due north of McCracken and 2½ miles south-southeast of Stock Range post-office. It is in the southern part of a large cattle range (10,000 acres) operated by Frank Meserve, esq., and is 1 000 feet north of the southern fence of the range, 350 feet south of where the hill slopes suddenly down into the Smoky Hill Valley, and 180 feet southwest of a point (of about the same elevation as the station) nearer this sudden slope. There are two hills to the west of station, a prominent one with nearly the same elevation as that on which the station is situated, 600 feet distant, and a smaller one 375 feet away. There is also a small hill to the east 430 feet, and one to the south 550 feet. There is a deep ravine to the east and a lesser one to the west, and a steep bluff to the north. Mr. James K. Hardwick's house is seven-eighths of a mile south of station. The underground mark is a half-gallon stone jug filled with small magnesia fragments and buried 3 feet below the surface, a tack in the cork marking the center of station. (See, also, notes 1, 2, and 3, p. 258.) The limestone witness posts are distant 14 and 12.83 feet, respectively, north and south of station. Windmill at Stock Range bears 159° 20′.

Trego (Trego County, Kans., F. D. Granger, 1893).—This station is in the northeast part of sec. 27, T. 13 S., R. 21 W., about 500 yards from the northeast corner of the section and about 120 yards south of the wire fence following the northern boundary of the section. The station is about 50 feet north of the highest point of a hill locally known as High Top, and about 60 feet west of a well-traveled road to Ellis. The road after passing the station leads through a gate to the northeast and between two prominent round mounds locally called "The Nipples." A branch of the road runs south of the southern "Nipple" to Stapelin's stone house. A little west of north about three-fourths mile distant is a very prominent round hill standing alone in the valley and known as Round Top Mound. (See notes 1, 2, and 8, p. 258–259.) The surface mark is a marble post as in note 1. The azimuths and distances to certain points are: To Round Top Mound, 155°; to northern "Nipple," 227°, 625 yards; to southern "Nipple," 239° 36′, 550 yards; to northeast corner of section 27, 256° 21′, 500 yards; to stone pile on top of prominent mound, 64° 40′, about 1¼ miles.

Skaggs (Ness County, Kans., F. D. Granger, 1893).—This station is in the southeastern part of sec. 16, T. 16 S., R. 22 W., on the land of Mr. G. W. Skaggs, about 1¼ miles north and one-fourth mile west of the town of Brownell, and about 200 yards from Mr. Skaggs' house. A farm road running east and west 55 feet north of the station leads into the well-traveled road to Brownell which passes in front of Mr. Skaggs's house. (See notes 1, 2, and 8, p. 258–259.) The surface mark is a marble post as in note 1. The azimuths and distances to certain points are: To southwest corner of Mr. Skaggs' barn, 227° 20′; to chimney of Mr. Skaggs' house, 244° 36′, 200 yards; to southeast corner of section 16, 335° 02′; to belfry of schoolhouse at Brownell, 343° 51′; to corner post of fence southeast, 83.1 feet; to corner post of fence southwest, 106.6 feet; to corner post of fence northwest, 105 feet. The witness posts are distant 13.45 and 12.30 feet, respectively, north and south from the center.

Big Creek (Trego County, Kans., F. D. Granger, 1893).—This station is in the extreme southwest corner of NE. ¼ of NE. ¼ of NW. ¼ of NW. ¼ sec. 17, T. 13 S., R. 23 W., 1 048 feet from the northwest corner stone of the section and 296 feet south of the center of the well-used trail which runs along the section line until a little east of station, and then turns northeast. The town of Wakeeney is 7 miles distant, the west cupola of the stone court-house being nearly due north (magnetic). A wide prominent fire guard was plowed around the signal and the camp, which was situated southeast of signal. About 200 yards to the northeast are the ruins of the foundation of the stone house belonging to Mr. Ferris, county surveyor. (See notes 1, 2, and 8, pp. 258-259.) Surface mark is as in note 1. The witness posts are of soft magnesia stone, distant 11.64 and 10.34 feet, respectively, north and south of station. The azimuths and distances to certain points are: To northwest corner stone, section 17, 105° 32′, 1 048 feet; to McCormick's windmill, 203° 13′.

Schmidt (Ness County, Kans., F. D. Granger, 1893).—This station is in the northeast corner of NE. ¼ of NE. ¼ of NE. ¼ of NW. ¼ sec. 2, T. 16 S., R. 25 W., on land belonging to Mr. Schmidt, of Wakeeney, just north of his deserted stone house, which is on the highest ground in that vicinity and is a prominent and well-known landmark. The station is just south of the county line and is nearly in line with the west face of Schmidt's house. About 70 feet to west of station is a trail, little used, running north and south. The nearest towns are Ransom and Utica, distant 9 miles southeast and southwest, respectively. (See notes 1, 2, and 8, pp. 258–259.) Surface mark as in note 1, but 5 by 5 inches. The azimuths and distances to certain points are: To quarter section corner, 240° 53′, 125.2 feet; to northeast corner of Schmidt's house, 351° 49, 154.3 feet; to northwest corner of Schmidt's house, 1° 33′, 152.3 feet.

Indian Creek (Gove County, Kans., F. W. Perkins, 1891).—This station is in the northeast corner of SE. ¼ of SE. ¼ of NW. ¼ of SE. ¼ of NW. ¼ sec. 6, T. 14 S., R. 28 W., about 7 miles south from Gove City, on the high land between Indian Creek and Smoky Hill River, about 1 mile south of Indian Creek and 2 miles northwest of the house of Mr. J. W. Huntington. The best way to reach the station is from Grainfield, on the Union Pacific Railroad, via Gove City, to a point 7 miles almost due south from the latter place. (See note 8, p. 259.) Two white-oak witness stakes were buried approximately north and south of station, a tin tack in top of each being 5 feet from station. Some pieces of broken jar were scattered in and on ground around station.

Canyon (Lane County, Kans., F. W. Perkins, 1891).—This station is in the southwest corner of SE. ¼ of NE. ¼ of SW. ¼ of SE. ¼ sec. 17, T. 16 S., R. 28 W., 2½ miles north and one-half mile east of Shields railroad station. (See note 8, p. 259.) Some pieces of broken jars were mixed with the earth and also left on the surface around the station mark.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, INDIAN CREEK—CANYON TO COLORADO LINE, THIRTY-NINTH PARALLEL TRIANGULATION.

Beaver (Logan County, Kans., F. W. Perkins, 1891).—This station is in the NW. ¼ of SW. ¼ sec. 27, T. 16 S., R. 32 W., near the northern edge of the plateau which extends south from the Smoky Hill River. Hell Creek Canyon is close to the northeast and the draws of the Beaver close to the north and west. Elkader, the nearest post-office, is 4 miles north. The mail route from Oakley to Scott City passes one-fourth mile west of station and a well-marked trail passes 100 yards to the north. (See note 8, p. 259.) Two white-oak witness stubs were placed north and south of station 5 feet distant. Some pieces of broken jars were mixed with the earth in filling the hole around the station and some pieces were left on the surface. The azimuths and distances to certain points are: To northeast corner of section 27, 231° 28'.6, 945 paces; to southwest corner of section 27, 39° 58'; to southeast corner of section 27, 325° 41'; to prominent mound at edge of bluff in section 22, 147° 30'.

Monument (Logan County, Kans., F. W. Perkins, 1891).—This station is in the southeast corner of NE. ¼ of SE. ¼ of SE. ¼ of NW. ¼ of NW. ¼ sec. 28, T. 13 S., R. 32 W., on the first high ground north from the Smoky Hill River, about 5½ miles from the river and 1½ miles southwest of the house of Warren A. Wharton. Cabbell post-office is about 2½ miles northeast. The road from Oakley to Scott City passes about 1½ miles east of station. A road leading from Wharton's house to Russell Springs passes within one-fourth mile of station to eastward. The station is on the timber claim of Mr. Burton Smith. (See note 8, p. 259.) Two triangular white-oak stakes were placed approximately north and south, with a tin tack in center of each, distant 5 feet from station.

Gopher (Logan County, Kans., F. W. Perkins, 1891).—This station is in the NW. ¼ of NW. ¼ of SE. ¼ of SE. ¼ of SW. ¼ sec. 24, T. 12 S., R. 35 W., on the highest ground in the pasture of Mr. Vincent W. Battreall, and one-third mile southwest from his house. Russell Springs is about 5 miles due south, and Winona is about 5½ miles northwest, the road between these two places passing within a short distance of the station. The underground mark is a 4-gallon stone jar buried 3 feet 8 inches below the surface, a ¼-inch hole in bottom marking station. Above this was placed a triangular white-oak post 2 feet 6 inches long with top flush with surface, a tack in center of post marking station. Two triangular white-oak stakes 2 feet long, with tin tack in center of each, were placed north and south (magnetic), distant 5 feet from station. A sod wall was built around the observing tent.

Sheridan (Logan County, Kans., F. W. Perkins, 1891).—This station is in the SE. ¼ of NW. ¼ of NE. ¼ of NE. ¼ sec. 7, T. 14 S., R. 36 W., on the northern edge of the table-land, 4 miles south of Smoky Hill River, 11 miles southwest of Russell Springs, 11 miles south of McAllaster, and 13 miles east southeast of Wallace. The azimuths and distances to certain points are: To northeast corner section 7, 236° 18'.3, 340 paces; to south gable of Freeman's stone house, 265° 26'; to ridge of Wurst's stone granary, 266° 18'; to north gable of Jessie Wagner's stone house, 320° 36'. The underground mark is a stone jar placed bottom up 3 feet below the surface, a ¼-inch hole marking station. Above this was placed a mass of bricks which had been partly melted and run together in baking. The surface mark is a white-oak stub, with a tin tack marking the center of station. Four white oak witness stubs were set north, south, east, and west, at a distance of 5 feet. A sod wall was built around the observing tent. Broken bricks were mixed with the earth in filling the hole around the station mark.

Teeters Hill (Logan County, Kans., F. W. Perkins, 1891).—This station is in the southwest corner of NW. ¼ of NE. ¼ of SW. ¼ of NW. ¼ sec. 30, T. 11 S., R. 37 W., on the highest of the bluffs on the south of the north fork of the Smoky Hill River, about 2 miles south of Mr. J. F. Teeter's ranch, and three-fourths mile west of the road running from McAllaster to Teeter's ranch. Wallace is 16 miles southwest and McAllaster is 7½ miles southeast. To reach the station take the road leading north from Mr. James Burr's place, 12 miles northeast of Wallace, and proceed about 3 miles to the middle of the McDermott claim; then turn east on a road to the station, which is about 1⅛ miles from the McDermott claim. The underground mark is a 1-gallon earthenware jar placed bottom up 4 feet below the surface, a ¼-inch hole in bottom marking station. Above the jar a 5½-inch drain tile 25 inches long was placed with top 22 inches below the surface, the center of tile marking station. Above the tile a white-oak post painted red was placed with top projecting about 4 inches above the ground, a galvanized tack in stub marking the center of station. Four witness stakes, with tack in top of each, were placed approximately north, east, south, and west, 5 feet distant. Pieces of broken drain tile were mixed with the earth about the point, and about 6 inches below the surface a paving of broken tile was made about 2 feet square. Some broken tile was left on the surface around the point. A sod wall was built around the observing tent.

Turtle (Wallace County, Kans., F. W. Perkins, 1891).—This station is in the northwest corner of NE. ¼ of SE. ¼ of NE. ¼ of SE. ¼ of SE. ¼ sec. 9, T. 12 S., R. 40 W., on the divide between the headwaters of Pond Creek on the south and Turtle Creek on the north, 9 miles almost due north from Sharon Springs and 5½ miles north of Smoky Hill River. The road running north from Sharon Springs passes about one-fourth mile west of station, while the Goodland road (so called) passes about 1 mile to the east. The house of Mr. John Wesley Bouslog is 3¼ miles south. (See note 8, p. 259.) Two white-oak posts painted red were placed approximately north and south of station, with a tack in each, 5 feet distant.

Curlew (Wallace County, Kans., F. W. Perkins, 1891).—This station is in the northeast corner of SW. ¼ of SW. ¼ of NE. ¼ of NE. ¼ sec. 17, T. 14 S., R. 40 W., 4 miles south and 1½ miles west of Sharon Springs, near the northern edge of the plateau, which, commencing about 6 or 7 miles south of the Smoky Hill River, extends south to the Arkansas. (See note 8, p. 259.) Four white-oak reference stubs, painted red, were placed about north by east, east by south, south by west, and west by north, with a tack in center of each, distant 7 feet from station. Some broken earthenware was mixed with the earth around the center post and a load of small stone was piled up over the center.

McLane (Wallace County, Kans., F. W. Perkins, 1891).—This station is about 14 miles northwest of Sharon Springs, and 11 miles north of Weskan, on the Goose Creek bluffs, about 1 mile south of the creek and 2½ miles southeast of McLane's Ranch. The road from McLane's Ranch to Sharon Springs passes about 200 meters south of the station. Lister post-office is about three-fourths of a mile northwest of station. To reach the station from Sharon Springs, take the road running northwest to Halsey's place, then follow a road up a ravine toward the westward to a gradually ascending plain, whence the elevation upon which the station is located can be seen. It is about 4 miles east of the Colorado border. The underground mark is a 1-gallon earthenware jar placed bottom up 4 feet 2 inches below the surface, a ¼-inch hole in bottom marking center of station. Above the jar a 5½-inch drain tile 25 inches long was placed, with top 21 inches below the surface of ground, the center of tile marking station. Above the tile was placed a white-oak stub, painted red, with top projecting 3 inches above the ground, a tin tack in center marking the station. Four white-oak reference stakes, painted red, were placed approximately north, south, east, and west, with a tin tack in center of each, distant 5 feet from center of station. A circle of brickbats was laid just above the top of the tile, and six inches below the surface 4 beer bottles were placed at right angles, with their necks pointing toward the center post and distant about 1 inch from it. Fragments of broken jar were left on the surface about the point.

Arapahoe (Cheyenne County, Colo., F. W. Perkins, 1891).—This station is about 7 miles southeast of Arapahoe, 11 miles southwest of Weskan, and 3 miles from the Kansas border, on the highest hill in the vicinity. From Weskan take the road that leads to the schoolhouse near James A. Johnson's and then bear a little westward to Daniel Dellenger's, from which place the trail leads nearly west to the signal. (See note 8, p. 259.)

Monotony (Cheyenne County, Colo., F. W. Perkins, 1891).—This station is about 14 miles north by west of Arapahoe, and 4½ miles east of the road leading from Cheyenne Wells to Burlington, on a round-topped hill. In going north from Arapahoe, after crossing the hill about 2 miles north of the Smoky Hill River, the hill upon which the station is located will appear to the northward and remain in sight the rest of the way. The road made in hauling lumber from Arapahoe to the signal should be distinguishable for many years. (See note 8, p. 259). Fragments of earthenware were scattered around the station, both above and below the surface of the ground.

DESCRIPTIONS OF SUBORDINATE TRIANGULATION STATIONS, MISSOURI LINE TO ELEVATION–MABON, IN THE THIRTY-NINTH PARALLEL TRIANGULATION.

Kansas City Astronomic Station 1882 (Jackson County, Mo., C. H. Sinclair, 1882).—This station is in the grounds of the Franklin School, corner of Washington and Fourteenth streets, 20 feet east of building and 16 feet 9 inches south of north end. The pier is made of two sandstone posts 8 by 11 inches, 5 feet 11 inches long, set in concrete, with tops 3 feet above the ground and 17 inches apart. Between these two stones is placed a smaller one with top just above the ground and a cross marking the center of station. (In 1900 the Survey was informed that a contract had been let for a building which would cover this station.)

State Line 1 (Johnson County, Kans., F. D. Granger, 1885).—This station is 51 feet 11 inches north of west from the Missouri boundary stone, which is at southeast corner of southwest fractional quarter of sec. 35, T. 13 S., R. 25 E., 1½ miles south of New Santa Fe, Mo., at intersection of State Line and Belton–Olathe roads.

State Line 2 (Johnson County, Kans., F. D. Granger, 1885).—This station is at the northeast corner of the northwest fractional quarter of sec. 26, T. 12 S., R. 25 E., and is 9 feet 6 inches (west of south) from the half-mile stone situated midway between two east and west roads on the State line.

Base 1 (Johnson County, Kans., F. D. Granger, 1885).—This station is situated between two east and west roads, east of station Marty, about 670 feet south of road to north and 2 470 feet west of State Line road to east, on property of Tryon Brothers. Marked by a bottle 2½ feet below surface.

Base 2 (Johnson County, Kans., F. D. Granger, 1885).—This station is 889 feet 11 inches from Base 1, in azimuth 18° 43′.

State Line 3 (Johnson County, Kans., F. D. Granger, 1885).—This station is on the west side of the State Line road and about one-half mile north from the road running east from Aubry, and is marked by a strong stake driven well into the ground, with a nail in it. It is 552.1 meters a little west of north from State Boundary Stone at the northeast corner of southwest fractional quarter of sec. 23, T. 14 S., R. 25 E.

Section Line 1 (Johnson County, Kans., F. D. Granger, 1885).—This station is at intersection of two roads 479 meters north 37° 55′ west of station Marty.

Section Line 2 (Johnson County, Kans., F. D. Granger, 1885).—This station is one-half mile due south of Section Line 1 and 520.4 meters south 34° 14′ east of station Marty.

Blue Mound (Douglas County, Kans., F. D. Granger, 1887).—This station is in SW. ¼ sec. 22, T. 22 S., R. 13 E., on a prominent hill about 8 miles southeast of Lawrence, on land belonging to Mr. Obadiah Stett. The underground mark is a white glass bottle filled with ashes and buried 2 feet 10 inches below the surface. The surface mark is a limestone post 2½ feet long and 6 inches square at top, buried flush with ground, marked with letters U. S. C. S., and two grooves at right angles. The south face has F. D. G. 1887 cut near top.

Carson (Douglas County, Kans., F. D. Granger, 1887).—This station is in the SE. ¼ sec. 22, T. 13 S., R. 19 E., about 7 miles south-southwest of Lawrence, and about 2 miles northwest of the Three Sisters, well-known hills on the Lawrence–Willow Springs road. The station is on land belonging to Samuel Carson, and the point has been recently christened Hazel Hill. The underground mark is a glass bottle filled with ashes and buried 2 feet 6 inches below the surface of ground. The surface mark is a limestone post 2¼ feet long and 6 inches square, marked on top by two rectangular grooves and the letters U. S. C. S. The distances to certain points are: To lone oak, north of east, 550 feet; to corner of stone fence (northwest corner quarter section), north of west, 206 feet; to fence north, 38 feet.

Le Compton, U. S. G. S. (Douglas County, Kans., U. S. Geological Survey, 1889).—This station is in the SW. ¼ sec. 15, T. 12 S., R. 18 E., 4 feet north and 950 feet east of southwest corner of the section.

Stenger (Osage County, Kans., F. D. Granger, 1887).—This station is on the summit of a small hill known as Stenger Hill, about 3 miles west of Carbondale, in NE. ¼ of SW. ¼ sec. 16, T. 14 S., R. 15 E. The underground mark is a dark-colored glass bottle filled with ashes and buried 1½ feet below the surface. The surface mark is a nail in top of a pine stub 2 by 4 by 16 inches. Surrounding the stub some flat limestone rocks were placed on end and the whole covered with earth.

Topeka Insane Asylum (Shawnee County, Kans., F. D. Granger, 1887).—This station is the higher of the two cupolas.

Topeka M. E. Church (Shawnee County, Kans., F. D. Granger, 1887).—This station is the spire on the northeast corner of the building southwest corner of Harrison street and Sixth avenue.

Topeka First Presbyterian Church (Shawnee County, Kans., F. D. Granger, 1887).—This station is the spire of the church on the west side of Harrison street, between Eighth avenue and Ninth street.

Topeka State House, west wing cupola (Shawnee County, Kans., F. D. Granger, 1887).—This station is the center of a small low cupola in the center of the wing.

DESCRIPTIONS OF SUBORDINATE TRIANGULATION STATIONS, ELEVATION–MABON TO SALINA BASE NET, IN THE THIRTY-NINTH PARALLEL TRIANGULATION.

Buffalo Mound, azimuth mark (Wabaunsee County, Kans., F. D. Granger, 1888).—This station is on a prominent rocky butte about 3 miles southwest of the old town of Maple Hill. The butte is well known in the vicinity, and has a large rock pile on its summit, said to have been placed there by the Indians. The station is a few feet south of the rock pile, and is marked by a bottle of ashes buried 8 inches below the surface of the ground.

Salina West Base Latitude Station (Saline County, Kans., F. D. Granger, 1896).—This station is 7.87 meters east of the Salina West Base, and is marked by a pier of stone and brick laid in cement.

DESCRIPTIONS OF SUBORDINATE TRIANGULATION STATIONS, WALDO–ALLEN TO INDIAN CREEK–CANYON, IN THIRTY-NINTH PARALLEL TRIANGULATION.

Castle Rock (Gove County, Kans., F. D. Granger, 1890).—This station is near sec. 1, T. 14 S., R. 26 W., about 11 miles south and 2 miles west of Collyer. To the northwest, a few hundred yards from the rock, stands the famous Castle Tower, which rises abruptly from the flat prairie to the height of 73 feet. The main Collyer road passes about 200 yards west of the rock.

Bluff (Gove County, Kans., F. D. Granger, 1890).—This station is in SW. ¼ sec. 3, T. 14 S., R. 26 W., about 2 miles west of Castle Rock. About one-half mile south of station is a sod house occupied by a Mr. McCartney.

DESCRIPTIONS OF SUBORDINATE TRIANGULATION STATIONS, INDIAN CREEK–CANYON TO COLORADO LINE, IN THE THIRTY-NINTH PARALLEL TRIANGULATION.

Hill (Lane County, Kans., F. D. Granger, 1890).—This station is in sec. 13, T. 16 S., R. 29 W., about 5 miles northwest of Shields. A flag pole was observed upon.

Pond (Wallace County, Kans., F. W. Perkins, 1891).—This station is in the southeast corner of the SW. ¼ of NW. ¼ of NE. ¼ of NW. ¼ of SE. ¼ sec. 26, T. 12 S., R. 40 W., 5½ miles north and one-half mile east from Sharon Springs, on the first high ground after crossing the Smoky Hill River and about 3 miles north of the river. A road running north from Sharon Springs passes 1 mile west of station, and a road running northward along the section line one-half mile east of Sharon Springs passes within one-half mile of station. The house of Mr. John Wesley Bouslog, who lives in NW. ¼ sec. 34, bears about west southwest from station. The underground mark is a 1-gallon earthenware jar buried with bottom up, 4 feet 2 inches below the surface, a ¼-inch hole in center of bottom marking the station. Above the jar was placed a drain tile pipe 5½ inches in diameter and 25 inches long, the top of tile 22 inches below the surface. Above the tile a white-oak post painted red, 3½ by 3½ inches, two feet long, was placed with top projecting 3 inches above ground, the center of station being marked by a galvanized tack. Four reference stakes of white oak, 3½ by 3½ by 2 feet, painted red, with tack in center of each, were placed approximately north, east, south, and west 5 feet from center. Pieces of tiles and earthenware jars were mixed with the earth in filling the hole. About 6 inches below the surface a paving of broken tiles and earthenware jars was laid around the center about two feet square. A small quantity of broken jar was left on the surface. A sod wall was built around station.

Wallace Latitude Station 1885 (Wallace County, Kans., E. Smith, 1885).—This station is in the northeastern corner of the small park belonging to the Union Pacific Railway Company, at Wallace, Kans. It is marked in a permanent manner by two limestone piers, each 5 feet in length, and set firmly in concrete to the depth of three feet below the general surface of the ground.

Kansas and Colorado Boundary Monument 73½ (Wallace County, Kans., F. W. Perkins, 1891).—This station is at the point formerly occupied by the stone monument marking the State line. The original monument had been carried away, but the position was recovered approximately, and is now marked by a 1-gallon jug buried with mouth up 2 feet 8 inches below the surface, the center of mouth of jug marking station. The jug was covered with one foot of earth and two thicknesses of inch boards 2 feet square were placed above it. A tack in boards marks center. Surface mark is a cross chiseled on hard conglomerate sandstone, 20 by 15 inches, 6 inches deep. The stone is an inch above the surface and is marked B. M. 73½. The surface mark is covered with a mound of limestone forming a prominent object.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, THIRTY-NINTH PARALLEL TRIANGULATION TO THE NEBRASKA LINE IN THE NINETY-EIGHTH MERIDIAN TRIANGULATION.

Dial (Osborne County, Kans., F. D. Granger, 1897).—This station is situated on a prominent hill locally known as Sand Mound, and is near the west center of the SW. ¼ sec. 22, T. 9 S., R. 13 W. A north and south section line road crosses Sand Mound at a short distance west of the station. The surface mark is a limestone post 6 inches square and 2 feet long, placed with its top flush with the surface, marked by the letters U. S. C. S., and with a drill hole marking the exact point, 6 inches deep, 0.7 inch in diameter, plugged with pine. The underground mark is a copper bolt 6 inches long and 0.6 inch diameter, set in a drill hole in a flat ledge of rock in its original position and firmly wedged in with wire nails. A cross is cut in top of the bolt to mark the exact point. The bolt is 2.03 feet below the top of the surface mark.

Kill Creek (Osborne County, Kans., F. D. Granger, 1897).—This station is situated about 880 feet north and 300 feet east of the southwest corner sec. 9, T. 9 S., R. 14 W., on a prominent swell of ground. The land belongs to a loan company. The nearest house is distant about 0.2 mile west, and is owned and occupied by J. E. Harris. The station is on line between the center of an old well and the southwest corner of an old sod house, 19.8 feet from the former and 16.35 feet from the latter. The line from the old well to the house is approximately northwest. The azimuth of the stone marking the southwest corner of section 9 is 17° 42′ 27″, and of the stone marking the northwest corner of section 9 is 174° 37′ 47″. The surface mark is a copper bolt with cross lines set in a limestone post 6 inches square and 2 feet long, marked with the letters U. S. C. S. on its top surface. (See note 4, p. 258.)

Lawrence, U. S. G. S. (Osborne County, Kans., U. S. Geological Survey).—This station is described in Bulletin No. 122, Results of Primary Triangulation, U. S. Geological Survey, as follows: "In Osborne County, Kans., on a swell of ground near the center of the west side of sec. 23, T. 6 S., R. 14 W., and about on the highest point. Permanent mark: Cross and U. S. G. S. cut on top on large flat stone. Jug with cross cut on it is underneath the flat stone."

Recovered in 1897, F. D. Granger. The flat stone referred to had been broken up, but the jug with cross cut on it remained undisturbed.

Lawrence 2 (Osborne County, Kans., F. D. Granger, 1897).—The station is 3.377 meters in azimuth 93° 27′ from the station Lawrence U. S. G. S. described above. The surface mark is a limestone post 1.6 feet long and 6 inches square, with two rectangular curves and the letters U. S. C. S. cut on its top. (See note 5, p. 258.)

Old Well, U. S. G. S. (Smith County, Kans., U. S. Geological Survey).—This station is described in Bulletin No. 122, Results of Primary Triangulation, U. S. Geological Survey, as follows: "In Smith County, Kans., in the SW. ¼ of the SE. ¼ sec. 16, T. 5 S., R. 11 W., and is 42 feet north and 138.75 feet west of the northwest corner of a stone foundation for a building. The permanent mark: Cross and U. S. G. S. cut in large rock, and a bottle top set underneath the rock." Recovered 1897, F. D. Granger.

Old Well 2 (Smith County, Kans., F. D. Granger, 1897).—The azimuths and distances to certain points are: From this station to Old Well U. S. G. S. described above, 92° 52′ 32″, 30.875 meters; to the stone marking the southwest corner of sec. 16, 282° 14′ 32″, 466.0 meters; to the center of Mr. Okke Bohlen's house, 317° 16′, 21.94 meters. The surface mark is a rough stone post 9.5 inches square and 2.2 feet long, with two V-shaped crosses at right angles and the letters U. S. C. S. cut on its top. (See note 4, p. 258.)

Lebanon (Smith County, Kans., F. D. Granger, 1897).—This station is near the northwest corner of the NE. ¼ of the NE. ¼ sec. 2, T. 2 S., R. 11 W., and about 1¼ miles north and 1¾ miles east of Lebanon. It is in the line of an east and west wire fence on the south side of the section line road, about 200 feet east of the head of a small ravine which runs to the south, and about 1300 feet west of the northeast corner of the section. The highest ground in the vicinity lies about one-third mile to the north. The azimuths to certain points are: To Anderson's house, 211° 35′; to the Church of the United Brethren, 268° 59′ 42″; to Mr. J. Housel's house, 314° 02′. The surface mark is a Georgia marble post 6 inches square and 2 feet long, with two V-shaped grooves at right angles, and the letters U. S. C. S. cut on its top. (See note 4, p. 258.) To the north, in the exact projection of the line from Old Well 2, at a distance of 2.832 meters, is a pine stub with a nail in it and underneath the stub at a depth of 30 inches a stone jug with the top upward.

Brown (Smith County, Kans., F. D. Granger, 1898).—This station is about 4 miles east of Smith Center, on high ground near the northwest corner of the SE. ¼ sec. 20, T. 3 S., R. 12 W., on land owned by Mrs. M. A. Brown, 264 feet south of the hedge row on the south side of the east and west half-section line road. (See notes 5 and 6, p. 258.)

Lipps (Smith County, Kans., F. D. Granger, 1898).—This station is in the SW. ¼ sec. 1, T. 1 S., R. 14 W., on land owned by Joseph Lipps, whose house stands near the center of the west side of the southwest quarter of the section. It is 600 feet east of the north and south road passing Mr. Lipps's house. (See notes 5 and 6, p. 258.)

Cooper (Smith County, Kans., F. D. Granger, 1898).—This station is near the center of the NE. ¼ of SW. ¼ sec. 8, T. 1 S., R. 14 W., in a cultivated field belonging to Mr. E. M. Cooper, about 700 feet south and 325 feet west of the center of section 8.

Red Cloud, the nearest town, is about 7.5 miles east and 7 miles north of the station. (See notes 4 and 6, p. 258.)

Blue Hill (Webster County, Nebr., F. D. Granger, 1898).—This station is near the south center of sec. 24, T. 4 N., R. 11 W., on land owned by Peter Paugh. It is about 2½ miles south and 3 miles west of the town of Blue Hill. The azimuths and distances to certain points are: To the standpipe at Blue Hill, 228° 33′ 21″; to W. W. Hogate's windmill, 339° 24′; to Hogate's house, 348° 19′; to the stone marking the south center of section 24, 350° 10′, 251.085 feet; to stone marking northwest corner of section 24, 152° 09′; to the wire fence, 90°, 43.7 feet. (See notes 5 and 6, p. 258.)

Herrick (Franklin County, Nebr., F. D. Granger, 1898).—This station is in the SW. ¼ of SE. ¼ sec. 2, T. 3 N., R. 13 W., about 3½ miles south and 1¼ miles west of the town of Campbell, on land owned by Lyman Herrick. The azimuths and distances to certain points are: To the stone marking the southeast corner of section 2, 271° 13′.4; to Lyman Herrick's windmill, 274° 38′.4, 149.8 feet; to the stone marking the south center of section 2, 84°, 27′.4; to the stone marking the southwest corner of section 2, 88° 21′.4; to the belfry of the schoolhouse at Campbell, 196° 21′ 25″; to the southwest corner of Mr. Herrick's house, 274°.6, 118.6 feet; to the wire fence to the southward of the station, 89.3 feet. (See notes 5 and 6, p. 258.) Surface mark is of hard limestone.

DESCRIPTIONS OF SECONDARY AND TERTIARY STATIONS BETWEEN MEADES RANCH-WALDO AND NEBRASKA LINE.

Blue Hill, U. S. G. S. (Mitchell County, Kans., United States Geological Survey).—This station is described in Bulletin 122 of the United States Geological Survey, page 192, as follows: "Permanent marks: Rock with cross and U. S. G. S. cut in the top." Recovered 1891, F. D. Granger.

Tipton, U. S. G. S. (Osborne County, Kans., United States Geological Survey).—This station is described in Bulletin 122 of the United States Geological Survey, page 192, as follows: "In Osborne County, Kans., on the east side of sec. 15, T. 8, R. 11, on high hill 2 miles west of the town. Permanent mark: Large limestone rock with cross cut and U. S. G. S. on top. Bottom of bottle placed 2 inches below the rock." Recovered 1897, F. D. Granger.

Hardilee, U. S. G. S. (Smith County, Kans., United States Geological Survey).—This station is described on page 193 of Bulletin 122 as follows: "In Smith County, Kans., on highest point of ground in sec. 20, T. 2, R. 14, near the center of the SE. ¼. Permanent mark: White sandstone rock marked with a cross and U. S. G. S." Recovered 1897, F. D. Granger.

Covert (Osborne County, Kans., F. D. Granger, 1897).—This station is in the NW. ¼ sec. 18, T. 8 N., R. 12 W., near the south end of a prominent range of hills about 5 miles south and 0.7 mile west of Osborne. The surface mark is a rough stone post marked with a cross and the letters U. S. C. S. The underground mark is a jug top.

Kansas and Nebraska State Line C (F. D. Granger, 1898).—This station is an earth mound at the southeast corner of sec. 32, T. 1 N., R. 11 W., Webster County, Nebr. The underground mark is a stone jug buried 2 feet beneath the surface.

Kansas and Nebraska State Line A (F. D. Granger, 1898).—This station is a stone at the southwest corner of sec. 36, T. 1 N., R. 14 W., Franklin County, Nebr.

Kansas and Nebraska State Line B (F. D. Granger, 1898).—This station is a flag near the Kansas and Nebraska State line.

Kansas and Nebraska State Line 1 (F. D. Granger, 1898).—This station is a stone at the southeast corner of sec. 36, T. 1 N., R. 14 W., Franklin County, Nebr.

Kansas and Nebraska State Line 2 (F. D. Granger, 1898).—This station is a stone at the northeast corner of sec. 1, T. 1 S., R. 14 W., Smith County, Kans.

DESCRIPTIONS OF PRIMARY TRIANGULATION STATIONS, THIRTY-NINTH PARALLEL TRIANGULATION TO THE ANTHONY BASE, IN THE NINETY-EIGHTH MERIDIAN TRIANGULATION.

Bossing (Ellsworth County, Kans.; W. Eimbeck, 1899; A. T. Mosman, 1900).—This station is in SW. ¼ sec. 33, T. 16 S., R. 9 W., on the little knob situated about 30 yards due north of Louis Bossing's house, about 5 miles west and 8 miles south of Ellsworth. The underground mark is a double brick (cemented together) buried 31 inches below the surface of the ground, with 8-inch or longitudinal edges due north and south. This brick is set in grouting and has a copper bolt for station mark. Three inches of dirt was placed over this and then a pine board 1 by 12 by 14 inches was laid flat above it. The surface mark is a marble post 6 by 6 by 27 inches buried flush with the ground, with the letters U. S. C. & G. S. cut on top, the intersection of two rectangular grooves marking center of station. Two witness stones 4 by 4 by 27 inches were placed north and south of station about 25 feet, an arrowhead in each pointing toward the center of station. The nearest railroad station is Lorraine.

Sherman (Ellsworth County, Kans.; W. Eimbeck, 1899; A. T. Mosman, 1900).—This station is about one-quarter mile north of corner of secs. 16, 17, 20, and 21, T. 17 S., R. 6 W., and about 95 yards west of the line fence between sections 16 and 17, near a gate and road crossing, about 2½ miles southeast from the Sherman Middle Ranch buildings. The underground mark is a bolt in a double brick (cemented together) buried 33 inches below the surface of the ground. The surface mark is a marble post 6 by 6 by 27 inches buried flush with the ground. The top is marked with two rectangular grooves and the letters U. S. C. & G. S., the intersection of the grooves being center of station. Two witness posts 5 by 5 inches at top are placed 25 feet north and south of station. The nearest railroad station is Langley, 3 miles distant.

Loder (Saline County, Kans., W. Eimbeck, 1899, A. T. Mosman, 1900).—This station is nearly in center of SE. ¼ sec. 21, T. 16 S., R. 5 W., on the middle summit or ridge of high and open pasture land belonging to the Union Pacific Railroad. The nearest ranch is one-half mile west and occupied by Mr. William Gross. The underground mark is a bolt in a double brick (cemented together) buried 30 inches beneath the surface of the ground and surrounded with plaster of paris. The surface mark is a marble post 6 by 6 by 27 inches set flush with ground. The top of this post is marked with two rectangular grooves and the letters U. S. C. & G. S., the intersection of the grooves being center of station. Two witness stones 4 by 4 by 26 inches are placed about 25 feet north and south of center of station. The station is reached from Falun, Marquette, or Brookville.

Central (Rice County, Kans., A. T. Mosman, 1900).—This station is in SW. ¼ sec. 26, T. 18 S., R. 8 W. The underground mark is a glass quart bottle filled with ashes and buried with mouth 2½ feet below surface of ground, surrounded by concrete

3 inches thick. Above this is a 6-inch drain tile pipe 2 feet long filled with concrete and buried with top flush with ground, the center of station being marked by a cross on a copper bolt three-eighths inch in diameter sunk in the concrete. North and south of station were placed drain tile pipes 4 inches in diameter filled with concrete and with iron nail in top of each, distant 4.41 and 4.53 feet, respectively. The corner of sections 26, 27, 34, and 35 is distant 1 317.54 meters, in azimuth 80° 21′.

Little River (Rice County, Kans., A. T. Mosman, 1900).—This station is in the SW. ¼ sec. 13, T. 19 S., R. 7 W., on land belonging to Peter Lundstrum, 2 miles north and 9 miles east from Lyons and 4½ miles from Little River. The corner of sections 13, 14, 23, and 24 is distant 388.72 meters, in azimuth 30° 00′.1. (See note 7, p. 258.)

Chase (Rice County, Kans., A. T. Mosman, 1900).—This station is in the NW. ¼ sec. 3, T. 20 S., R. 10 W., opposite the house of Mr. C. J. Wood. (See note 7, p. 258.) It is 4 miles west of Chase and 4 miles north of Raymond. The azimuths and distances to certain points are: To northeast corner of Mr. Wood's house, 53° 43′, 66.65 meters; to fence on east side of road running north and south, 20.52 meters; to section corner, 172° 46′, 252.6 meters.

Savage (Rice County, Kans., A. T. Mosman, 1901).—This station is in the NE. ¼ sec. 12, T. 22 S., R. 9 W., about 6 miles southwest of Sterling. (See note 7, p. 258.)

Gilmore (Reno County, Kans., A. T. Mosman, 1901).—This station is on a sand hill about 300 yards south of Mr. Fenwick's house, 8 miles north and 2 miles west of Hutchinson, and 6 miles east and 2 miles north of Nickerson. The west side of the sand hill is being scooped out by the wind, and the station will probably soon disappear. (See note 7, p. 258.)

Partridge (Reno County, Kans., A. T. Mosman, 1901).—This station is one-fourth mile north of the southwest corner of sec. 4, T. 24 S., R. 7 W., on the farm of J. W. Hamilton, 1¼ miles north and one-half mile west of Partridge. (See note 7, p. 258.)

Arlington (Reno County, Kans., A. T. Mosman, 1901).—This station is on the north side of SE. ¼ sec. 16, T. 25 S., R. 8 W., on land belonging to Mr. W. A. Brown, 1½ miles south of Arlington. (See note 7, p. 258.)

Sunflower (Reno County, Kans., A. T. Mosman, 1901).—This station is in the northeast corner of SW. ¼ sec. 22, T. 25 S., R. 5 W., on land belonging to A. C. Galbreath, who lives on the west line of the quarter section. (See note 7, p. 258.)

Pretty Prairie (Reno County, Kans., A. T. Mosman, 1901).—This station is near the middle of sec. 20, T. 26 S., R. 6 W., one-half mile south and one-half mile east of town of same name, on land owned by Jacob R. Graber, who lives 4 miles east of station. The station is in the southeast corner of a pasture, 31.85 meters from south fence line and 33 meters from east fence line. U. S. bench mark T_4 is distant 774.01 meters, in azimuth 150° 33′.7. (See note 7, p. 258.)

Cheney (Kingman County, Kans., A. T. Mosman, 1901).—This station is in SE. ¼ sec. 26, T. 27 S., R. 5 W., 200 yards northeast of schoolhouse on open prairie. (See note 7, p. 258.)

Kingman (Kingman County, Kans., A. T. Mosman, 1901).—This station is on the west line of sec. 25, T. 28 S., R. 8 W., on land of Thomas Gillen, about 350 yards from the corner of sections 23, 24, 25, and 26, where there is a schoolhouse, and 43.2 feet from west fence line on road. U. S. bench mark X_4 is distant 342.97 meters, in azimuth 177° 55′. (See note 7, p. 258.)

Belmont (Kingman County, Kans., A. T. Mosman, 1901).—This station is in SE. ¼ sec. 16, T. 29 S., R. 6 W., on land owned by Mr. James Baldwin, on east side of quarter section, about one-fourth mile from southeast corner, near the road, and about 75 yards southeast of Mr. Baldwin's house. (See note 7, p. 258).

Prairie (Harper County, Kans., A. T. Mosman, 1901).—This station is about three-fifths mile north of southeast corner of sec. 1, T. 31 S., R. 8 W., on east section line, 3 miles west and five-eighths mile south of Duquoin, on land of Mr. Andrew Titus, of Anthony. (See note 7, p. 258).

Sumner (Sumner County, Kans., A. T. Mosman, 1901).—This station is in SW. ¼ sec. 30, T. 30 S., R. 4 W., about 250 yards east and 200 yards south of the northwest corner of the quarter. Mr. Mat. Hamilton, who has charge of the land, lives 1⅜ miles south and one-fourth mile east of station. The nearest railroad station and post-office is Norwich, 3 miles north and 2 miles west. (See note 7, p. 258).

Quarry (Harper County, Kans., A. T. Mosman, 1901).—This station is in SE. ¼ sec. 21, T. 32 S., R. 6 W., about three-eighths mile west and 150 yards north of the southeast corner of section, on land owned by Z. T. Robinson, of Harper. Mr. A. Wohlford lives 200 yards south of the station, on the south side of the road, and Mr. O. H. Riggins, heliotroper, lives three-eighths of a mile west of station. The nearest railroad station is Harper, 3½ miles west and 3 miles north. The station is near an old stone quarry and is marked by a copper bolt 4 inches long and one-half inch in diameter set in solid rock with its upper end 2.15 feet below the surface mark, a cross on head of bolt being center of station. The surface marks are the same as those described in note 7, p. 258.

Rutherford (Harper County, Kans., A. T. Mosman, 1901, W. Bowie, 1902).—This station is in NW. ¼ sec. 29, T. 33 S., R. 7 W., about 400 yards east and 250 yards south of the northwest corner of the section, and about 4¼ miles west of Anthony, on land belonging to a mortgage company and rented by Mr. Rutherford, who lives 1 mile south of the station. (See note 7, p. 258.)

Anthony Northwest Base (Harper County, Kans., A. L. Baldwin, 1900, A. T. Mosman, 1901, W. Bowie, 1902).—This station is on the north line of sec. 3, T. 33 S., R. 7 W., 4 miles north and 2½ miles west of Anthony. The underground mark is a stone 6 by 6 inches and 21 inches long, embedded in cement, with its top 4 feet below the surface of the ground. A copper bolt is set in top of stone, and a millimeter hole in bolt is center of station. The surface mark is a hard limestone block 23 by 23 inches and 16 inches high, set in a mass of concrete 4 feet square and 4 feet deep, with top flush with surface of ground. In the center of the top of this block was placed one of the bronze station marks similar to the one described in note 7, except that the center of station is marked by a millimeter hole instead of a cross. A draintile 7 inches in diameter and 25 inches long is embedded in the mass of cement, with lower end resting on underground mark.

Anthony Southeast Base (Harper County, Kans., A. L. Baldwin, 1900, O. W. Ferguson, 1902).—This station is on the north line of east and west road, 1⅛ miles directly north of large schoolhouse at Anthony and 89 meters east of Springfield avenue, on land belonging to Mr. R. R. Beam, of Anthony. The station marks are the same as at Northwest Base, described above. A large stone, 28 by 11 by 5 inches, was placed at north side of the east and west road and at east line of Springfield avenue, with top 4 inches above ground. A hole one-half inch in diameter is drilled an inch deep in center of top of stone. It is distant from Southeast Base 89.320 meters, in azimuth 90° 19′.6.

Miller (Harper County, Kans., William Bowie, 1902).—This station is in sec. 36, T. 34 S., R. 6 W., on a low ridge on land of George Miller, and 22 meters north of the northwest corner of Miller's house. The distances and azimuths to certain points are: To reference mark, 202.509 meters, 3° 32′.2; to corner sections 35, 36, 1, and 2, 210.22 meters, 6° 08′.6. The underground mark is a piece of 4-inch terra-cotta pipe 2 feet long filled with cement and buried with top 2½ feet below the surface of ground. A 60-penny wire nail set in cement with point projecting one-fourth inch marks center of station. Over this is placed 6 inches of sand. The surface mark is a 4-inch terra-cotta pipe 2 feet long filled with cement and placed with top flush with surface of ground, the center of station being marked by a 60-penny wire nail set in cement with point projecting one-fourth inch. Cement surrounds the pipe and covers the top to a depth of one-half inch. The reference mark in the southwest corner of section 36 is a 4-inch terra-cotta pipe 2 feet long filled and surrounded with cement and buried with top flush with surface of ground; a 60-penny wire nail set in the cement projects one-fourth inch.

Fowler (Harper County, Kans., W. Bowie, 1902).—This station is in SW. ¼ sec. 36, T. 33 S., R. 5 W., on land belonging to S. P. Joyner, 3¼ miles east and 3 miles north from Bluff City. The distances and azimuths to certain points are: To stone at southwest corner of section, 68° 27′.8, 562.98 meters; to reference mark, 348° 17′.2, 193.294 meters; to chimney of main house of Mr. Joyner, 329° 57′.7, about 130 meters; to shaft of windmill at north roadside, 353° 48′.9, about 190 meters. The reference mark is set in field at corner of fence, 0.35 meter north of north road fence and 0.70 meter west of north and south fence along west side of Mr. Joyner's dooryard. Station and reference marks are same as at Miller, just preceding.

GENERAL STATEMENT IN REGARD TO THE DETERMINATION OF ELEVATIONS SOUTHWARD ALONG THE NINETY-EIGHTH MERIDIAN.

While the measurement of horizontal angles was in progress at each station, the vertical angles to each station of the primary scheme were also measured on as many days as possible. Vertical measures were also made on secondary and tertiary stations. The observations in the primary scheme were reciprocal but not simultaneous—i. e., each line was observed in both directions but in general at different times. Vertical measures were as a rule made during the middle part of the day when the refraction is near its minimum value and when its diurnal change is slow. The most notable exceptions are that during the season of 1899, at Bossing, Sherman, and Loder a considerable number of observations were made during the early and late hours of the day, and at stations Miller, Fowler, and Anthony Southeast Base the observations were made between 3 and 4 p. m., and also at night. The night observations were not used in the computation.

Along the ninety-eighth meridian triangulation to the northward and on some parts of the thirty-ninth parallel triangulation in Kansas, the zenith distances of but few of the primary stations visible from a given station were observed directly with a vertical circle. The vertical angles to the other visible stations were determined by measuring the differences of zenith distances between these stations and the two or more at which absolute measures had been made. For this purpose an eyepiece micrometer on the telescope of the theodolite used in measuring horizontal angles was employed. On the other hand, all the vertical angles were measured directly with a vertical circle at stations southward along the ninety-eighth meridian.

At stations on the thirty-ninth parallel triangulation to the westward of Big Creek and Schmidt, no elevations were determined by means of vertical angles.

It is useless to aim at a high degree of accuracy in such vertical measures over lines from 10 to 30 miles long or longer, since the irregular variation of the refraction from hour to hour and day to day produces changes in vertical angles which affect the tens of seconds, and sometimes even the minutes. All differences of elevation computed from such observations are subject to large errors, due to these atmospheric changes, regardless of the degree of refinement of the instrumental measures. The accuracy of the elevations determined along the ninety-eighth meridian would probably have been increased somewhat by extending the observations at each station over many days, but such slight increase in accuracy would not have justified the extra expenditure of time and money.

The accuracy of the elevations has been kept within such limits as to make them valuable for topographic and cartographic purposes by frequent connection of the measures with bench marks of which the elevations have been accurately determined by precise leveling forming a part of the level net covering the eastern half of the United States.

The computation, with the adjustment, of the elevations determined by vertical angles from the Salina Base westward and northward to the Shelton Base has already been published in detail.*

The adjustment eastward from the Salina Base to the Missouri State line has been made in a similar manner. The computation of elevations from the thirty-ninth parallel triangulation southward to the Anthony Base is stated fully below.

COMPUTATION, ADJUSTMENT, AND ACCURACY OF THE ELEVATIONS ALONG THE NINETY-EIGHTH MERIDIAN SOUTHWARD.

The zenith distances directly observed at each station were first computed and were corrected for height of object observed and of instrument so as to refer them all to the station marks.

The difference of elevation of each pair of stations in the main scheme was then computed from the observations over the line joining them by the formula

$$h_2-h_1=s \tan \tfrac{1}{2}\,(\zeta_2-\zeta_1)\left[1+\frac{h_2+h_1}{2\rho}+\frac{s^2}{12\rho^2}\right]$$

in which h_2 and h_1 are the elevations of the stations, ζ_2 and ζ_1 are the measured zenith distances, s is the horizontal distance between the stations, and ρ is the radius of curvature.

As there are always two or more lines to each new station, many rigid conditions

* See Appendix 6, Report 1901, pp. 417-420.

existed between the observed differences of elevation, even if the connections with the precise leveling were ignored, and the least square adjustment furnishes the readiest accurate means of deriving the required elevations.

The elevations from the stations Iron Mound, Heath, and Wilson, of the thirty-ninth parallel triangulation, southward to and including the Anthony Base were all adjusted in one set of equations.

In the following tabulation the observed differences of elevation are shown, together with their adjusted values. The weight p assigned to each observed difference of elevation is inversely proportional to the length s of the line between stations in meters and was conveniently computed by the formula, $\log p = 9 - 2 \log s$. The observed difference of elevation is given the sign of the elevation of the second station named minus the elevation of the first. The quantity contained in the last column but one is the correction to be applied to an observed difference of elevation to obtain the adjusted difference of elevation.

Station 1.	Station 2.	Weight p.	Observed diff. of elev. h_2-h_1	Adjusted diff. of elev. h_2-h_1	Adj.-Obs. v.	pv^2
			m	*m*	*m*	*m*
Iron Mound	Loder	0.76	+39.27	+35.56	−3.71	10.461
Heath	Loder	1.32	−62.71	−61.66	+1.05	1.455
Loder	Sherman	5.50	+12.88	+12.62	−0.26	0.374
Heath	Sherman	1.07	−50.79	−49.04	+1.75	3.279
Heath	Bossing	0.82	+21.92	+22.74	+0.82	0.551
Wilson	Bossing	1.01	+ 8.34	+ 8.97	+0.63	0.401
Sherman	Bossing	1.25	+72.09	+71.78	−0.31	0.120
Bossing	Central	2.02	−37.92	−37.91	+0.01	0.000
Sherman	Central	2.52	+34.53	+33.87	−0.66	1.099
Sherman	Little River	2.43	+29.03	+30.08	+1.05	2.678
Central	Little River	6.87	− 3.24	− 3.79	−0.55	2.075
Bossing	Little River	0.89	−43.20	−41.70	+1.50	2.002
Bossing	Chase	1.04	−27.94	−28.36	−0.42	0.183
Central	Chase	1.56	+ 8.23	+ 9.55	+1.32	2.718
Little River	Chase	0.91	+12.82	+13.33	+0.51	0.237
Chase	Savage	1.57	−20.62	−19.28	+1.34	2.820
Little River	Savage	0.96	− 5.81	− 5.95	−0.14	0.019
Little River	Gilmore	1.41	− 1.10	− 1.97	−0.87	1.067
Savage	Gilmore	1.35	+ 3.98	+ 3.98	0.00	0.000
Savage	Partridge	1.82	−30.00	−28.81	+1.19	2.577
Gilmore	Partridge	1.75	−32.78	−32.79	−0.01	0.000
Partridge	Sunflower	1.50	−18.96	−18.79	+0.17	0.034
Gilmore	Sunflower	0.82	−50.09	−51.58	−1.49	1.829
Savage	Arlington	1.00	−28.55	−28.73	−0.18	0.032
Partridge	Arlington	4.42	− 0.34	+ 0.08	+0.42	0.778
Sunflower	Arlington	1.09	+21.88	+18.87	−3.01	9.875
Arlington	Pretty Prairie	2.30	−11.82	−12.50	−0.68	1.063
Sunflower	Cheney	2.37	−23.84	−22.87	+0.97	2.230
Pretty Prairie	Cheney	2.93	−28.35	−29.24	−0.89	2.321
Cheney	Kingman	1.10	+51.51	+50.59	−0.92	0.931
Kingman	Belmont	3.21	−27.48	−27.74	+0.26	0.218
Cheney	Belmont	2.20	+22.24	+22.85	+0.61	0.818
Belmont	Sumner	2.64	−25.66	−25.42	+0.24	0.153
Cheney	Sumner	1.10	− 1.96	− 2.57	−0.61	0.409
Kingman	Prairie	1.80	− 6.62	− 6.16	+0.46	0.382
Belmont	Prairie	2.17	+21.62	+21.58	−0.04	0.004
Sumner	Prairie	1.18	+47.91	+47.00	−0.91	0.977
Prairie	Quarry	2.41	−62.89	−63.26	−0.37	0.330
Sumner	Quarry	1.79	−16.12	−16.26	−0.14	0.036
Quarry	Rutherford	3.99	−10.39	−10.21	+0.18	0.128

Station 1.	Station 2.	Weight p.	Observed diff. of elev. h_2-h_1	Adjusted diff. of elev. h_2-h_1	Adj.-Obs. v.	pv^2
			m	*m*	*m*	*m*
Prairie	Rutherford	1.60	−73.79	−73.47	+0.32	0.163
Quarry	Anthony Northwest Base	11.94	−13.76	−14.05	−0.29	1.003
Rutherford	Anthony Northwest Base	17.14	− 3.86	− 3.84	+0.02	0.000
Quarry	Anthony Southeast Base	10.96	−19.80	−19.76	+0.04	0.022
Rutherford	Anthony Southeast Base	17.42	− 9.55	− 9.55	0.00	0.000
Sumner	Fowler	1.03	−67.04	−65.77	+1.27	1.661
Quarry	Fowler	2.79	−49.90	−49.51	+0.39	0.424
Rutherford	Fowler	1.44	−39.52	−39.30	+0.22	0.069
Rutherford	Miller	2.47	−15.47	−15.25	+0.22	0.119
Anthony Southeast Base	Miller	3.63	− 5.20	− 5.70	−0.50	0.908
Fowler	Miller	5.04	+23.79	+24.05	+0.26	0.343
Fowler	Anthony Southeast Base	2.67	+29.22	+29.75	+0.53	0.751
Anthony Northwest Base	Anthony Southeast Base	27.48	− 5.78	− 5.71	+0.07	0.137

In the adjustment of which the direct results are indicated above, the elevations of the stations Iron Mound, Heath, and Wilson were considered fixed at the values 456.65, 553.87, 567.64 meters, respectively, which are the elevations derived for them in the adjustment set forth on pages 417–419, 422 of Appendix 6, Report for 1901, corrected by $+4^{cm}$ to take account of the effect of new leveling recently introduced into the precise level net. Certain other elevations were fixed by precise leveling as follows: Pretty Prairie, 487.74 meters; Kingman, 509.09 meters; Anthony Southeast Base, 419.91 meters, and Anthony Northwest Base, 425.62 meters.

The elevations of the 19 remaining stations connected by the observations are the elevations to be determined by least squares from the 53 observed differences of elevation indicated above.

The observations over the line Sunflower–Pretty Prairie were rejected. The discrepancy developed on this line was 5.7 meters, and the coefficient of refraction computed from the observations was abnormal.

The probable error of an observation of weight unity derived from the adjustment is ±0.91 meter. In other words, the reciprocal observations over a line 31.7 kilometers (19⅔ miles) long, this being the length of the line corresponding to unit weight, determined the elevation of two points with such a degree of accuracy that it is an even chance whether the error is greater or less than 0.91 meter. The probable errors of lines for other lengths were assumed to be proportional to their lengths.

The probable errors of the elevations of the four stations fixed by precise leveling are about ±0.06 meter. The probable error approaches this value for stations adjacent to those fixed by precise leveling and is greatest for the most remote stations. Station Chase was assumed to be the one least accurately determined, and its probable error was therefore computed as a limiting value and was found to be ±0.72 meter from the vertical angle measures alone, or, when combined with the probable error of the elevations fixed by the precise leveling, it was still ±0.72.

In other words, for the least accurately determined station in the main scheme between the thirty-ninth parallel triangulation and the Anthony Base there is an even chance that the elevation is correct within 0.7 meter, or 2.3 feet, and for most stations in the main scheme the accuracy is much greater than this.

TABLE OF ELEVATIONS.

The datum for all the elevations is mean sea level.

The stations are in three classes: First, those fixed directly by the precise leveling, and of which the elevation is subject to a probable error of ±0.06 meter; second, the primary stations fixed by reciprocal measures of vertical angles and which are subject to probable errors varying from ±0.1 to ±0.7 meter; third, the tertiary stations of which the elevations are fixed by measurements of vertical angles which are not reciprocal, the tertiary stations not being occupied. These elevations are subject to probable errors which may be as great as ±2 meters in some cases. For more exact elevations of the stations fixed by the precise leveling and for an exact description of the point on each station mark to which such elevations are referred, the published results of precise leveling should be consulted.

The accuracy with which each elevation in the main scheme is determined depends mainly upon the remoteness of that station from the nearest one of which the elevation is fixed by precise leveling as indicated in class 1 of the following table. As already noted, station Chase is probably least accurately determined of the stations to the southward of the thirty-ninth parallel tringulation, its probable error being ±0.7 meter. Of the stations to the northward Brown is supposed to be the least accurately determined, having a probable error of ±0.3 meter.

Table of elevations.

Station.	Point to which elevation refers.	Elevation.
Class 1		*Meters.*
Bowler	Stone	331.18
Class 2		
Berry	Stone	341.4
Marty	Stone	332.2
Haskin	Stone	342.2
Thomas	Stone	331.5
Bebe Mound	Stone	343.9
Eckman	Stone	307.1
Kanwaka	Stone	345.2
Simmons	Stone	364.2
Mabon	Stone	378.3
Elevation	Stone	360.6
Powell	Stone	387.2
Adams	Stone	400.3
Clark	Stone	479.6
Meyer	Stone	447.7
Zean Dale	Stone	464.8
Erricssen	Stone	412.3
Humboldt	Stone	430.7
Reinhard	Stone	473.4

Table of elevations—Continued.

Station.	Point to which elevation refers.	Elevation.
White City	Stone	452.4
Robbins	Ground	406.2
Taylor	Stone	400.0
Wilmer	Stone	407.4
Frey	Ground	414.4
Class 3		
Lenexa M. E. Church	Spire	342.3
Dennis Barn	Cupola	341.4
Base 1*	Ground	313.6
State Line 2*	Stone	290.7
State Line 3*	Stone	324.1
Spring Hill Presbyterian Church	Spire	352.4
Ochiltree Church	Cupola	342.2
Olathe High School	Top of cupola	339.7
Olathe M. E. Church*	Spire	333.6
Olathe Deaf and Dumb Asylum*	Chimney	342.6
Gardner Methodist Church	Cupola	345.1
Lawrence, Kansas State University	Top of north dome	344.5
Lawrence Water Tower	Wind vane	343.4
Kellams House	Chimney	362.4
Roberts Windmill	Axle	353.4
Big Springs Windmill	Top	349.4
Le Compton, U. S. G. S.	Ground	344.5
Carbondale Schoolhouse	Cupola	368.3
Blue Mound	Stone	321.8
Stenger	Ground	374.9
Carson	Stone	324.8
Prominent Windmill*		371.1
Scranton Schoolhouse*	South cupola	359.1
Stone House*	Roof	374.0
White House on Hill	Center chimney	400.7
Knox Knob	Ground	348.0
Topeka First Presbyterian Church	Spire	336.8
Topeka M. E. Church*	Spire	324.4
Topeka State House*	West wing, cupola	319.2
Topeka Insane Asylum*	Cupola	322.4
Buffalo Mound, azimuth mark*	Ground	388.7
Newbury Catholic Church*	Spire	346.9
St. Marys Catholic Church*	Spire	326.8
Martins Hill*	Ground	332.2
Fort Riley Reservoir	Top	408.3
Grand View Schoolhouse	Belfry	402.3
White City Schoolhouse*	Cupola	467.1
Abilene Catholic College*	Cupola	410.5
Class 1		
Hays	Stone	662.60
Class 2		
Fairmount	Stone	614.4
La Crosse	Stone	658.6
Smoky Hill	Stone	712.8
Trego	Stone	725.8
Skaggs	Stone	743.9
Big Creek	Stone	765.7
Schmidt	Stone	781.6

* No check on this elevation.

Table of elevations—Continued.

Station.	Point to which elevation refers.	Elevation.
Class 3		*Meters.*
Gorham Elevator	Top	597.4
Walker Schoolhouse *	Roof	600.4
Katherinestadt Catholic Church *	Spire	652.8
Hertzog Catholic Church *	Tower	611.4
Castle Rock	Ground	787.3
Bluff	Ground	794.0
Indian Creek *	Stone	845.9
Canyon *	Stone	850.4
Class 1.		
Salina East Base	Bolt	366.20
Salina West Base	Bolt	372.30
Bunker Hill (or B. M. S.)	Stone	570.44
Russell Southeast Base (or B. M. T.)	Stone	573.50
Russell Northwest Base	Stone	561.16
Blue Hill, Nebraska	Stone	622.47
Class 2.		
North Pole Mound	Stone	446.9
Iron Mound	Stone	456.6
Vine Creek	Stone	460.0
Thompson	Stone	486.6
Heath	Stone	553.9
Lincoln	Stone	513.3
Golden Belt	Stone	527.8
Wilson	Stone	567.6
Meades Ranch	Stone	599.4
Allen	Stone	579.7
Blue Hill	Stone	652.7
Waldo	Stone	619.0
Dial	Stone	624.0
Kill Creek	Stone	623.1
Lawrence 2	Stone	569.4
Old Well 2	Stone	549.6
Brown	Stone	589.8
Lebanon	Stone	587.6
Cooper	Stone	612.7
Lipps	Stone	651.8
Herrick, Nebraska	Stone	639.4
Class 3.		
Soldier Cap Mound	Ground	480.4
Sugar Loaf Mound	Ground	512.5
Salina, St. Johns Military College	Top of cupola	403.7
Salina, Phillips House	Top of dome	411.6
Ellsworth Water Tower	Top	510.7
Turkey Point	Ground	532.6
Small Peak	Ground	564.1
Lincoln College	Top of cupola	452.6
Blue Hill, U. S. G. S.	Ground	535.3
Lone Tree (Cottonwood)	Ground	497.2
Bunker Hill Water Tower	Tank	581.9
Russell High School	Top of cupola	585.4
Russell North School	Top of cupola	577.8
Russell Tripod	Ground	565.6
Bunker Hill Methodist Church	Spire	583.8

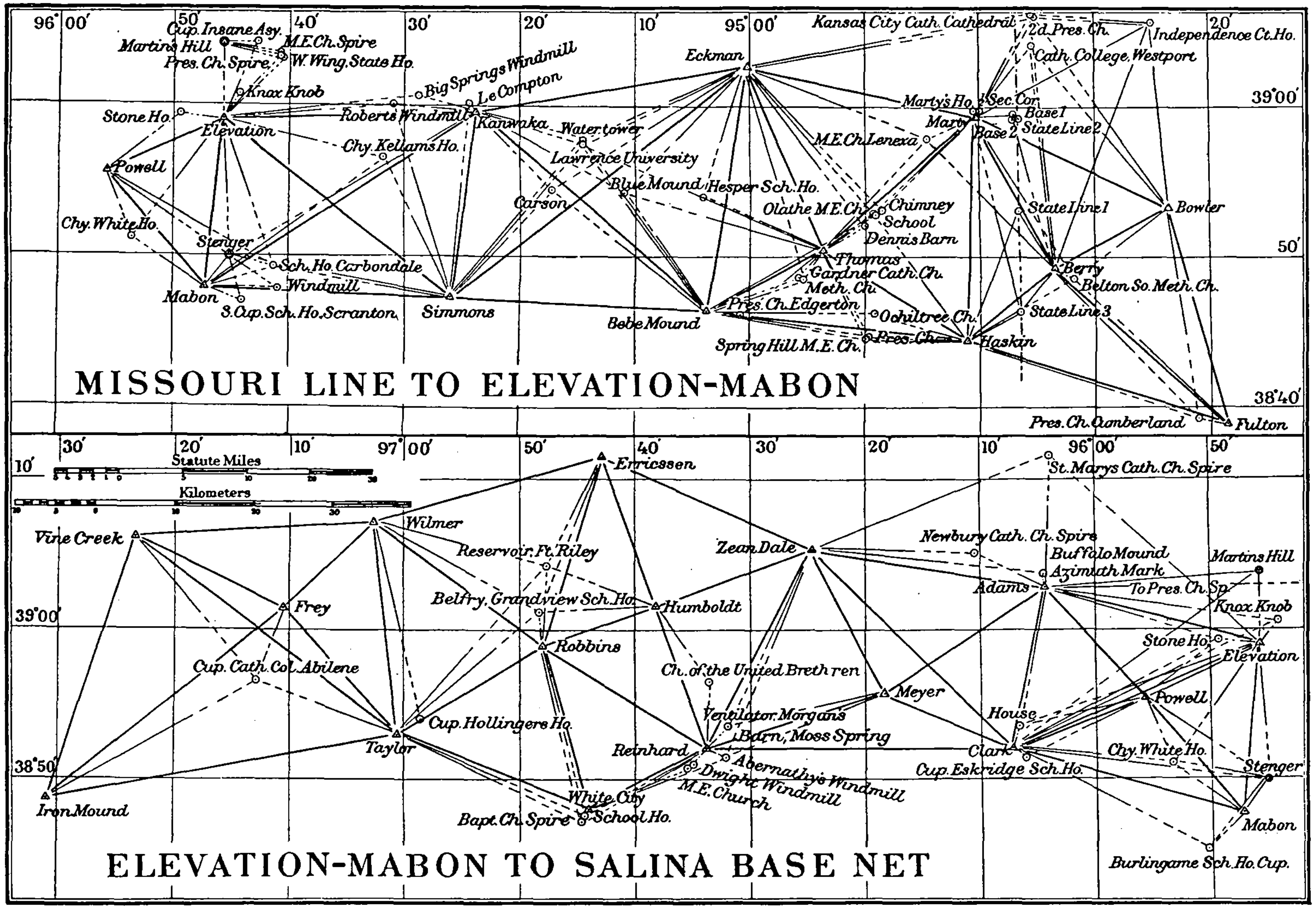
* No check on this elevation.

Table of elevations—Continued.

Station.	Point to which elevation refers.	Elevation.
Class 3—Continued.		*Meters.*
Bunker Hill Schoolhouse	Top of cupola	581.2
Tipton, U. S. G. S.	Ground	553.1
Covert	Ground	561.9
Medicine Peak	Ground	541.6
Smith Center Standpipe	Top	589.7
Hardilee, U. S. G. S.	Ground	615.6
Kansas-Nebraska State Line 1	Stone	641.5
Kansas-Nebraska State Line B	Ground	632.1
Kansas-Nebraska State Line 2	Stone	627.6
Kansas-Nebraska State Line C	Mound	590.6
Class 1.		
Pretty Prairie	Stone	487.74
Kingman	Stone	509.09
Anthony Southeast Base	Stone	419.91
Anthony Northwest Base	Stone	425.62
Class 2.		
Loder	Station mark	492.2
Sherman	Station mark	504.8
Bossing	Station mark	576.6
Central	Station mark	538.7
Little River	Station mark	534.9
Chase	Station mark	548.2
Savage	Station mark	529.0
Gilmore	Station mark	533.0
Partridge	Station mark	500.2
Arlington	Station mark	500.2
Sunflower	Station mark	481.4
Cheney	Station mark	458.5
Belmont	Station mark	481.4
Sumner	Station mark	455.9
Prairie	Station mark	502.9
Quarry	Station mark	439.7
Rutherford	Station mark	429.5
Fowler	Station mark	390.2
Miller	Station mark	414.2
Class 3.		
Oxide	Ground	524.2
Geneseo Schoolhouse	Top of tower	554.6
White Cliffs*	Cairn	498.9
German Church*	Roof	556.0
Butte*	Highest point	494.5
Loders House*	Chimney	484.1
Kanopolis Salt Works	Center hoist	507.6
Frederic Elevator	Top of roof	554.8
Bushton Elevator*	Top of roof	557.6
North Sherman*	Top of cairn	502.5
Windom Water Tower	Top	519.3
Sterling College	Top of tower	531.1
Anthony Schoolhouse	Top of tower	439.1

*No check on this elevation.

No. 1.



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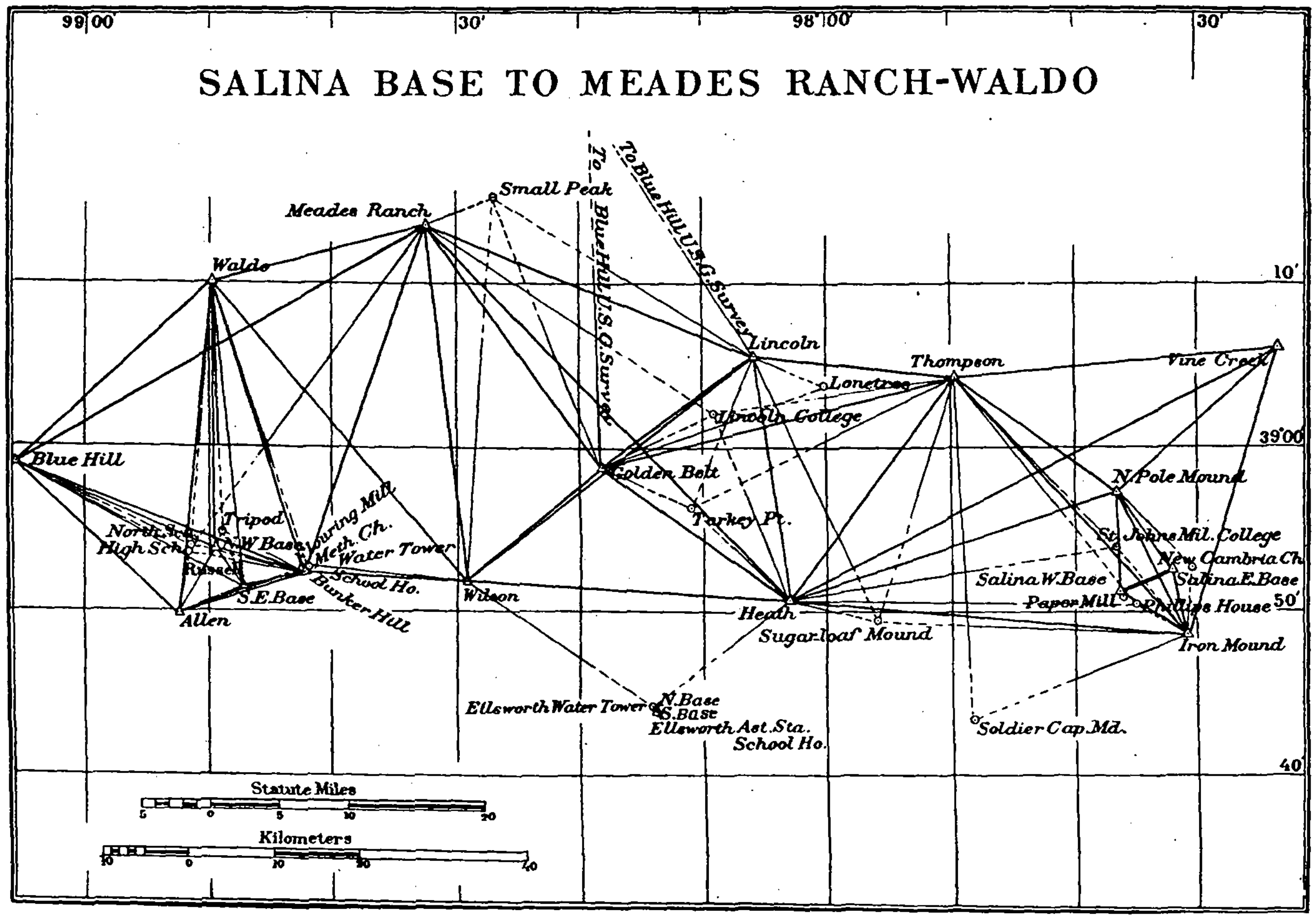
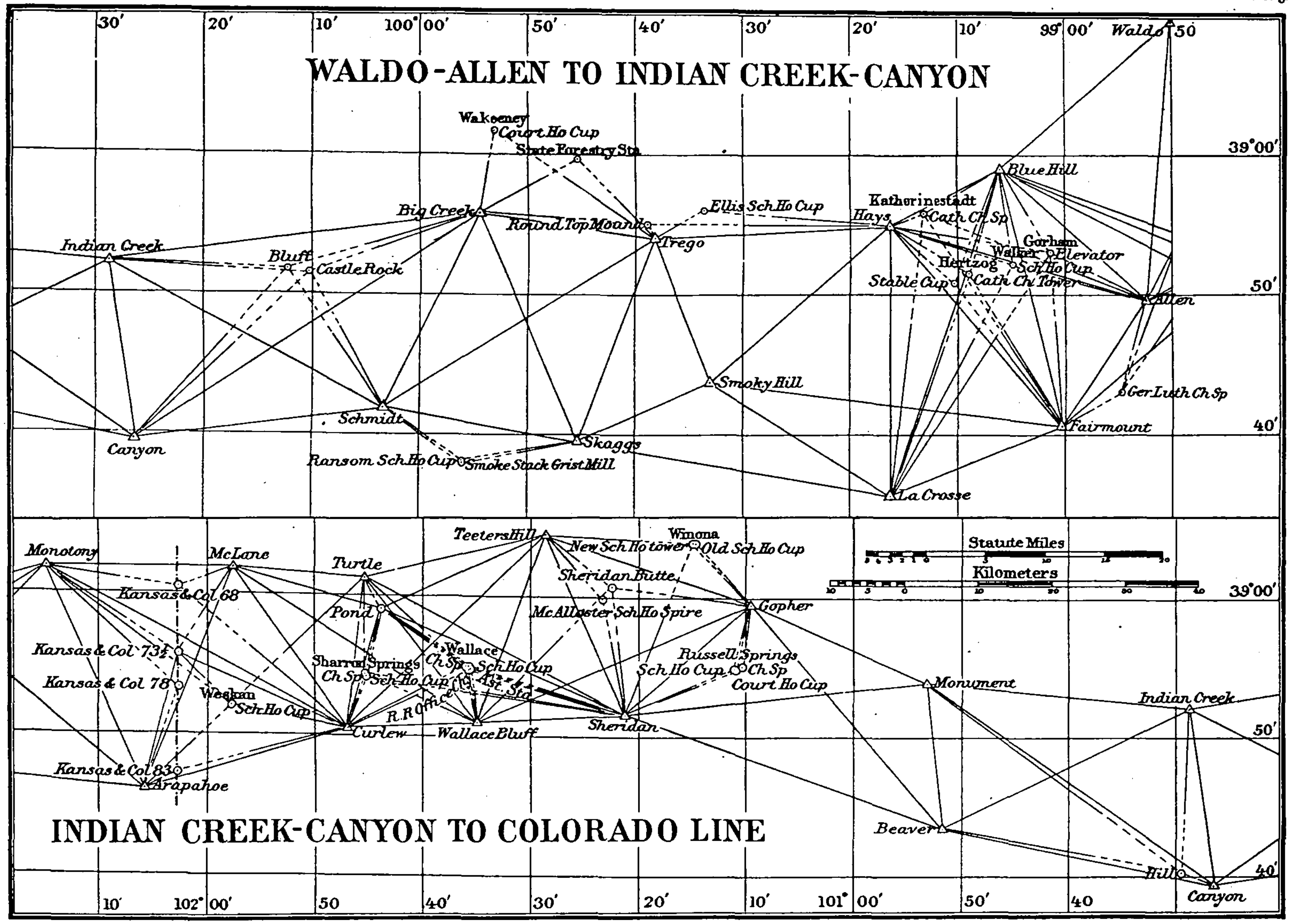
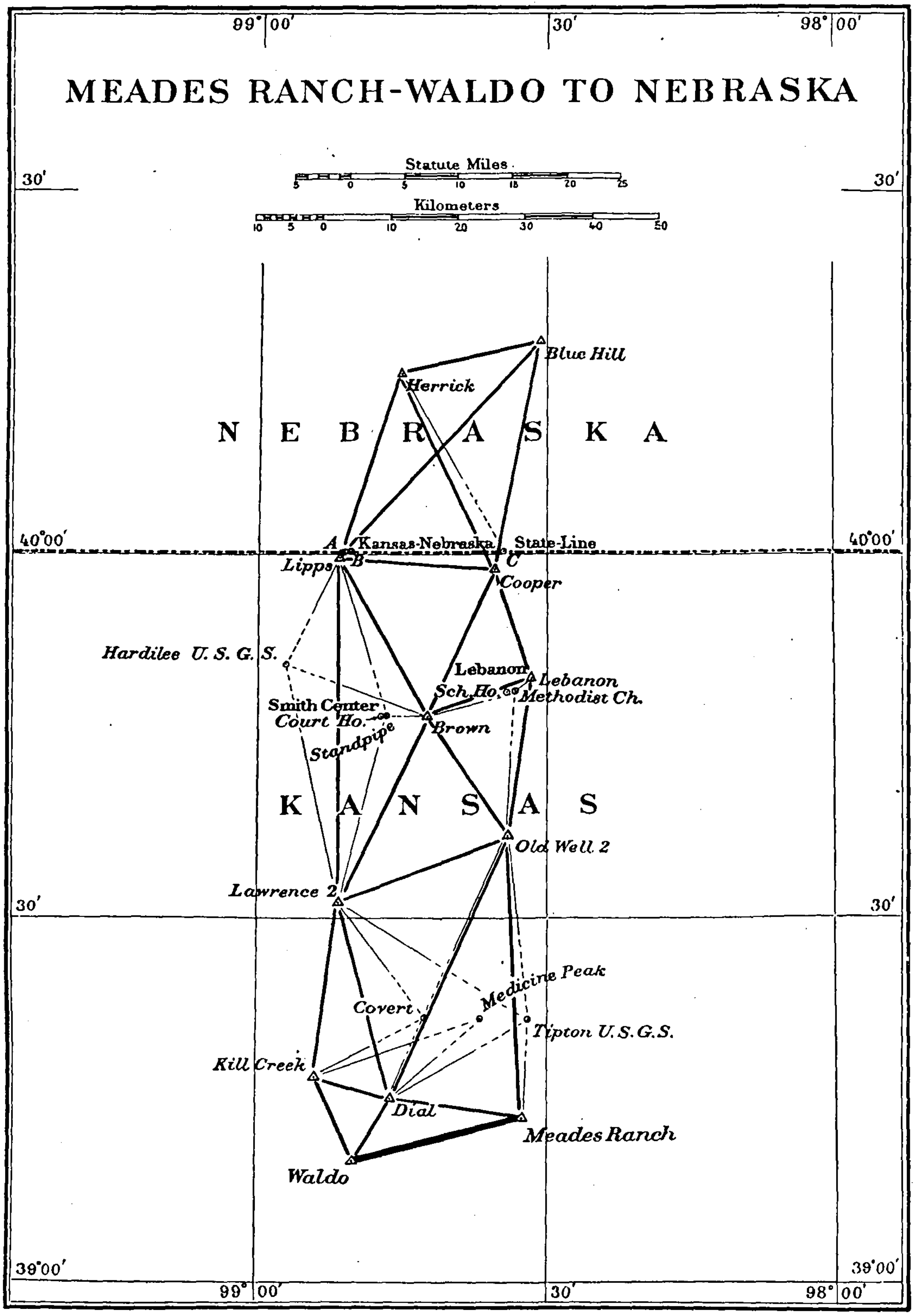

SALINA BASE TO MEADES RANCH-WALDO
99 00
30'
98 00'
30'
10'
39 00
50'
40'
Meades Ranch
Small Peak
Waldo
To Blue Hill U.S.G. Survey
To Blue Hill U.S.G. Survey
Lincoln
Lonetree
Thompson
Vine Creek
Lincoln College
Blue Hill
Golden Belt
N. Pole Mound
Turkey Pt.
Tripod
N.W. Base
Meth. Ch.
Water Tower
School Ho.
Bunker Hill
Russell
S.E. Base
Allen
Wilson
Heath
Sugar-loaf Mound
St. Johns Mil. College
New Cambria Ch.
Salina W. Base
Salina E. Base
Paper Mill
Phillips House
Iron Mound
Ellsworth Water Tower
N. Base
S. Base
Ellsworth Ast. Sta.
School Ho.
Soldier Cap. Md.
Statute Miles
Kilometers

No. 3.

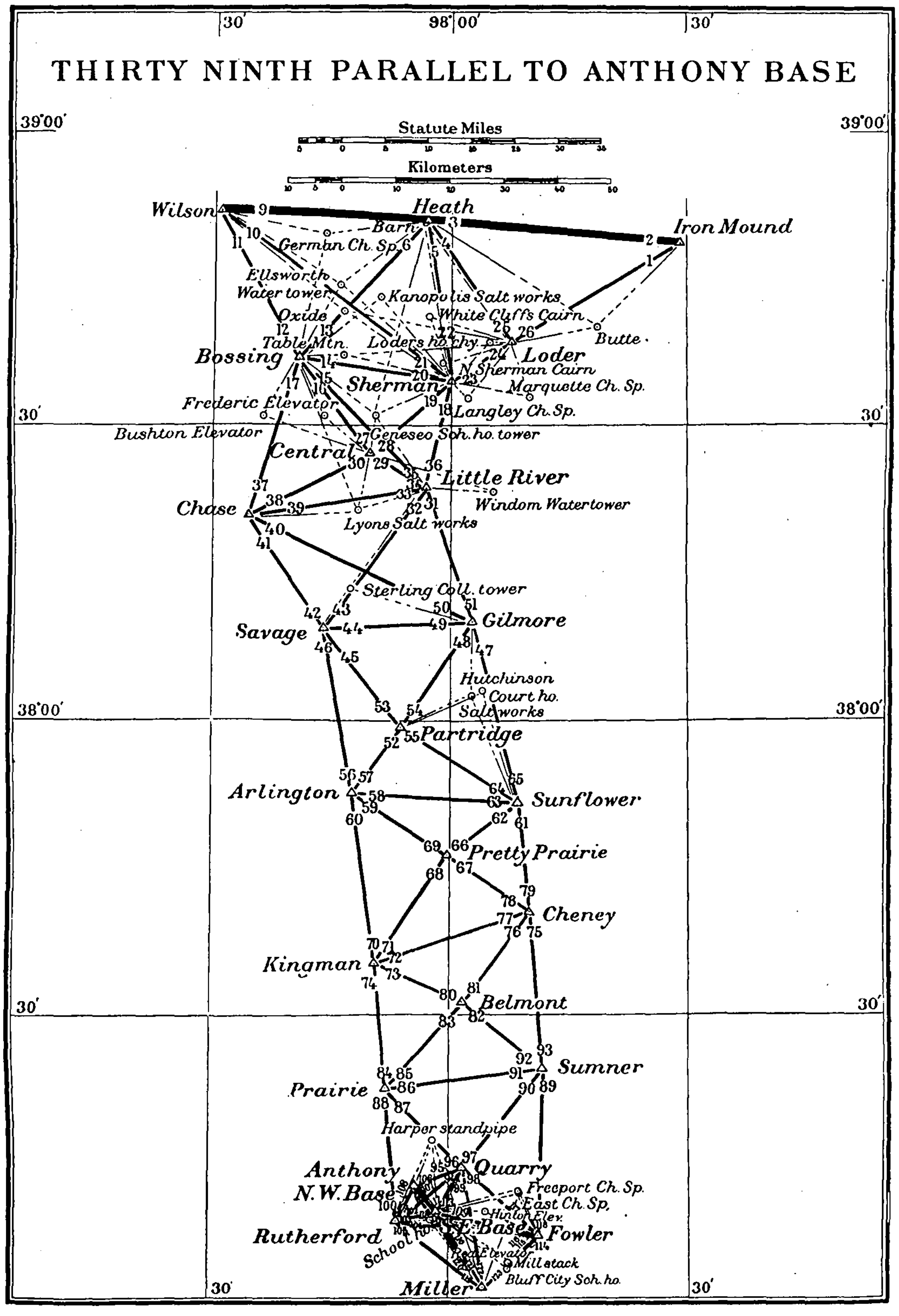

WALDO-ALLEN TO INDIAN CREEK-CANYON
Wakeeney
Court Ho Cup
State Forestry Sta.
Big Creek
Round Top Mound
Trego
Ellis Sch Ho Cup
Katherinestadt
Hays
Cath Ch Sp
Blue Hill
Waldo
Gorham
Walker
Elevator
Hertzog
Sch Ho Cup
Stable Cup
Cath Ch Tower
Allen
Indian Creek
Bluff
Castle Rock
Smoky Hill
Ger Luth Ch Sp
Schmidt
Canyon
Skaggs
Fairmount
Ransom Sch Ho Cup
Smoke Stack Grist Mill
La Crosse
Teeters Hill
Winona
New Sch Ho tower
Old Sch Ho Cup
Monotony
McLane
Turtle
Sheridan Butte
Kansas & Col 68
Pond
McAllaster Sch Ho Spire
Gopher
Statute Miles
Kilometers
Kansas & Col 73½
Wallace
Ch Sp
Sch Ho Cup
Sharron Springs
Ch Sp
Sch Ho Cup
Russell Springs
Sch Ho Cup
Ch Sp
Court Ho Cup
Monument
Kansas & Col 78
Weskan
Sch Ho Cup
1st Sta
R.R Office
Indian Creek
Curlew
Wallace Bluff
Sheridan
Kansas & Col 83
Arapahoe
INDIAN CREEK-CANYON TO COLORADO LINE
Beaver
Hill
Canyon
30′
20′
10′
100° 00′
50′
40′
30′
20′
10′
99° 00′
50
39° 00′
50′
40′
10′
102° 00′
50
40′
30′
20′
10′
101° 00′
50′
40
39° 00′
50′
40′

No. 4.

MEADES RANCH-WALDO TO NEBRASKA



No. 5.


THIRTY NINTH PARALLEL TO ANTHONY BASE
30'
98° 00'
30'
39°00'
39°00'
Statute Miles
Kilometers
Wilson
Heath
Iron Mound
Barn
German Ch. Sp.
Ellsworth Water tower
Kanopolis Salt works
White Cliffs Cairn
Oxide
Butte
Table Mtn.
Loders ho. chy.
Loder
Bossing
N. Sherman Cairn
Sherman
Marquette Ch. Sp.
Frederic Elevator
Langley Ch. Sp.
Bushton Elevator
Geneseo Sch. ho. tower
Central
Little River
Chase
Windom Watertower
Lyons Salt works
Sterling Coll. tower
Gilmore
Savage
Hutchinson Court ho.
Salt works
38°00'
38°00'
Partridge
Arlington
Sunflower
Pretty Prairie
Cheney
Kingman
Belmont
Sumner
Prairie
Harper standpipe
Anthony N.W. Base
Quarry
Freeport Ch. Sp.
East Ch. Sp.
Rutherford
S.E. Base
Fowler
School
Mill stack
Bluff City Sch. ho.
Miller
30'
30'

APPENDIX No. 4.

REPORT 1902.

THE HYPSOGRAPH.

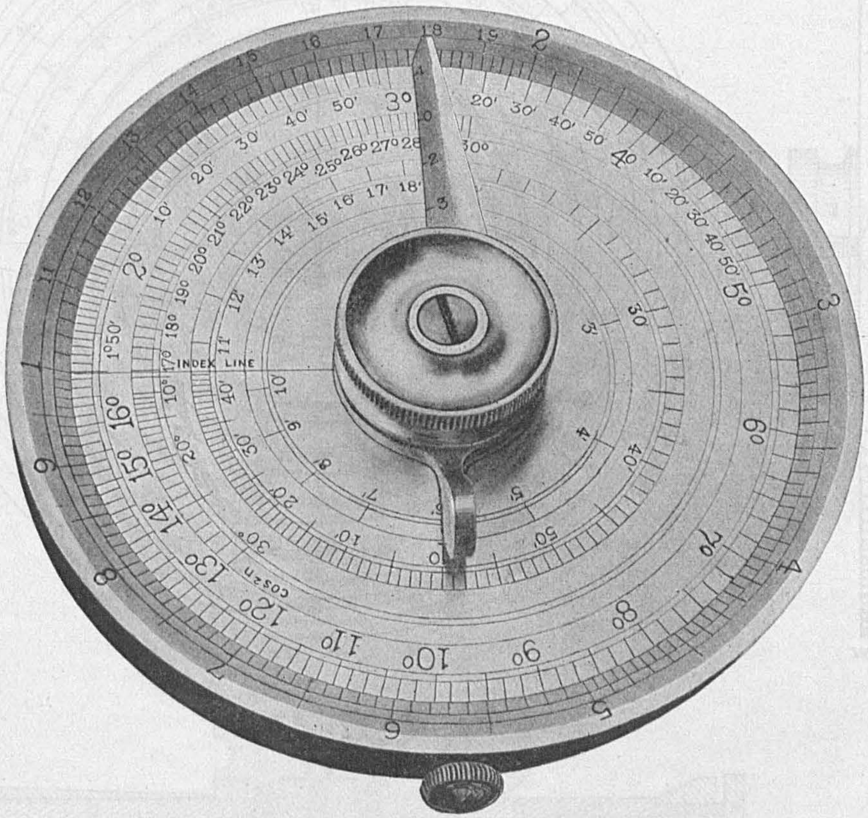
DESIGNED BY

FREMONT MORSE,
Assistant, Coast and Geodetic Survey.

THE HYPSOGRAPH.

This instrument was designed by Assistant Fremont Morse for use in the Coast and Geodetic Survey and differs from the ordinary form of topographic slide-rule used by engineers in three particulars: First, it is circular instead of rectilinear; second, it does not give elevations in the same unit as the distances, but gives heights in feet

No. 1.



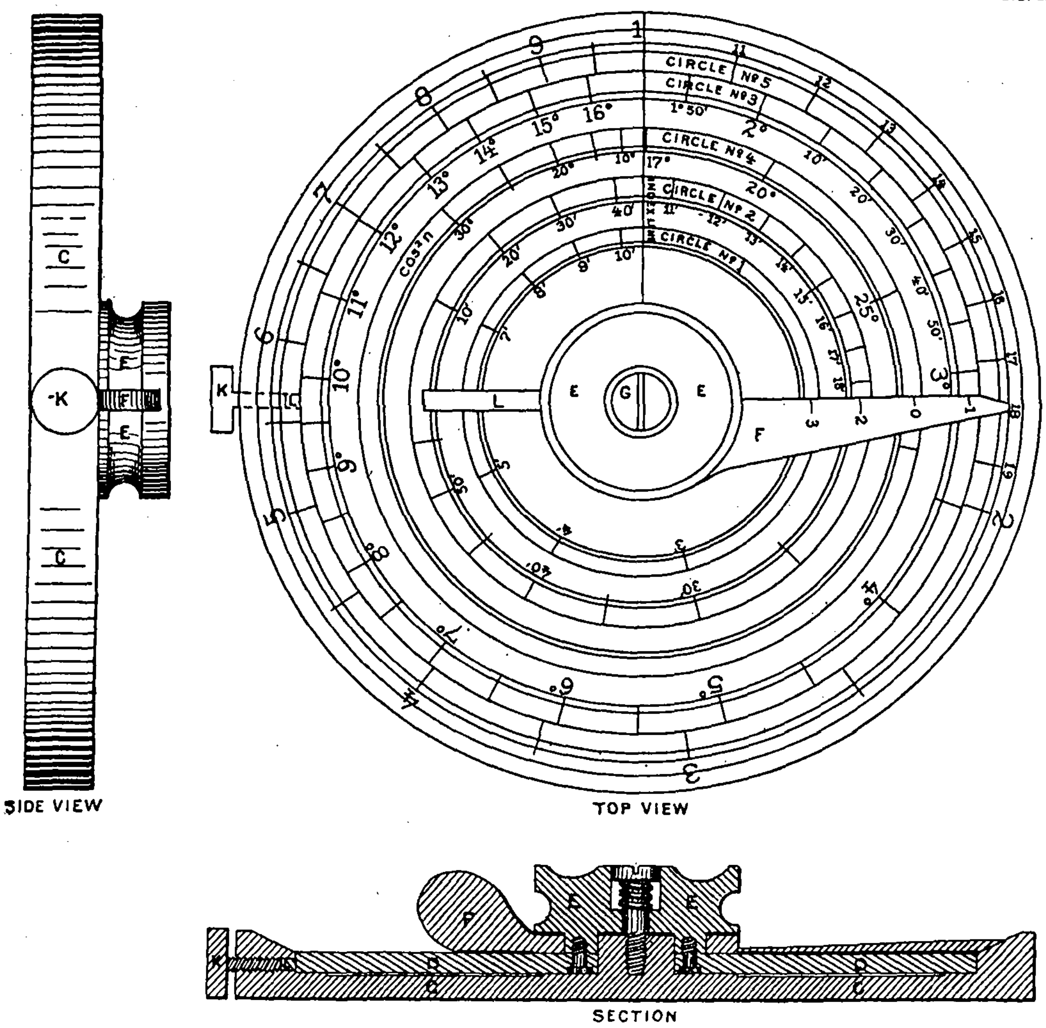
when the distances are measured in meters; and third, the arguments used for determining the heights are the horizontal distance and angle of elevation instead of inclined distance and angle of elevation.

The instrument will indicate the difference of height (uncorrected for curvature and refraction) for any distances and angles encountered in ordinary topographic work, with an error much smaller than the probable error of observation of the plane-table alidade.

DESCRIPTION.

It is constructed of aluminum and consists of two concentric disks C C and D D, the inner one revolving about a spindle fixed in the center of the outer one. The outer disk C C has a logarithmic scale of numbers (circle No. 5) engraved on its beveled upper surface. The principal graduations on this scale correspond to the logarithmic value of the numbers from 1 to 100, with intermediate graduations corresponding to 102, 104,

No. 2.



106, etc., increasing by single unit intervals up to 20, and then 205, 215, 225, etc., increasing by intervals of 5 up to 50. These intermediate graduations, as well as the intermediate ones on the other scales to be described are not shown on the drawing.

The inner disk D D has four concentric logarithmic scales engraved upon its upper surface, representing the values of the quantities 3.2809 × tan n (3.2809 being the ratio of the meter to the foot, and n the vertical angle) for angles from 2′ up to 30°.

The inner one of the four (No. 1) is graduated for angles from 2′ to 10′, inclusive; the next (No. 2) from 11′ to 1° 44′; the next (No. 4) from 17° to 30°, and the outer circle (No. 3) from 1° 45′ to 16° 30′. They are placed in this order so as to bring the one most frequently used next to the number scale. To the left of the index line, on a part of the circle of scale No. 4, is another scale representing the logarithmic values of $\cos^2 n$ for reducing rod readings to horizontal distance when the rod is held above or below the plane of the observer's instrument.

Referring to the drawing, E E is a milled head for revolving the inner disk; F F is a reading arm, its fiducial edge serving as a guide line for reading the graduation marks on the outer circle (on C C) corresponding to a given angle on either of the inner circles; G is a screw that holds the two disks together; a spiral spring in the open space around the shank of this screw keeps the two disks in contact by its constant pressure; H H are two screws that secure the milled head E E to the disk D D; K is a clamping screw that works against a cylindrical lug L, which in turn presses against the circumference of the disk D D and holds it securely clamped. The lug is introduced between the screw and disk so that there may be no tendency to rotate the disk when the clamp screw is set.

DIRECTIONS FOR USE.

To Find the Difference in Height, Corresponding to a Given Distance in Meters and Angle of Elevation or Depression.

Unclamp the instrument by loosening the small brass screw.

Turn the inner disc until the index line coincides with the given distance, in meters, on the outermost circle.

Clamp the instrument.

Swing the reading arm around to the right, clockwise, till its fiducial edge coincides with the graduation mark of the given angle.

Then, on the outermost circle, at the fiducial edge of the reading arm, read the scale for the numbers composing the integer and decimal of the required difference of height in feet.

To Locate the Decimal Point in the Result.

FROM THE INDEX LINE TO THE ORIGIN OF THE OUTER SCALE.

On the reading arm will be seen the numbers —1, 0, —2, and —3. These numbers show how many figures of the scale reading are to be pointed off for the decimal. Thus, if the index line be set at distance 300, and the given angle is 3°, there will be seen on the reading arm over the circle on which the 3° is located, the number —1. This indicates that there will be one figure of the scale reading pointed off for the decimal. Hence the required difference of height is 51.6 feet.

Similarly, if the given distance is still 300 meters but the angle 30°, the required difference of height is 568 feet. The number 0 on the reading arm, over the circle on which 30° is located, indicates that the whole number of figures of the scale reading is to be taken for the required difference of height.

In like manner if the distance is still 300 meters but the angle 20′, the difference of height is 5.73 feet; and for 300 meters and 2′ it is 0.573 foot.

WHEN THE READING ARM PASSES BEYOND THE ORIGIN OF THE OUTER SCALE.

If, however, the reading arm, in swinging around to the right, clockwise, from the index line to the given angle, *passes the starting point, 1, of the outermost scale*, then the numbers on the reading arm must each be *increased by unity*, and instead of —1, 0, —2, and —3, they become 0, +1, —1, and —2, and the number of figures in the integer is increased accordingly.

REDUCTION OF ROD READINGS ON INCLINED SIGHTS TO HORIZONTAL PLANE OF OBSERVER.

Set the index line on the graduation mark on the outermost scale corresponding to the reading of the inclined sight, and then swing the reading arm to the left, traversing the graduation on circle No. 4 marked cos ²n, until its fiducial edge coincides with the given angle of inclination. Then, on the outermost circle, read the graduation under the edge of the reading arm for the required horizontal distance.

Thus, for an inclined distance of 300 meters and an angle of 20° the horizontal distance is 265 meters.

For distances greater than 1 000 meters a correction for curvature and refraction must be applied.

MEMORANDA.

The large center milled head is not a clamp, but a handle for turning the inner disc and index line to any desired position.

The clamp is the small milled-head brass screw on the outer edge of the instrument.

The graduation on the beveled portion of the instrument refers to distances and heights.

To move the index line after the instrument is clamped use the projecting finger hold at the base of the arm.

Be careful not to attempt to move the inner circle before the instrument is unclamped.

APPENDIX No. 5.

REPORT 1902.

THE MAGNETIC OBSERVATORIES OF THE UNITED STATES COAST AND GEODETIC SURVEY IN OPERATION ON JULY 1, 1902.

BY

L. A. BAUER,
Inspector of Magnetic Work,
Assistant, Coast and Geodetic Survey,

AND

J. A. FLEMING,
Aid, Coast and Geodetic Survey.

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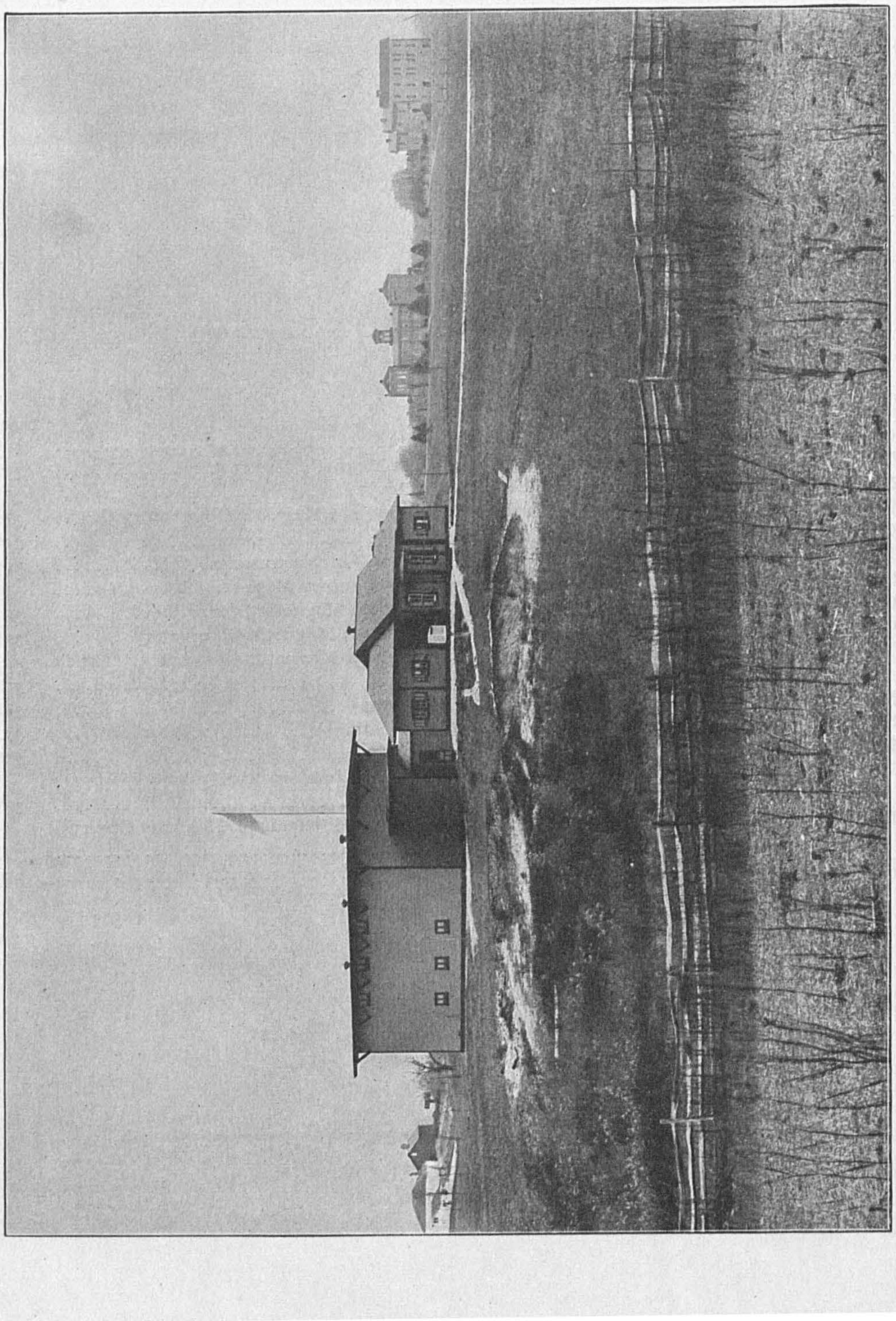
ILLUSTRATIONS.

No. 1.



Cheltenham Magnetic Observatory (looking northeast).

THE MAGNETIC OBSERVATORIES OF THE UNITED STATES COAST AND GEODETIC SURVEY IN OPERATION ON JULY 1, 1902.

By L. A. BAUER, *Inspector of Magnetic Work*, and J. A. FLEMING, *Aid.*

I. SELECTION OF SITES OF THE MAGNETIC OBSERVATORIES.

The United States Coast and Geodetic Survey has in operation, in conformity with the plan of the magnetic survey of the United States and countries under its jurisdiction, outlined in Appendix 10, Report of the Superintendent of the Coast and Geodetic Survey for 1899, four magnetic observatories at which the manifold variations of the Earth's magnetism are being continuously recorded by photographic means. These continuous records, besides serving other useful purposes, are utilized in referring the values of the magnetic elements, obtained at various stations and at various times by the field parties engaged in the magnetic survey, to a common time.

These four magnetic observatories, which constitute at present the primary magnetic base stations of the magnetic survey of the United States and countries under its jurisdiction, are as follows:

1. *The Cheltenham Magnetic Observatory*, situated at Cheltenham, Md., 14 miles, or 22½ kilometers, in an air line, southeast from the United States Capitol at Washington City. This is the principal or standard magnetic observatory, where, in addition to the regular observatory work, all magnetic instruments are standardized;
2. *The Sitka Magnetic Observatory*, located at Sitka, Alaska, near the new Russian Cemetery. The magnetic and meteorological observatory, which the Russians had in operation between 1842 and 1867, was situated on Japonski Island, in Sitka Harbor, about three-eighths of a mile, or three-fifths of a kilometer, west of the present site;
3. *The Honolulu Magnetic Observatory*, located on an immense coral plain 12½ miles, or 20 kilometers, in an air line, west of the city of Honolulu, Hawaii;
4. *The Baldwin Magnetic Observatory*, situated at Baldwin, Kans., 13 miles, or 21 kilometers, in an air line, south of Lawrence, Kans. This observatory is a temporary one, and the magnetograph was mounted in an existing structure. The site for a more permanent observatory in the Western States has not yet been chosen.

In addition to the above, the Survey is contemplating, in the near future, the erection of a magnetic observatory in Porto Rico,* a region recommended as a desirable one for a magnetic observatory by the International Magnetic Conference held at Bristol, England, in 1898, and one which the recent volcanic eruptions in Martinique and concomitant magnetic storms have made doubly interesting and important for magnetic investigation. As soon as the magnetic survey of the extreme Western States is undertaken, the establishment of a magnetic observatory in that region will be imperative.

*A set of self-registering instruments (declination and horizontal intensity) was mounted temporarily in Fort Isabel, Vieques Island, east of Porto Rico, and put in operation in February, 1903.

The selection of a suitable site for a magnetic observatory to be continuously and uninterruptedly in operation for a period of fifteen years, at least, is a most difficult matter in view of the rapid spread and development of electric car lines and electric power and lighting establishments. Nearly every prominent magnetic observatory over the entire globe has suffered more or less in recent years from stray industrial electric currents. Thus the two principal observatories in England, Kew and Greenwich, in operation for a half a century and more, have been affected by the London electric car lines. Kew is at present making preparations to move to a new site. Nearly every magnetic observatory in France has suffered, and its principal observatory has been moved from Parc Saint Maur to Val Joyeux. The Belgians and the Austrians have likewise been obliged to select new sites for their principal magnetic observatories, and the Dutch are now making preparations to resume work at their new magnetic observatory in Java, their former observatory at Batavia, so long in successful operation, having had its work vitiated by the Batavia electric car lines. By the decree of the Emperor, forbidding a closer approach of electric car lines than 16 kilometers, the Germans have been able to keep their principal observatory at Potsdam free from disturbance. Considerable pressure has been exerted, however, on the part of the inhabitants in the district where electric car lines are excluded for better rapid-transit facilities than now existing, and there has already been some talk of placing the observatory in a more isolated site. The New Zealand observatory recently started at Christchurch is in danger of having its work interrupted by contemplated electric car lines.

The disastrous effects from uninsulated electric car systems were first experienced in the United States, in 1892, at the Coast and Geodetic Survey magnetic observatory situated at San Antonio, Tex. When the facts were made known to prominent magneticians, some of them would not admit that the disturbances were due to stray currents from the San Antonio electric car line. To-day there is no longer any question that effects from such sources may be obtained 5 miles distant from the car lines. It was necessary to move the observatory at San Antonio to a new site, where it continued its work uninterruptedly until 1895, when the work was closed. Since then the Canadians have been obliged to move the famous Toronto Magnetic Observatory, which had been in operation for nearly six decades. The United States Naval Observatory, which undertook to maintain a magnetic observatory within the limits of a large city was obliged to close its magnetic work entirely, and the Mexicans, immediately after the installation of the instruments in a newly erected observatory, were compelled to abandon the work because of the effects from the electric car lines extended from the City of Mexico.

Having these experiences in mind, special care was taken in the selection of the sites for the new magnetic observatories of the Coast and Geodetic Survey. The idea was abandoned altogether that it would be possible to maintain an observatory for several years in any locality already well settled or possessing inducements for settlement in the near future.

The next point of prime consideration is the uniformity in the distribution of magnetism within the area to be occupied for the various kinds of work at a magnetic observatory, so as to avoid the necessity of a reduction of the magnetic elements to a normal station, and thereby to eliminate the necessity of controlling the constancy of the reduction—following a rule that pertains especially to magnetic work, viz, to avoid, *ab initio*, any cause for correction.

Further points to be considered apply to accessibility of the station, to freedom from other disturbing influences than those from electrical sources, to facilities obtainable in the locality for carrying out the observatory work, such as supplies and abundance of pure water for the photographic work, comfort and convenience of observers, mail and telegraphic communications, etc. If other than magnetic work is to be carried on, such as investigations in atmospheric and telluric electricity, seismology, and meteorology, full consideration must likewise be given to the demands of these special branches.

The sites for the first three observatories were selected after a careful personal examination of the regions by L. A. Bauer, that at Cheltenham in the spring and summer of 1899 and those at Sitka and Honolulu in the fall of 1900. Furthermore, as an additional precaution, J. A. Fleming was instructed that the selected sites were to be given another careful examination before the erection of the Sitka and Honolulu observatories. In both instances the choice of the original location was confirmed. The site of the provisional magnetic observatory at Baldwin, Kans., was selected by W. C. Bauer and C. K. Edmunds. The four sites have thus far proven satisfactory.

The Site of the Cheltenham Magnetic Observatory.

A number of sites within a radius of about 25 miles of Washington city, in Virginia and Maryland, were examined, and the distribution of the magnetic elements tested before the final location was decided upon. The problem of establishing a standard magnetic observatory, which is expected to have a life embracing the period necessary for the general magnetic survey of the United States, and which is to be within convenient reach of the office of the Coast and Geodetic Survey at Washington, required special care, and several months were accordingly spent before a decision was reached. As far as uniformity in distribution of magnetism was concerned, the magnetic survey of Maryland by L. A. Bauer, under the auspices of the Maryland Geological Survey, had already indicated that the region to the southeast of Washington would probably furnish the best site in this respect, and the additional examinations resulted in the selection of that region.

An area examined toward the northwest of Washington, embracing the region about Gaithersburg, Md., where one of the international latitude stations is situated, exhibited such remarkable local disturbances, even within the small strip of land occupied by the latitude observatory, that it had to be rejected at once as the site of a normal magnetic observatory.

Suggestions regarding the selection of an island in the Chesapeake Bay received consideration, but this plan was abandoned in view of the possibility of disturbing influence from passing ocean steamers, and because of the difficulty of access at all times, and of transporting delicate instruments to such a place.

The topographic sketch, page 310 (Illustration No. 2), shows the site finally selected, on the grounds of the Maryland Reform School, about 1¼ miles west of the railroad station at Cheltenham, reached from Washington or Baltimore via the Pennsylvania Railroad, changing cars at Bowie to the Pope Creek Railroad, a single-track branch of the Pennsylvania system. The traffic on this branch consists of two local passenger trains in the morning, one in each direction; two similar trains in the afternoon; and an occasional local freight train. The grounds of the reform school embrace about 800 acres, and are surrounded on all sides by farms of large extent. The site leased by the Coast and Geodetic Survey for an indefinite number of years comprises nearly 6 acres, and is

No. 2.

Topographic map showing the location of the Cheltenham Magnetic Observatory.

situated on the highest land between the Potomac and Patuxent rivers, the altitude being about 225 feet above sea level. Cheltenham consists principally of the buildings belonging to the reform school, about half a dozen frame cottages, two churches, and the railroad station.

The land in this region, while in a flourishing condition before the civil war, when slaves were available for tilling the soil, is not now so desirable, and as far as can be seen at present, there will be little inducement to run electric car lines into this region. From the site of the magnetic observatory an extensive view is obtained of the country round about, and the opportunities are favorable for the successful prosecution of all the work planned for this observatory.

The Site of the Sitka Magnetic Observatory.

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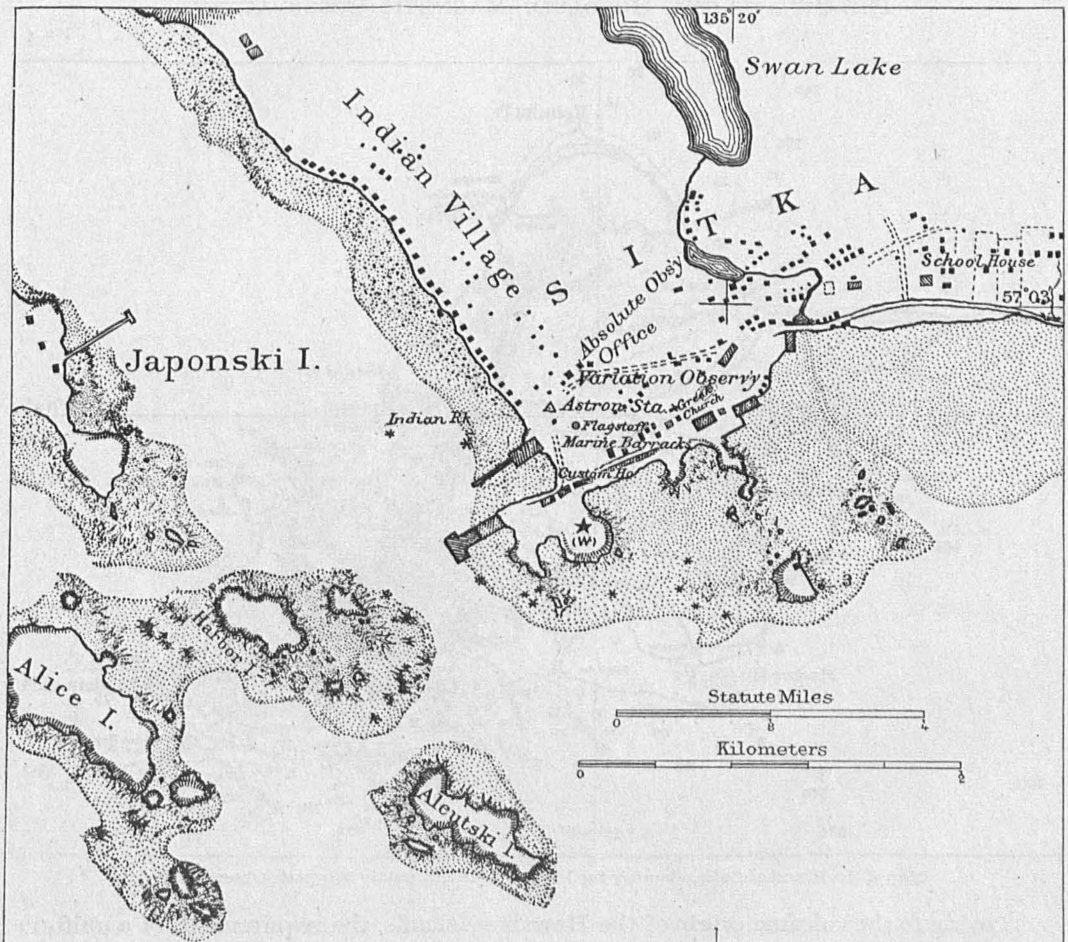

Map showing location of the Sitka Magnetic Observatory.

After an inspection of various places in southeastern Alaska, Sitka was decided upon as fulfilling most nearly the requirements above set forth. Owing to the rapid development of some of the Alaskan towns in recent years and the general prevalence of local magnetic disturbances, special care had to be exercised. Sitka has steamer communication with Seattle about once a week throughout the year.

The precise location at Sitka is shown on the map (Illustration No. 3), preceding page. The site used by the Russians from 1842 to 1867 on Japonski Island is no longer suitable and is occupied as a naval station. Owing to the mountains immediately back of Sitka it was not possible to get far away from the town. After a careful examination of various sites at Sitka by L. A. Bauer and J. A. Fleming, the site on a Government reservation near the new Russian cemetery was adopted. This site has since been set apart for the use of the Coast and Geodetic Survey by special Executive order of the President of the United States. The magnetic observations made at the various sites examined revealed a sufficiently uniform distribution prevailing about Sitka.

The Site of the Honolulu Magnetic Observatory.

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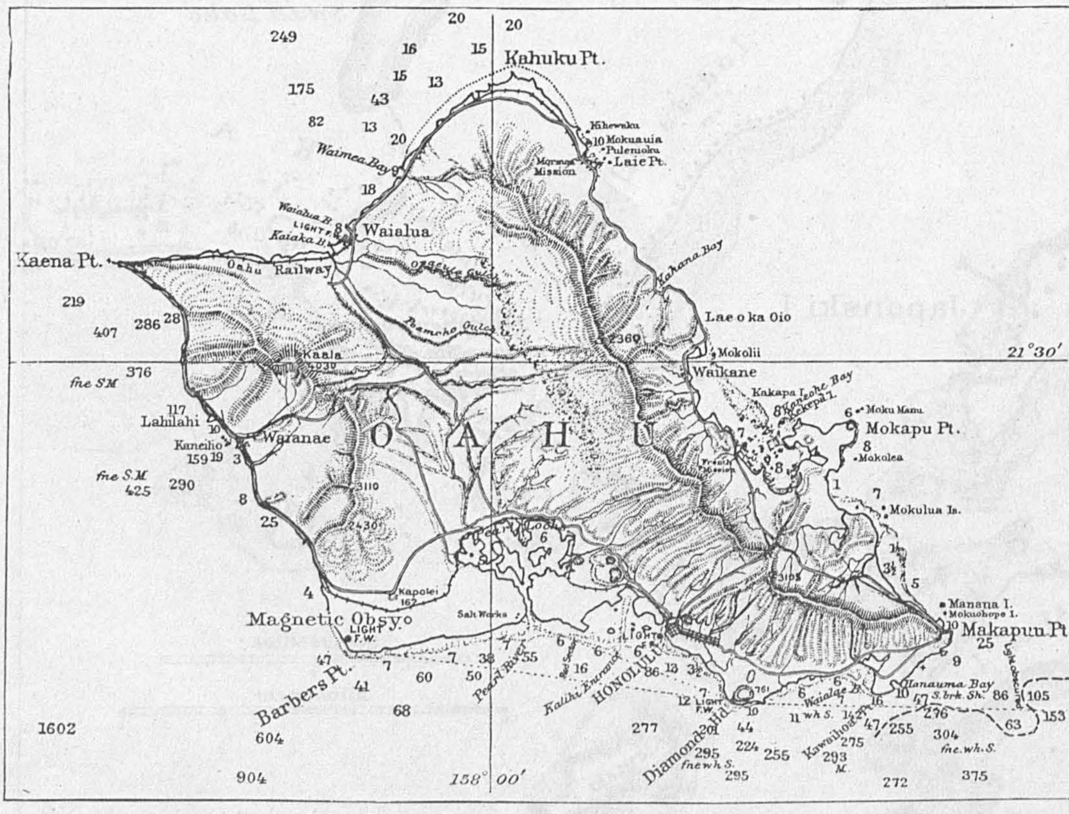

Map of the Island of Oahu, showing the location of the Honolulu Magnetic Observatory.

Owing to the volcanic origin of the Hawaiian Islands, the requirements of a uniform magnetic distribution presented special difficulties. About a dozen sites on the Island of Oahu were inspected and tested, and usually pronounced local disturbances within small areas manifested themselves in one or more of the magnetic elements. Sites on the Island of Hawaii were also inspected. As the facilities of communication are best for the Island of Oahu, on which Honolulu is situated, this island received first consideration.

Observations made by L. A. Bauer and J. A. Fleming at various points on the immense coral plain to the west of Honolulu and Pearl Harbor, while indicating small irregularities in magnetic distribution, served to mark out a site within which sufficient uniformity was secured.

It was necessary to locate the observatory beyond any possible influence likely to arise from the large works to be erected at Pearl Harbor by the United States Navy Department and to provide against the possibility of electric-car communications of Pearl Harbor with Honolulu; also the observatory had to be sufficiently removed from the existing and contemplated mills and power plants of the neighboring large sugarcane plantation and of the adjacent sisal plantation. This necessitated putting the observatory over 2½ miles from the nearest village, in the midst of the coral plain, where, because of the absence of sufficient amount of tillable soil, the danger of encroachments from the plantations is minimized. This coral plain is mainly used at present as a cattle ranch. The map, opposite, of the Island of Oahu (Illustration No. 4) shows the location of the observatory on the coral plain west of Honolulu, the area of the site leased from the ranch company being 4.3 acres. The site is about two-thirds of a mile from the railroad station, Sisal, on the Oahu Railroad, a single-track narrow-gauge road, the station consisting of the house occupied by the manager of the sisal plantation. From this station communication is had direct with Honolulu, distant 12½ miles in an air line and 20 miles by railroad.

The Site of the Baldwin Magnetic Observatory.

This observatory, as already stated, was intended to be in operation for a brief period while the magnetic survey of the States in the vicinity was in progress, and no special buildings were erected, but such as already existed were adapted for the work.

Baldwin is a small college town, the site of Baker University. This place, being surrounded on all sides by large farms and being centrally situated, offered a good place for a temporary observatory. Owing to the international magnetic work begun in January, 1902, and because of delay in completing the magnetic survey of the neighboring States on account of the difficulty experienced in obtaining new magnetic outfits promptly, it has been necessary to continue the observatory longer than was originally contemplated.

II. CONSTRUCTION OF THE MAGNETIC OBSERVATORIES.

The following description of the construction of the Cheltenham, Sitka, and Honolulu magnetic observatories was prepared by the designer, J. A. Fleming, Aid, Coast and Geodetic Survey.

No attempt at architectural display in the construction of the buildings was made. In view of the uncertain life of a magnetic observatory, they were designed simply to fulfill as adequately as possible the requirements of the work without going to any unnecessary expense.

The general design of the three observatories, Cheltenham, Sitka, and Honolulu, planned by the writer under the direction of the Inspector of Magnetic Work, is the result of a careful study of past and existing plans and methods. Besides the reports mentioned below, which were utilized, special acknowledgment is made to Dr. Snellen, who courteously furnished copies of plans and other information regarding the De Bilt Magnetic Observatory. The reports used were—

Coast and Geodetic Survey: Various MS. reports of the Coast and Geodetic Survey concerning the magnetic observatories at Madison (Wisconsin), Los Angeles (California), and San Antonio (Texas).

Eschenhagen, M.: Ergebnisse der magnetischen Beobachtungen in Potsdam in den Jahren 1890 und 1891. Berlin, 1894.

Leyst, E., and Passalskij, Paul: Aufstellung der erdmagnetischen Variations-apparate im magnetischen und meteorologischen Observatorium der K. Universität in Odessa. Odessa, 1897.

Marsh, C. C.: A report upon some of the magnetic observatories of Europe. Washington, Government Printing Office, 1891. Magnetic observations at the United States Naval Observatory, 1894. Washington, Government Printing Office.

Moureaux, Th.: Le nouveau pavillon magnétique de l'observatoire du Parc Saint-Maur. Journal "Terrestrial Magnetism," Vol. III, 1898, pp. 1-4.

Murat, Ion St.: Observatoire magnétique de l'Institut Météorologique de Roumanie à Bucharest. Analele Institutului Meteorological Romaniei. Vol. XIII, Part II, No. 9, 1897.

Snellen, M.: The magnetic observatory at De Bilt, near Utrecht. Journal "Terrestrial Magnetism," Vol. V, pp. 49-58, 1900.

Wild, H.: Ueber die Möglichkeit vollständige magnetische Observatorien ganz oberirdisch und in einem Gebäude einzurichten, and Completes oberirdisches magnetisches Observatorium. Journal "Terrestrial Magnetism," Vol. IV, pp. 153-198, 1899.

This study indicated that, after the selection of sites well removed from all present and probable future local magnetic disturbance, the chief requisites desirable were: First, the elimination in construction of all materials showing any magnetic properties, even in the case of the variation observatory;* second, the arrangements for absolute

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* Magneticians are not agreed as to the necessity of excluding magnetic materials in the construction of a building not intended for absolute determinations, but simply for recording the variations of the magnetic elements. The most notable case in Europe in which magnetic material was used in the construction of a variation observatory is the one planned with most scrupulous care by Prof. Heinrich von Wild, and situated at Pawlowsk, near St. Petersburg, Russia, red (iron-containing) brick having been used. Professor Wild's argument was based on the assumption that the magnetic effect from the brick walls would be a constant one, and hence would not affect the variation or differential results. It is a well-known fact that the magnetic variations are functions of the absolute magnetic elements. If, then, the absolute values are disturbed, as they certainly will be inside a red brick magnetic observatory, the question arises whether the variations observed therein can properly be associated with the undisturbed absolute elements observed in another and nonmagnetic building. Furthermore, it remains to be proven that the effect exerted by the magnetic walls on both the variations and the absolute values is such that the observed variations can always be properly associated with the prevailing absolute values. This is a question which in the present state of our knowledge of the Earth's magnetism and of its variations can not be answered save by actual experiment.

So, likewise, is it doubtful whether the magnetic effect of the brick walls can be regarded as constant, owing to their susceptibility to changes in magnetization with seasonal changes.

The safest principle to be followed at present in the construction of magnetic observatories is to eliminate at the start any questionable cause of magnetic effect whatsoever, so as to simplify the solution of the causes underlying the many vexed variations continually occurring. The initial expense incurred by following this rule is a mere trifle compared to the aggregate cost of maintenance of an observatory for a long period.

Test magnetic observations at the three magnetic observatories (Cheltenham, Sitka, and Honolulu), before the permanent mounting of the instruments, resulted in showing that the magnetic elements were the same within the error of determination in each case outside the buildings, in the absolute building, and in the variation building. Hence no question need arise in these cases as to the proper correlation between the absolute elements and the variation observations.—L. A. B.

and variation instruments to be such that the mutual interaction of the various instruments would be inappreciable; third, the buildings for measurement of absolute values to be such as to admit of a number of simultaneous determinations without danger of appreciable mutual interaction of magnets of the various instruments; fourth, the building for variation observations to be constructed so as to have as nearly a uniform temperature throughout the year as possible, without employing extensive means for heating or cooling the rooms; fifth, the variation observatories to have accommodations for at least two sets of instruments—one eye-reading and one self-registering set—and that they be of a size sufficient to meet all reasonable demands now and later.

Three observatories—Cheltenham, Sitka, and Honolulu—are described in the order of their construction.

Cheltenham Observatory.

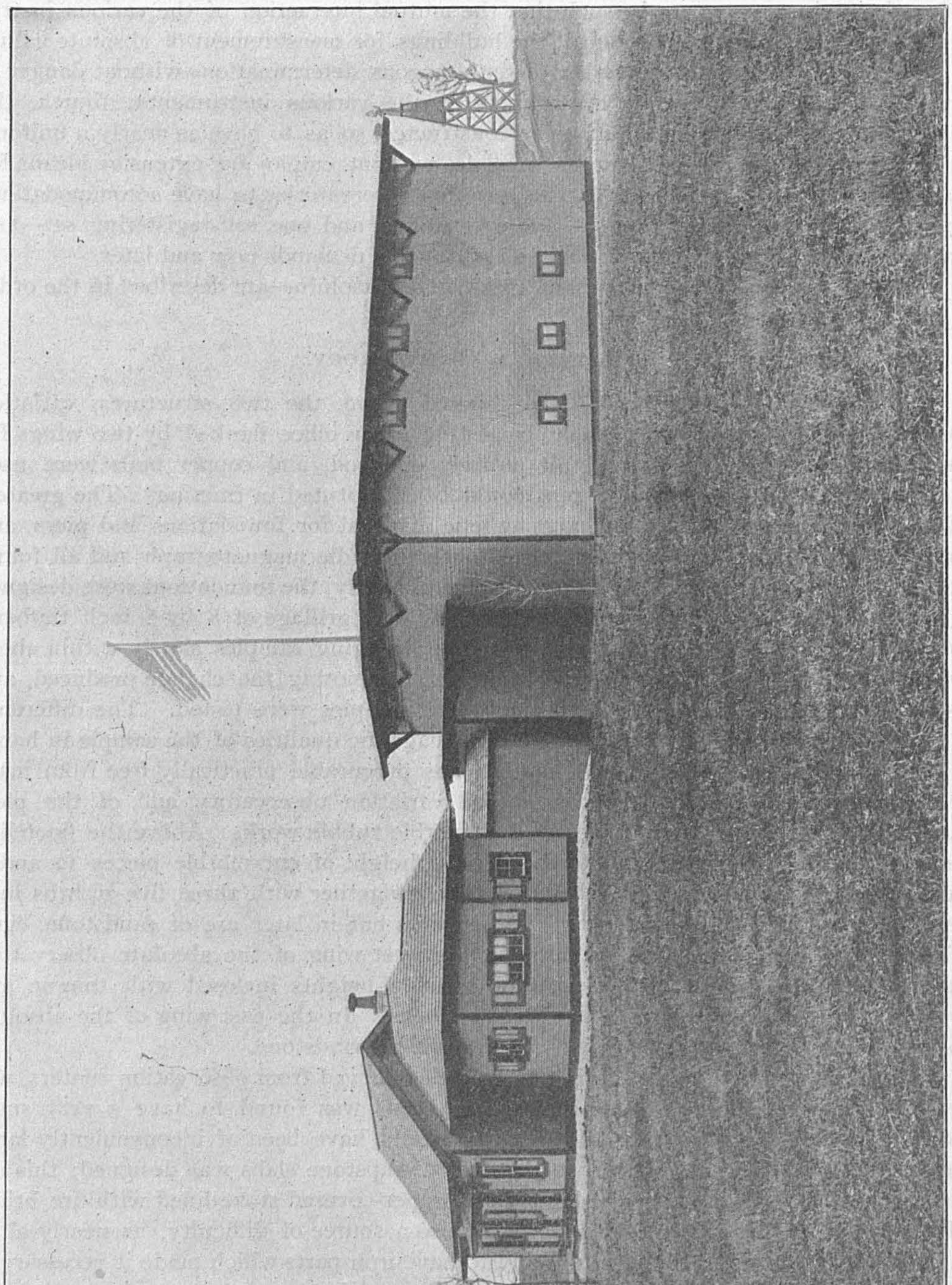
As a result of the *first condition* imposed above, the two structures, variation observatory and absolute observatory, consisting of an office flanked by two wings for the absolute observations, were built entirely of wood, and copper nails were used exclusively except when wooden pins could be substituted in framing. The greatest difficulty was found in selecting nonmagnetic material for foundations and piers, and ten samples of building stones were tested with the Adie magnetograph and all found more or less unsatisfactory. To overcome this difficulty, the foundations were designed to be 2½ feet deep of rubble work, surmounted by a grillage of 8 by 8 inch timbers, five pieces high. The materials were tested by bringing samples slowly within about five centimeters of an inclosed magnetometer needle, noting the change produced, and also noting the normal readings before and after samples were tested. The difference in readings sufficed to give a measure of the magnetic qualities of the sample in hand.

Fortunately, at Cheltenham a marble was procurable practically free from magnetic properties. The foundations of the variation observatory and of the piers extending to floor line were constructed of marble rubble work. Above the floor line some of the piers were built up to the desired height of cut marble pieces 12 and 8 inches thick, the separate pieces being doweled together with three five-eighths inch copper dowels set in plaster of paris. Other piers put in later are of sandstone, carefully tested. The instrument supports in the west wing of the absolute observatory were made temporarily of cedar posts of suitable heights inclosed with tongue and grooved casing and capped with hard-wood blocks. In the east wing of the absolute observatory the instrument piers are of nonmagnetic sandstone.

The chimney for the office being fairly well removed from observation centers, was designed to be of a white brick which from tests was found to have a very small magnetic effect; a stone rubble construction would have been of inconveniently large section. For heating the office a wood stove of soapstone slabs was designed; this did not prove satisfactory and was replaced by a copper-covered stove lined with fire brick. The question of hardware furnishings was also a source of difficulty, as nearly all of the so-called "brass" fittings were found to have iron parts which made it necessary to place special orders for the greater part of this material.

The *second condition* made it preferable that the buildings for absolute and variation observations should be separate and distinct, though questions of practical convenience required that they be as close together as possible without danger of appreciable

No. 5.



Cheltenham Magnetic Observatory (looking northwest).

magnetic interaction between the various instruments. Rough calculations of the mutual actions between a C. & G. S. magnetometer and the Adie instruments for varying intervening distances were made according to formulæ taken from the article by Professor von Wild referred to above. The effect was found to be practically zero, for the instruments mounted 40 feet apart, and the plans were made accordingly. The two buildings were connected by a covered wooden corridor.

In fulfilling the *third condition* the general plan already used by the Coast and Geodetic Survey at San Antonio, Tex., seemed best to follow. This consisted in erecting two buildings for absolute determinations, attaching the same as wings on either side of the office and connecting them by passageways. (Illustrations Nos. 1, 5, and 8.) The doors from the office to these wings and also the rear door of the west wing of the absolute observatory have glass panels, so that communication by signal, or otherwise, from one wing to the other and to parties in tents outside can be conveniently and readily made. The east wing of the absolute observatory has a bay window extension on the north side to accommodate the Wild-Edelmann observatory declinometer. (Illustration No. 5.)

The *fourth condition* requires that either some sort of insulation be provided if the variation observatory be erected above ground, or that the general use of an underground construction be followed. The success in the matter of uniform temperature conditions attained at the Dutch observatory at De Bilt, as well as the generally unsatisfactory conditions prevailing in most underground observatories because of moisture encountered in such structures, confirmed the opinion that a building above ground could be built so as to satisfy temperature conditions as well, or nearly so, as an underground structure, and would at the same time have the advantages of greater economy, convenience, and accessibility.

The choice of insulating packing for the walls was a question of prime consideration. The manufactured insulating materials on the market, on inquiry and examination, were found to contain more or less iron in their composition, and at the same time would have involved a much greater cost than permissible when used in such quantities as required. After a careful consideration of the nonmagnetic materials available, carefully dried sawdust was decided upon as best adapted to the existing conditions.

In deciding upon the necessary thickness of insulating wall to reduce annual mean temperature range to within 4° C to 5° C, Fourier and Poisson's formula,

$$\log \frac{\Delta_0}{\Delta_p} = p \log e . \sqrt{\frac{\pi}{TK}}, \qquad (1)$$

as found in Wild's article cited above, was adopted for a working basis. The significance of the various symbols is as follows: Δ_0 = external range of temperature in a time T expressed in minutes, Δ_p = range of temperature in the same time T in a room surrounded by a thickness of p cm. of insulating material, e = base of natural logarithms, and $K = \frac{k}{c}$ = what might be called the heat constant of the insulator, being a relation between its heat conductivity and its specific heat. According to Forbes, K for pine sawdust is 0.021, for pine across the grain 0.018, and for pine along the grain 0.053, whence it was assumed that for a wall packed with sawdust, with such bracing

No. 6.

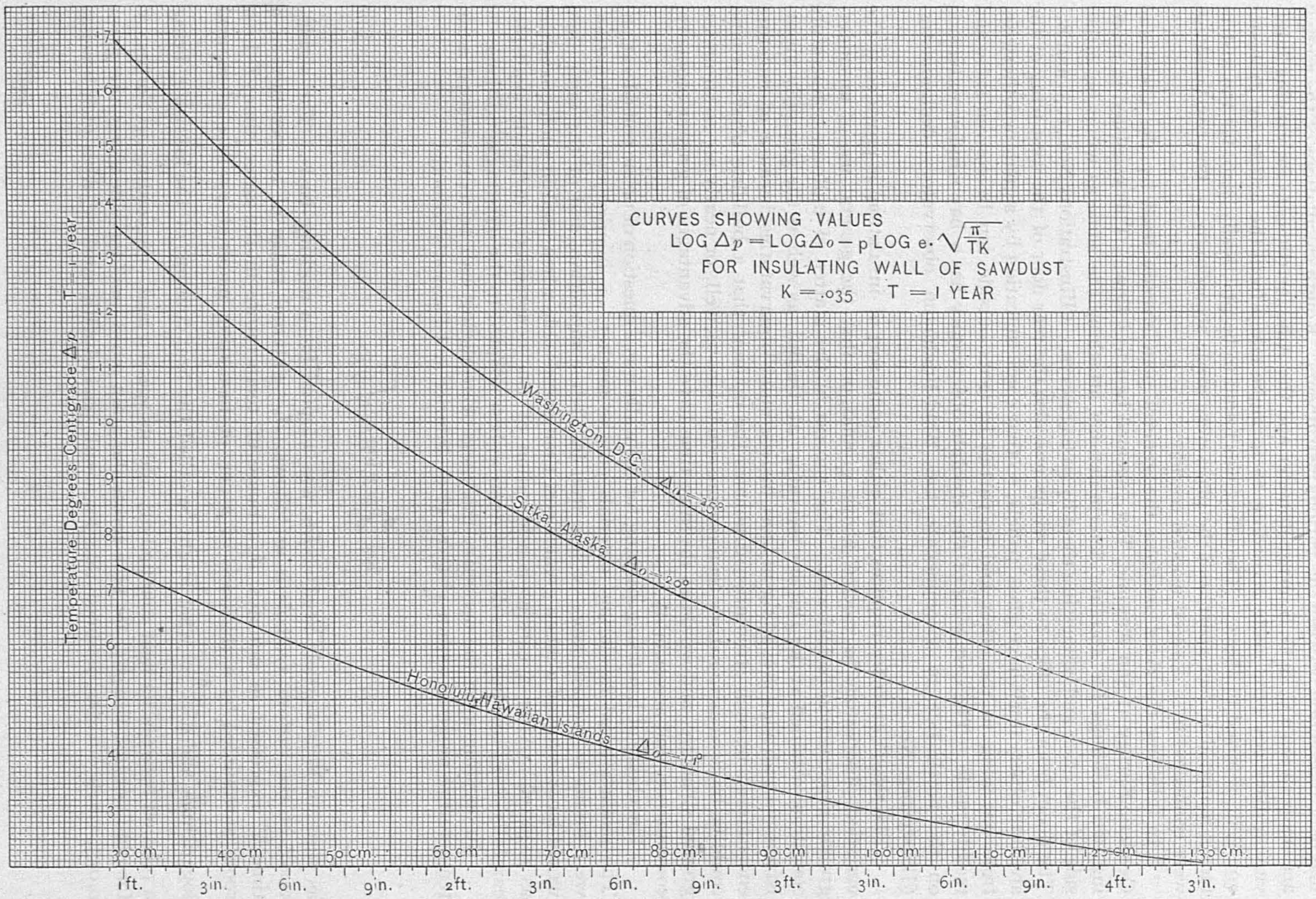


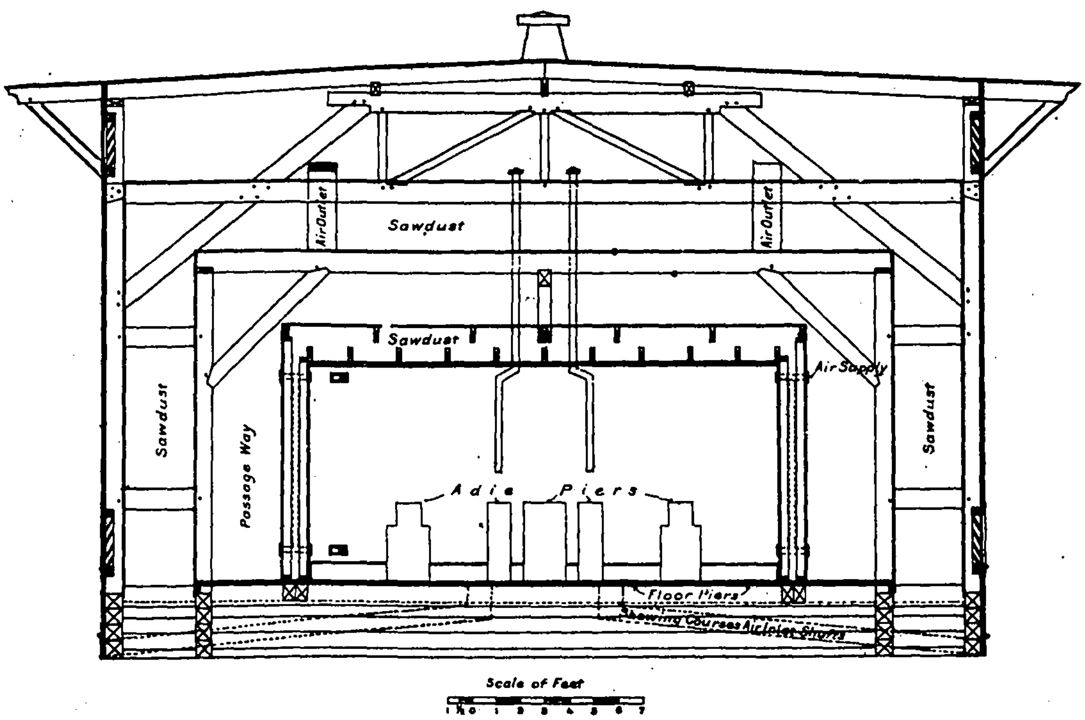
Diagram of curves giving thickness of insulation sawdust.

and tying timbers as might be necessary, $K=0.035$. Reducing formula (1) with this value, we have for:

$$T=1 \text{ day}; \log \Delta_p = \log \Delta_0 - 0.1084\,p, \qquad (2)$$
$$T=1 \text{ year}; \log \Delta_p = \log \Delta_0 - 0.0057\,p. \qquad (3)$$

The mean daily range at Cheltenham was assumed to be 10° C., with a mean annual range of 25° C. Substitution of $\Delta_0=10°$ in (2) for values of p from 30 to 100 cm. indicated that under ideal conditions the interior mean daily range for such thicknesses of sawdust insulation would scarcely be an appreciable quantity. In determining upon a proper thickness to sufficiently reduce mean annual range, the curves as shown on the diagram (Illustration No. 6) were constructed from values of Δ_p derived by

No. 7.



Section of variation observatory, Adie room, Cheltenham Magnetic Observatory.

substitution in (3) of $p=30, 40, 50$— . . . 130 cm. with $\Delta_0=25°$, 20°, and 11° (the last two being the values of Δ_0 for Sitka and Honolulu, respectively, as furnished by the United States Weather Bureau). Thus, for a wall with sawdust packing 4 feet thick, Δ_p for Washington, according to the curve on the diagram, would be about 5°.1 without artificial heating or cooling, on the assumption of ideal conditions. Perfect conditions were, of course, practically impossible, but further insulation precautions were made as noted hereafter so as to bring about the best possible results.

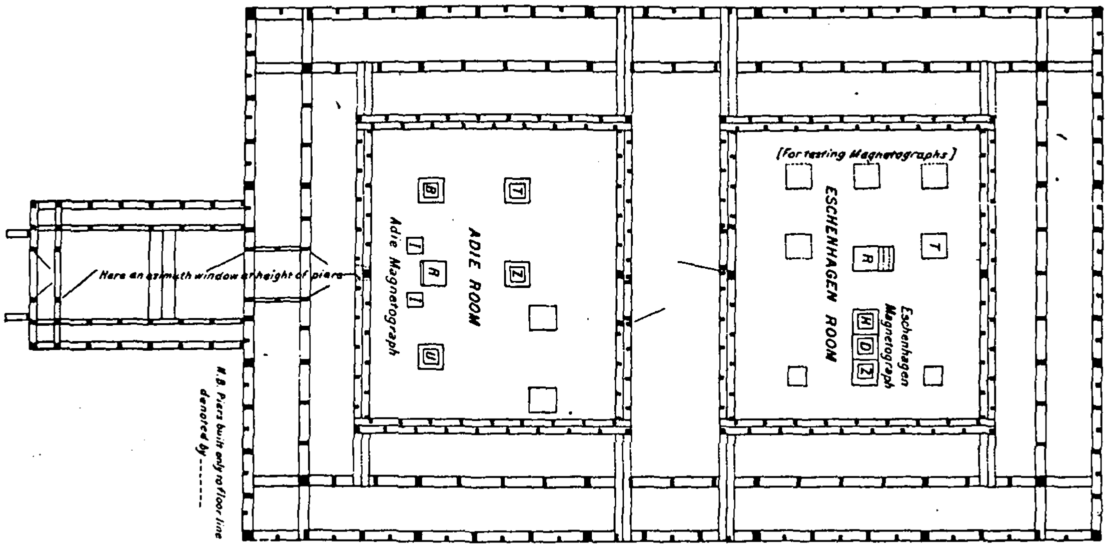
The wall insulation of the variation observatory is as follows (Illustration No. 7): Beginning at outside of building, pine weatherboarding, 8-ply building paper, 1-inch pine sheathing, 8-inch air shaft, 1-inch pine sheathing, 8-ply paper, 3 feet pine sawdust, 8-ply paper, seven-eighths inch pine ceiling, 3 feet 2 inches air space of passageway, seven-eighths inch pine ceiling, 8-ply paper, 1 foot pine sawdust, 8-ply paper, seven-eighths inch pine ceiling. Slat ventilators or louvre windows are so arranged and provided with closely fitting shutters that during the winter the 8-inch air shaft referred to can be made practically air-tight, while during summer when opened these tend to admit of the passage and circulation of a cooling draft around building. The insulation beginning at the roof and going down is: Gravel and asphalt pitch roof, 1-inch pine sheathing, 3 feet 8 inches air space communicating with 8-inch air shaft around building and provided with six louvre windows with close-fitting shutters as on those at the bottom of the air shaft, 1-inch rough pine floor, 3-foot filling of pine sawdust, 8-ply paper, seven-eighths inch pine ceiling, 3-foot air space above rooms, 1-inch rough pine floor, 1 foot 6 inches pine sawdust, 8-ply paper, seven-eighths inch ceiling. Insulation from bottom of foundation is 2 feet 8 inches of earth, 6-inch to 8-inch layer of screened gravel, about 3 feet pine sawdust, 1-inch pine under floor, 8-ply paper, seven-eighths inch pine tongue-and-groove floor.

The greatest difficulty in obtaining the desired results lay in the necessity of providing openings through the walls for the ventilation of the rooms and for the means of ingress and egress. Four shafts, each 5 by 10 inches and about 16 feet long, furnish the air supply to the passageway, through wooden floor grates. These are provided with heavy rabbeted shutters made to fit very closely and fitted with refrigerator fasteners, so that they may be made air-tight. They are also provided at inlet with copper wire screens of double thickness to break force of wind blowing toward opening and to keep out such vermin as field mice. Ventilation of passageway is effected by four shafts opening into air space below the roof, each 6 by 10 inches and about 16 feet long, provided with close-fitting slides. Ventilation of air space below the roof is effected by three 14-inch copper "Star" ventilators. By the judicious use of these air ducts and ventilators, the danger of direct conduction of temperature changes through the shafts can be entirely eliminated. Ventilation of the magnetograph rooms from and into the passageway is effected in each room by four 3-inch square vertical shafts in the sawdust packing, having inlet or outlet just below the ceiling or above the baseboard, according to the arrangement of four closing slides provided for each. To carry off gases of combustion from the lamps of the magnetograph, 3-inch copper ventilators are provided.

Entrance into the building proper is had through a vestibule on the south side, as shown in the illustrations (Nos. 1, 5, and 8), 10 feet by 13 feet 8 inches outside dimensions. The walls of the entrance are built like those of the main building, without the air shaft and with only 2 feet of sawdust packing. The outside door can be closed before opening a second door in a small entrance hall, which is 6 feet wide and 11 feet long; from this room a third door leads into an opening in the sawdust packing, whence a fourth door opens into the passageway around the rooms. In placing these doors particular care was taken to make them close fitting. Entrance into either of the magnetograph rooms is to be had only from the hall between the two rooms through 8-inch refrigerator-patterned doors packed with sawdust.

The diurnal range of the temperature was thus reduced at Cheltenham to a matter of a few tenths of a degree, and, in fact, it is believed that even this small variation will be eliminated as soon as some other source of light than the present lamps has been introduced. It has been repeatedly found that any sudden change of temperature which may amount to 50°–60° F. outside only makes itself felt gradually inside, and then does not amount to much over 0°.5, and may even be less than this amount. (Illustra-

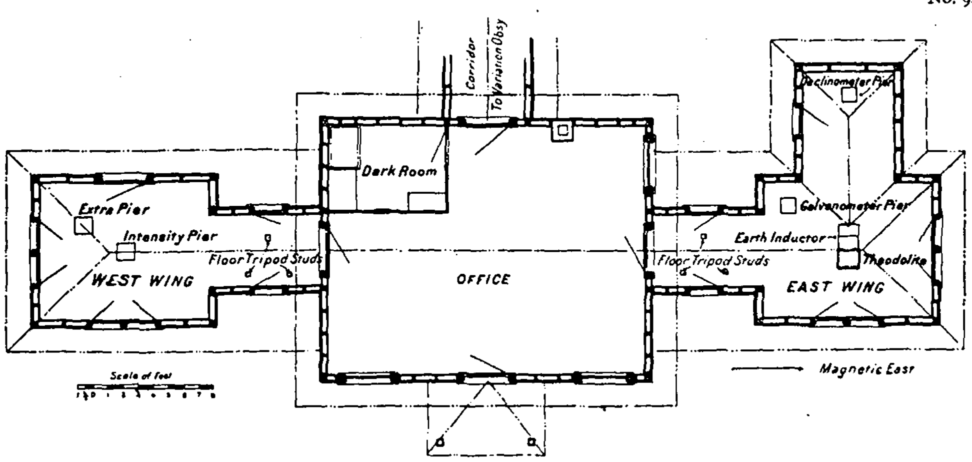
No. 8.



Ground framing plan of variation observatory, Cheltenham Magnetic Observatory.

tion No. 10, reproducing thermograms obtained outside and inside the variation observatory, March 17–24, 1902.) The annual range has been converted into a gradual progressive change, for which allowance can easily be made, and amounting to between one-half and one-third of what it would be outside.

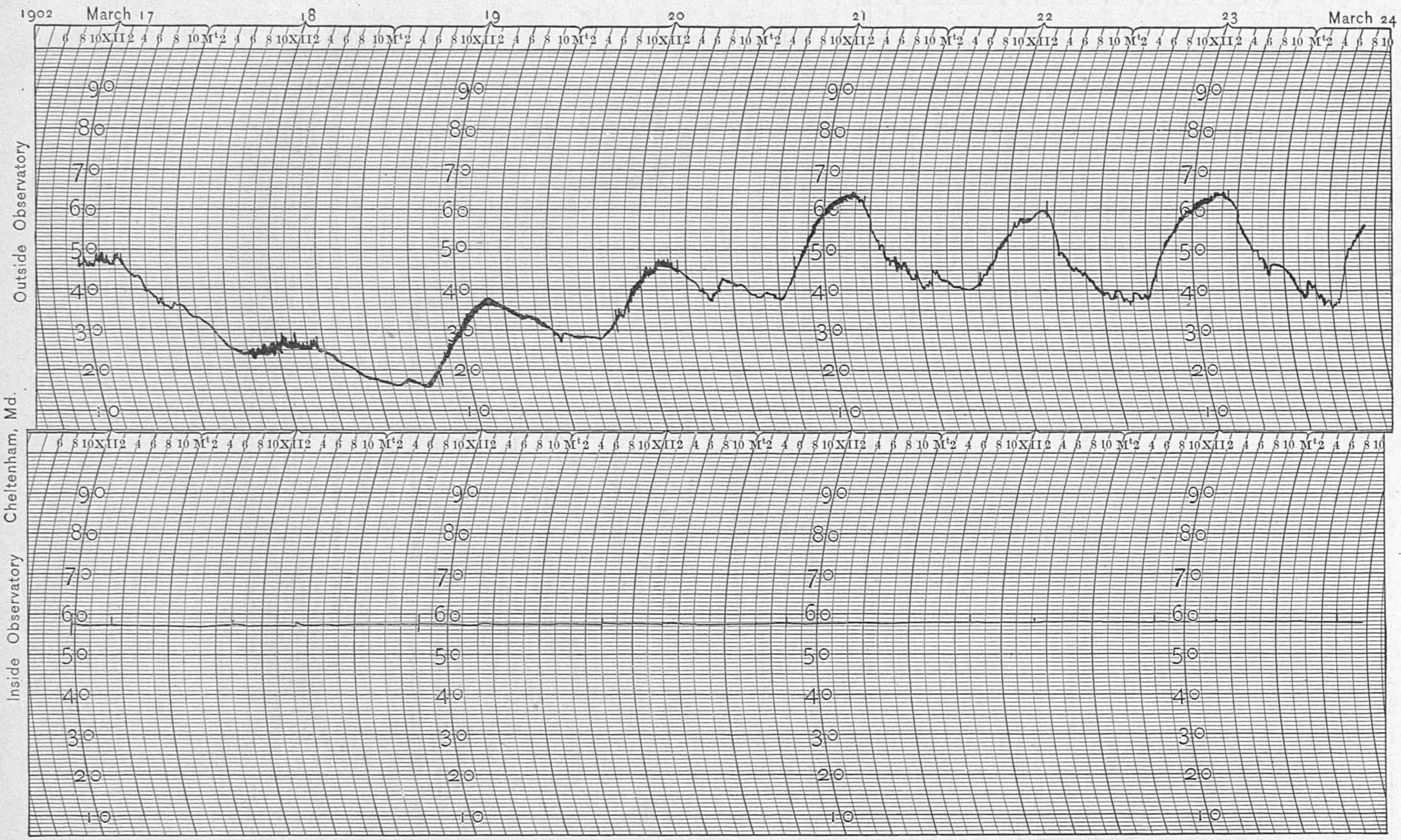
No. 9.



Ground plan of absolute observatory, Cheltenham Magnetic Observatory.

The *fifth condition* imposed by the contemplated use of the Adie magnetograph as the eye-reading instrument and reserve magnetograph, made necessary two magnetograph rooms in the variation observatory, and that they be placed as far apart as

No. 10.



Thermograms obtained outside and inside of Cheltenham Magnetic Observatory.

economy of construction would permit. The rooms are each 16 feet by 19 feet 6 inches, these dimensions giving ample space for the accommodation of the eye-reading Adie instruments in the south room, and for both the regular set of Eschenhagen self-registering instruments and a test set in the north room. The hallway between the two rooms is 5½ feet wide. (Illustration No. 9.)

The following general statements are of interest. The outside dimensions of the variation observatory are 36 feet by 56 feet by 24 feet high, with entrance 10 feet by 13 feet. The outside dimensions of office are 18 feet by 22 feet, with two 5 feet by 7 feet passages leading to two wings for absolute observations, each 10 feet by 12 feet, thus making the total length of the absolute observatory, inclusive of the office, 60 feet. As already stated, the east wing of the absolute observatory has a bay-window extension of 6 by 7½ feet on the north side. (Illustration No. 7.) The materials used were about 90 tons of building marble for foundations and piers, 85 000 feet of lumber, a trifle over 1 ton of copper nails, and something more than 190 tons of sawdust and shavings for insulation. No satisfactory bid from contractors for erecting the buildings having been received, the construction was placed in the hands of the writer. The total cost of the buildings, including masonry and pier work, was something less than $6 900, which is $2 500 less than the lowest bid received. Some subsequent additions (piers, bay window, and covered corridor) have increased the cost about $500.

From Illustration No. 8 it will be seen that provision was made, by the insertion of an azimuth door in the south wall of the Adie room of the variation observatory, for sighting from a point inside, through the corridor and office, on a distant azimuth mark whenever absolute observations are made inside the variation observatory. Attention is also called to the arrangement of the absolute instruments on a straight line passing east and west through the entire absolute building.

Sitka Observatory.

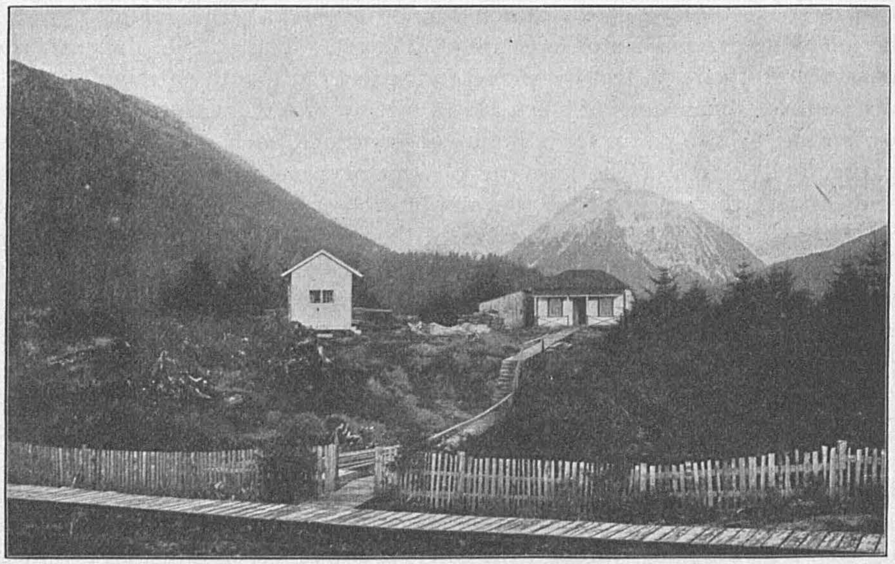
On account of the swampy condition of the ground at this observatory site, charred wooden posts, coated with tar and gravel and set in cement, were used instead of a stonework foundation. The piers are similar in construction, and were provided with hard-wood caps suitable to support the instruments. As a result of the prevailing moisture at Sitka it was necessary to replace these hard-wood caps by marble slabs. The posts are inclosed above the floor line with tongue-and-groove casing.

A dwelling house situated opposite the selected site was leased as an office building, and the absolute observatory, 10 by 12 feet in size, was placed near it for convenience. The absolute observatory is, therefore, at a greater distance from the variation observatory than is the case at Cheltenham.

The general construction of the variation observatory is similar to that at Cheltenham, save that a pitched roof is provided, the greater height so obtained offering a greater draft through the louvre windows at the sides.

The wall insulation was designed to secure the results desired at Cheltenham observatory, namely, a mean annual range of about 5° C. The insulation is as follows: Beginning at the outside of the building, pine weatherboarding, two thicknesses of 4-ply paper, 1-inch pine sheathing, 2-inch by 6-inch studding, forming air spaces connected by auger holes at bottom through studding, 1-inch sheathing, two thicknesses of 4-ply paper, 2 feet 4 inches of sawdust packing, two thicknesses of 4-ply paper, seven-eighths inch pine ceiling, 2 feet 2 inches air space of passageway, save on west side, where it is 2 feet 10 inches, seven-eighths inch pine ceiling, 2 thicknesses of 4-ply

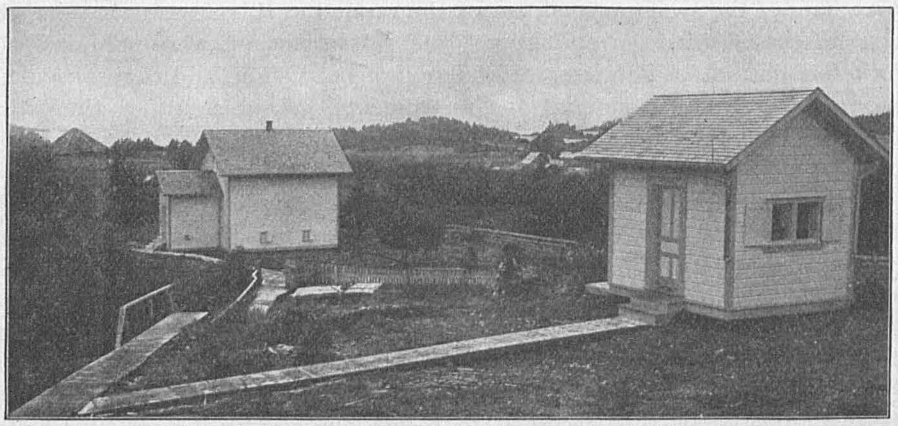
No. 11.



Sitka Magnetic Observatory, office and absolute buildings.

paper, 11 inches of sawdust packing, two thicknesses of 4-ply paper, seven-eighths inch pine ceiling. Louvre windows with shutters, as at Cheltenham, are provided on the sides for the 6-inch air space. The insulation beginning at the roof and going down

No. 12.



Sitka Magnetic Observatory, variation and absolute buildings.

is: Shingle roof, attic air space, two thicknesses 4-ply paper, 1-inch rough pine floor, 2 feet 4 inches of sawdust, 1-inch rough pine floor, 2-inch air space, two thicknesses 4-ply paper, seven-eighths inch pine tongue-and-groove ceiling, 2 feet air space above magnetograph room, two thicknesses of 4-ply paper, 1-inch rough pine floor, 13 inches of sawdust, 1-inch rough pine floor, 2-inch air space, two thicknesses of 4-ply paper, seven-eighths inch ceiling. The insulation from bottom up is: One-inch rough pine floor, two thicknesses of 4-ply paper, 2 feet 6 inches of sawdust, 1-inch pine under floor, two thicknesses of 4-ply paper, seven-eighths inch tongue-and-groove floor.

The ventilation system is somewhat improved over that at Cheltenham in that the air supply is admitted first into the entrance vestibule by two 6-inch by 8-inch by 8-foot shafts in the walls, thence into the passageway through two 5-inch by 8-inch shafts, instead of there being direct communication from the outside to the passageway. The supply of air to the magnetograph room is admitted from the passageway by three sets of ventilators. These consist of 4-inch square vertical shafts in the walls, with openings at the bottom and top, both into the inner room and into the passageway, the openings not being opposite each other, thus preventing entrance of light and dust. Ventilation of lamps from magnetograph room is effected by 3-inch zinc tubes to the attic space. Air communication from the passageway to the air space below the roof is effected by two horizontal square shafts, 8 by 8 inches, and about 6 feet long. Ventilation of the attic is effected by a 20-inch copper ventilator.

As it was expected that both the eye-reading and self-recording instruments would be of the small Eschenhagen type, it was not necessary to provide two magnetograph rooms, as both sets could be accommodated, with the arrangements of piers shown in the plan, in one room 11½ by 14½ feet. The vestibule is 6 by 9½ feet, inside measure.

The outside dimensions of the variation observatory are: 24 by 27 feet, with an entrance 9½ by 12 feet. The absolute observatory is 10 by 12 feet. About 35 000 feet of lumber and 3 000 sacks of sawdust were used in the construction. The buildings were constructed under contract with James P. Jorgenson, of Juneau, Alaska, for $3 450. H. M. W. Edmonds, Magnetic Observer, Coast and Geodetic Survey, supervised the construction.

HONOLULU MAGNETIC OBSERVATORY.

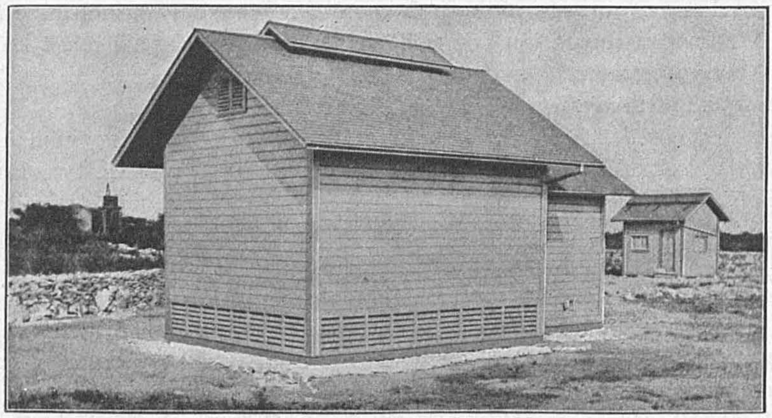
Owing to the isolation of this station, an office with quarters for the observer had to be provided in addition to the two observatory buildings. On account of the excessive cost of building in the Hawaiian Islands the original plan to have this observatory similar to that at Sitka was abandoned and, in view of the more equable climatic conditions, the passageway was dispensed with, so that the instrument room is entered directly from the vestibule. The foundations and piers for both the absolute and the variation observatories are constructed of the coral rock which abounds in the immediate neighborhood which was found to be practically nonmagnetic in character.

As the office had also to be used for living quarters where an uncertain amount of iron was likely to accumulate, it seemed best to remove it to some distance from the observatory. Owing to the natural conditions of the site the distance between office and observatories is 450 feet.

As at Sitka, a pitched roof was provided. The air supply and outlet are also similar to those at Sitka with such exceptions as are necessary because of the omission of the passageway. The louvre windows to a 6-inch air space in the outer wall were made continuous around the bottom of the building, but were not provided with blinds because the small annual range of temperature rendered them unnecessary. The upper louvre windows were omitted and a lower cornice board was used, thus allowing direct outside communication to an air space under the roof made by covering the underside of the 6-inch rafters with heavy 3-ply building paper well battened on. An outlet from this 6-inch air shaft and the attic was made through an open ventilator, as shown by the illustrations. This arrangement was intended to accomplish the same result as the passageway and was better adapted to the prevailing climatic conditions.

The wall insulation is based on the same principles as at the other stations. The insulation is as follows: Beginning at the outside of the building, pine weatherboarding, 3-ply paper, 6-inch air space, 1-inch pine sheathing, 3-ply paper, 2 feet 2 inches of sawdust, 3-ply paper, seven-eighths inch tongue-and-groove ceiling. The insulation, beginning at the roof and going down, is: Shingle roof, 6-inch air space, 3-ply paper,

No. 13.



Honolulu Magnetic Observatory.

attic air space, 3-ply paper, 2 feet of sawdust, 1-inch rough floor, 2-inch air space, 3-ply paper, seven-eighths inch tongue-and-groove ceiling. The insulation from the bottom up is: 3 to 4 inches of broken coral rock, 2 feet 2 inches of sawdust, 3-ply paper, seven-eighths inch tongue-and-groove floor.

As at Sitka, accommodations for two sets of instruments were provided in one room, 12½ by 14½ feet. The vestibule is 6 by 9½ feet, inside measure.

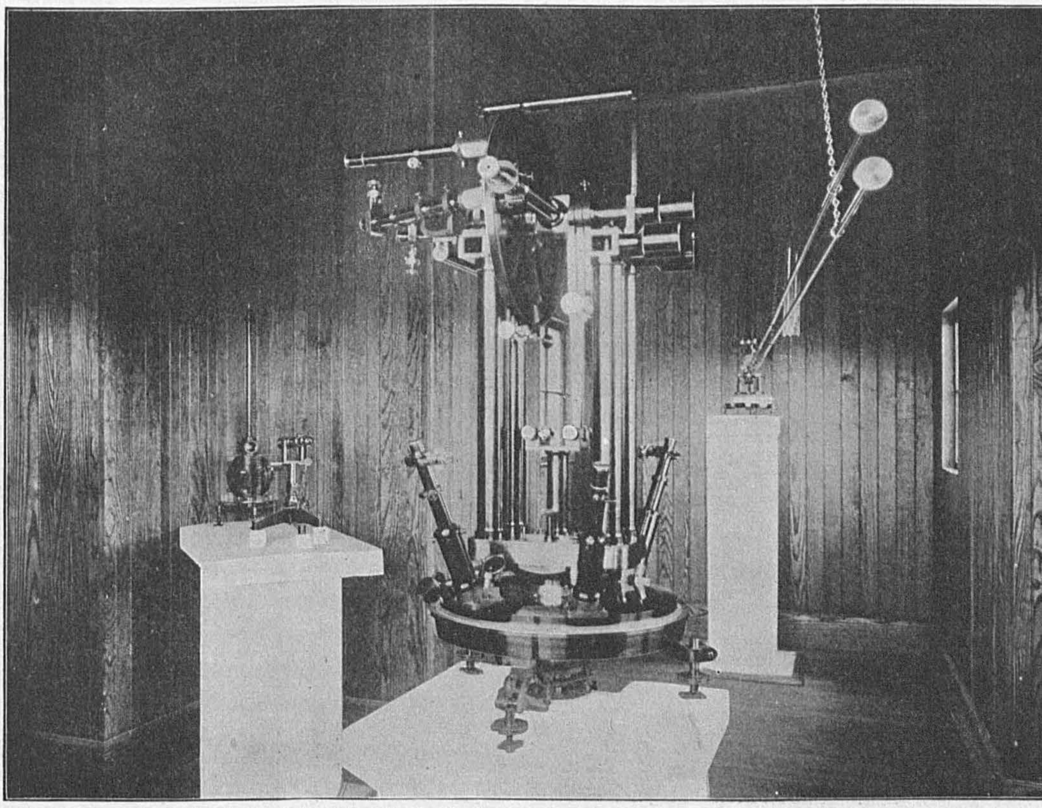
The outside dimensions of the variation observatory are 18 by 20 feet, with an entrance 9½ by 12 feet. The absolute observatory is 10 by 12 feet. The office is 12 by 16 feet, with a porch 6 by 12 feet, with a basement room for storage purposes, etc., 12 feet by 22 feet. The buildings were constructed under contract with Philip Savary, of Honolulu, H. I., for $2 450. The work of construction was supervised by the writer, who also installed the instruments.

III. EQUIPMENT OF THE OBSERVATORIES

Cheltenham Magnetic Observatory.

Variation instruments: Eschenhagen-Toepfer magnetograph as the principal photographic set and an Adie magnetograph formerly mounted at Los Angeles, Cal., from 1882 to 1889, and at San Antonio, Tex., from 1890 to 1895, this magnetograph having telescopes and scales for eye readings. It is the intention ultimately to use the Adie instrument simply for eye-reading observations, retaining, however, the photo-

No. 14.



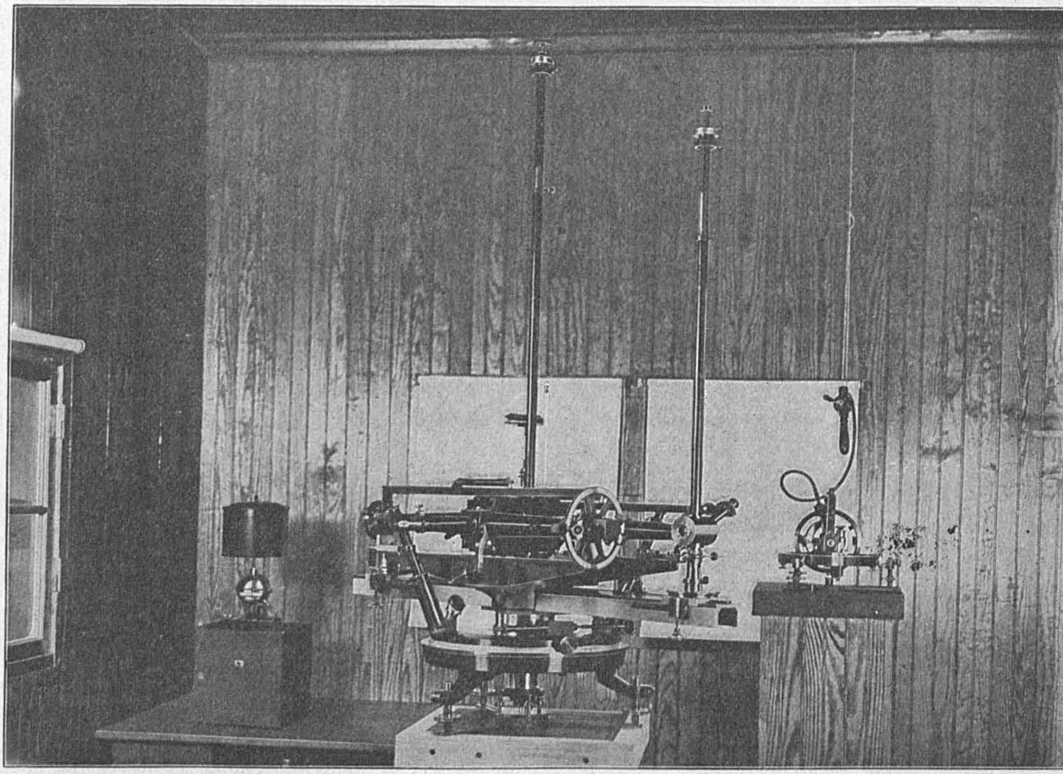
Instrument for determining absolute declination and inclination, Cheltenham Magnetic Observatory.

graphic arrangement so that it can be put into function either to prevent loss of record as, for example, during adjustments of the Eschenhagen magnetograph or for the purpose of obtaining, in special investigations, a duplicate record with a totally different instrument. The plan of the Observatory (Illustration No. 8) shows how the two magnetographs are mounted in separate rooms.

Absolute instruments: A large observatory Wild-Edelmann declinometer, earth inductor, and magnetometer, to determine, respectively, the declination, dip, and horizontal intensity, the instruments being always in place and ready for observations at any time. The declinometer, earth inductor, galvanometer, and large theodolite are mounted in the east wing of the absolute observatory (Illustration No. 9), whereas the magnetometer for horizontal intensity observations (adapted also for secondary magnetic declination determinations with short magnet, when needed), is mounted in the west wing of the observatory (Illustration No. 9). A set of field magnetic instruments also forms part of the outfit.

Illustration No. 14 gives a view of the instruments, obtained by looking north through the south window of the east wing of the absolute observatory (Illustration No. 5). In the center is shown the large Wild-Edelmann theodolite having a horizontal and a vertical circle, each 30^{cm} in diameter, which with micrometer microscopes can

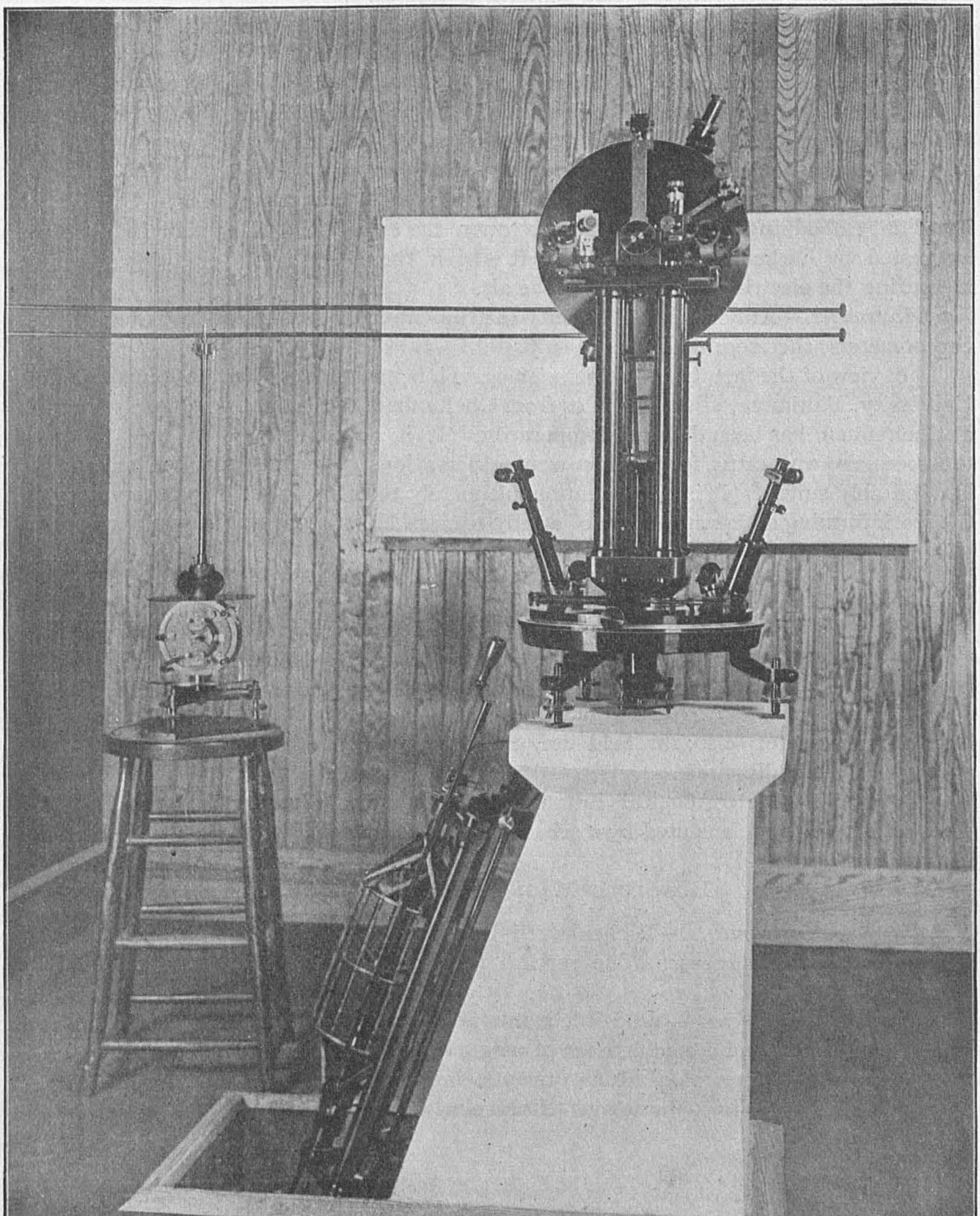
No. 15.



Instruments for determining horizontal intensity, Cheltenham Magnetic Observatory.

be read directly to 2″. The position of the magnet of the declinometer shown in the back of the picture on the right is observed with the aid of the telescope of the theodolite and read on the large horizontal circle, the observer performing all manipulations of the magnet, such as clamping and reversing it in its stirrup for the determination of the magnetic axis, from his position at the telescope, with the aid of the 12-foot long brass rods shown on the right. Behind the pier supporting the theodolite is mounted the earth inductor shown in Illustration No. 16, and on the pier to the left is the Rosenthal-Edelmann microgalvanometer and reading telescope with scale, used in connection with the earth inductor. The inclination of the axis of the inductor is obtained with the aid of the telescope of the theodolite and the angle is read by means of the microm-

No. 16.



Large earth inductor, Cheltenham Magnetic Observatory.

eter microscopes on the large vertical circle. The same theodolite can be used for the determination of time, latitude, and azimuth if necessary.

Illustration No. 15 presents a view looking west from the office into the west wing of the absolute observatory. In the center is seen the large Wild-Edelmann magnetometer designed principally for determining the horizontal intensity; the horizontal circle of this instrument has likewise a diameter of 30^{cm} and is read with micrometer microscopes to $2''$. With the aid of these instruments the absolute elements are determined with the degree of accuracy requisite for the variation observations.

On the right of the picture is shown a smaller earth inductor made by Schulze, of Potsdam, embodying slight modifications upon the small Wild-Edelmann inductor, as suggested by Eschenhagen. On the left is seen the Elster and Geitel apparatus for measuring the electric conductivity of the air.

Accessories.—Atmospheric electricity instruments, meteorological instruments, two chronometers, thermographs, etc.

[In view of the fact that a Milne seismograph is now mounted at the Johns Hopkins University, Baltimore, about 40 miles from Cheltenham, the mounting of a seismograph at Cheltenham has been deferred temporarily. It is hoped soon to be able to install the necessary apparatus for earth-current observations, for which the Cheltenham site is admirably suited. It is the intention ultimately to carry out at this observatory all the work forming an essential part of a fully equipped, first-class magnetic observatory.]

SITKA MAGNETIC OBSERVATORY.

Variation instruments.—Eschenhagen-Toepfer magnetograph, to be supplemented also with eye-reading instruments; the vertical intensity variometer is to be supplied by Schulze, of Potsdam.

Absolute instruments.—Eschenhagen-Tesdorpf magnetometer, dip circle, and vertical force magnetometer; also, for field use, one Coast and Geodetic Survey magnetometer and an additional dip circle.

Accessories.—Meteorological instruments, two chronometers, thermographs, etc. This list is to be supplemented by a seismograph and atmospheric and telluric electricity instruments.

HONOLULU MAGNETIC OBSERVATORY.

Variation instruments.—Eschenhagen-Toepfer magnetograph, to be supplemented by eye-reading instruments. The vertical intensity variometer is to be supplied by Schulze.

Absolute instruments.—Wild-Edelmann field magnetometer, with earth inductor and galvanometer, and a complete set of magnetic instruments for field use.

Accessories.—Meteorological instruments, two chronometers, thermographs, etc., to be supplemented by atmospheric and telluric electricity instruments, and a seismograph.

Baldwin Magnetic Observatory.

Variation instruments.—Eschenhagen-Toepfer magnetograph. The vertical intensity variometer is to be supplied by Schulze.

Absolute instruments.—Cooke (India Magnetic Survey pattern) magnetometer and Casella dip circle. Also one set of field instruments.

Accessories.—Atmospheric electricity instruments, meteorological instruments, two chronometers and thermographs. This list to be supplemented by a seismograph.

The instruments and their mounting will be described in detail and illustrated in the publications of the results of the various observatories.

IV. GEOGRAPHIC POSITIONS OF AND MAGNETIC ELEMENTS AT THE MAGNETIC OBSERVATORIES.

Approximate magnetic elements at the magnetic observatories for the period January–June, 1902.

Observatory.	Latitude north.		Longitude west of Greenwich.		Approximate altitude.		Declination.	Inclination.	Horizontal intensity in C.G.S. units.	Observer in charge July 1, 1902.
	°	′	°	′	Feet.	Meters.	° ′	° ′		
Cheltenham	38	44.0	76	50.5	235	72	5 06 W	70 23	0.2019	L. G. Schultz.
Baldwin	38	47.0	95	10.0	1100	335	8 23 E	68 36	.2197	W. F. Wallis.
Sitka	57	02.9	135	20.2	50	15	29 50 E	74 48	.1541	H. M. W. Edmonds.
Honolulu	21	19.2	158	03.8	50	15	9 17 E	40 15	.2925	W. Weinrich, jr.

APPENDIX No. 6.

REPORT 1902.

RESULTS OF MAGNETIC DIP AND INTENSITY OBSERVATIONS MADE BY THE UNITED STATES COAST AND GEODETIC SURVEY BETWEEN JANUARY, 1897, AND JUNE 30, 1902.

BY

DANIEL L. HAZARD,
Computer, Division of Terrestrial Magnetism,

WITH PREFACE BY

L. A. BAUER,
Inspector of Magnetic Work and Chief of Division of Terrestrial Magnetism,
Assistant, Coast and Geodetic Survey.

CONTENTS.

ILLUSTRATIONS.

PREFACE.

The following appendix containing the results of the magnetic dip and intensity observations made by the United States Coast and Geodetic Survey between January, 1897, and June 30, 1902, together with the special publication, the United States Magnetic Declination Tables and Isogonic Charts for 1902, United States Coast and Geodetic Survey, Washington, 1902, brings the publication of the results of the magnetic survey work up to the date June 30, 1902. Hereafter the results for each fiscal year will appear annually in the Report of the Superintendent.

No attempt was made in the present publication to reduce the results to the same date. This would have involved a reinvestigation of the secular change on the basis of more or less inadequate data. As the data required for this purpose will be greatly multiplied within a comparatively short time by the special field investigations now in progress, the labor involved in reducing the results to a common date and the delay in publication, which would have followed, were not deemed warranted at the present time. For similar reasons, and also because of some of the reasons set forth later touching upon the corrections of the various instruments, it was decided not to make at present any correction for diurnal variation of dip and intensity, corrections which are generally on the order of observation errors.

Experience has shown that it is questionable whether the expense of the great labor involved in the determination of these corrections would at the present stage be justifiable, and also, whether a real gain in accuracy would, in general, be obtained without having recourse to more observatories than now exist in the United States. For the observations made before the establishment of the present observatories, and before the intercomparison of the various instruments, no other corrections than for secular change can safely be made.

As far as determining the distribution of the magnetic elements over a region is concerned, when all errors in observation, reduction, and presentation of data are fully considered, experience has certainly taught that a more valuable contribution to science would often have resulted if the time which was spent in refining office reductions had been devoted to acquiring additional field data. For all investigations which really require the utmost refinement in reduction, the results as given in this paper will be corrected, when warranted, in the papers devoted to those special investigations.

The publication of this paper and of the Magnetic Declination Tables marks, in a certain sense, the close of the initial period of the detailed and systematic magnetic survey of the United States and countries under its jurisdiction, which was inaugurated on May 1, 1899. During this period, from May 1, 1899, to June 30, 1902, a little over three years, all the instruments (16 dip instruments and 15 magnetometers), have been overhauled, modified, and improved whenever needed, and intercompared; four magnetic observatories have been established and the instruments with which they are equipped have been carefully examined, tested, and put in operation. Field instruments of nearly every pattern now on the market (English, French, German, and Russian), have been purchased, critically studied, tested and compared, and a variety of investigations relating to instrumental constants, standardizations, and methods of observation have been made. Twenty persons have been trained in magnetic work, and, in addition to special field investigations, the magnetic elements have been determined at about 800 stations (about one-fifth of the total number proposed for the general magnetic survey) and the results have been prepared for publication.

The completion of this arduous initial work makes it possible to continue the magnetic survey (land and coast waters) and observatory work with unexcelled facilities and instrumental equipment. With this indication of future field activity, effort will be made to keep the office computations and reductions up with the observational work, as nearly as that is possible, so as to insure prompt publication of the results.

Having published the magnetic survey results up to the date given, and made arrangement for the prompt publication of the results in the future, the attempt will be made next to put the results of the observatory work on an equally satisfactory basis.

L. A. BAUER,

Inspector of Magnetic Work and Chief of Division of Terrestrial Magnetism.

RESULTS OF MAGNETIC DIP AND INTENSITY OBSERVATIONS MADE BY THE UNITED STATES COAST AND GEODETIC SURVEY BETWEEN JANUARY, 1897, AND JUNE 30, 1902.

D. L. HAZARD, *Computer, Division of Terrestrial Magnetism.*

INTRODUCTION.

In Appendix 6 of the Report of the Superintendent for the year 1885 were published the results of all magnetic dip and intensity observations in the United States and adjacent territory made by the Coast and Geodetic Survey up to that time, together with similar data obtained by other observers collected from all available sources. The publication also contained a discussion of the secular change of dip and horizontal intensity, by means of which the results were reduced to a common epoch, January 1, 1885, and isoclinic and isodynamic charts were constructed. The intensity results were published in British units.

In the Report of the Superintendent for 1897, Appendix 1, this collection of results was brought up to date by the addition of observations made in the interval and the conversion of intensity results to C. G. S. units. The results were reduced to January 1, 1900, by means of the secular change data discussed in Appendix 1 for 1895, and isoclinic and isodynamic charts for that epoch were constructed and published.

Since 1896, and especially since the inception by the Coast and Geodetic Survey in 1899 of a detailed magnetic survey of the United States, a great many results have accumulated, and a rediscussion of the secular change of dip and horizontal intensity and the publication of new isoclinic and isodynamic charts will soon be warranted and demanded. It is the purpose of the present appendix to present the results of observations of dip and intensity made by the Coast and Geodetic Survey between January 1, 1897, and June 30, 1902, so that they may be available for reference, leaving their discussion for a future paper. The publication of magnetic declination results was brought up to the same date in the Magnetic Declination Tables,* just issued, and it is proposed hereafter to publish each year in the Report of the Superintendent the results of all magnetic observations made by the Coast and Geodetic Survey during the fiscal year covered by the report.

The descriptions of magnetic stations occupied prior to July, 1882, were published in Appendix 9 for 1881; those occupied between that date and June, 1902, will be found described in the Magnetic Declination Tables referred to above.

SUMMARY OF RESULTS.

The number of observations made in each of the three periods is shown in detail in the table on the following page.

*U. S. Magnetic Declination Tables and Isogonic Charts for 1902, by L. A. Bauer; Washington, Government Printing Office, 1902.

TABLE No. 1.—*Geographic distribution of results.*

State or Territory.	Number of dip results. Up to 1885, various.	Up to 1885, C. & G. S.	1885 to 1896.	1897 to 1902.	Total.	Number of intensity results. Up to 1885, various.	Up to 1885, C. & G. S.	1885 to 1896.	1897 to 1902.	Total.
Alabama	2	7	9	7	25	1	8	9	7	25
Alaska	34	38	55	62	189	5	34	52	39	130
Arizona	69	0	2	0	71	34	0	2	0	36
Arkansas	0	0	3	14	17	0	0	3	14	17
California	38	32	47	49	166	23	36	52	49	160
Colorado	4	5	13	12	34	4	5	14	12	35
Connecticut	10	21	2	0	33	6	22	2	0	30
Delaware	7	2	1	6	16	6	2	1	6	15
District of Columbia	24	33	9	5	71	9	32	9	19	69
Florida	1	27	7	14	49	0	26	7	14	47
Georgia	1	20	8	9	38	2	20	8	9	39
Hawaiian Islands	0	0	12	25	37	0	0	12	21	33
Idaho	4	3	0	0	7	5	3	0	0	8
Illinois	31	2	7	4	44	14	2	7	4	27
Indiana	14	5	4	16	39	11	5	4	17	37
Indian Territory	1	2	1	0	4	1	2	1	0	4
Iowa	22	6	9	39	76	19	6	9	39	73
Kansas	8	3	4	16	31	4	3	4	16	27
Kentucky	12	13	3	14	42	8	13	3	14	38
Louisiana	17	8	11	2	38	11	8	11	3	33
Maine	28	48	19	1	96	3	48	19	1	71
Maryland	9	31	2	57	99	5	30	2	55	92
Massachusetts	31	45	8	4	88	12	43	8	4	67
Michigan	61	4	5	3	73	44	5	5	3	57
Minnesota	8	5	4	16	33	8	5	4	16	33
Mississippi	9	1	7	11	28	8	3	7	11	29
Missouri	84	0	2	9	95	82	0	2	9	93
Montana	5	2	11	0	18	5	2	11	0	18
Nebraska	12	3	6	44	65	5	3	6	43	57
Nevada	8	19	4	0	31	0	19	4	0	23
New Hampshire	13	12	2	1	28	5	11	2	1	19
New Jersey	14	22	5	0	41	10	22	5	0	37
New Mexico	18	0	6	33	57	5	0	6	34	45
New York	79	43	7	0	129	55	43	7	0	105
North Carolina	7	11	21	100	139	5	11	21	100	137
North Dakota	0	3	6	0	9	0	3	6	0	9
Ohio	67	5	4	16	92	32	5	4	17	58
Oklahoma	0	0	0	5	5	0	0	0	4	4
Oregon	4	11	5	1	21	2	12	7	1	22
Pennsylvania	55	15	6	33	109	51	15	6	33	105
Philippine Islands	0	0	0	2	2	0	0	0	1	1
Porto Rico	0	0	0	6	6	0	0	0	5	5
Rhode Island	5	7	2	2	16	5	4	2	2	13
South Carolina	0	7	5	13	25	1	9	5	13	28
South Dakota	0	1	4	5	10	0	1	4	5	10
Tennessee	7	12	8	5	32	6	12	8	5	31
Texas	9	9	40	81	139	2	9	40	81	132
Utah	5	13	20	0	38	2	11	20	0	33
Vermont	8	5	2	4	19	6	5	2	4	17
Virginia	15	22	10	91	138	14	22	10	87	133
Washington	25	12	10	6	53	21	18	12	5	56
West Virginia	4	5	0	54	63	4	5	0	54	63
Wisconsin	15	9	4	3	31	9	10	4	3	26
Wyoming	11	9	1	0	21	3	9	1	0	13
Adjacent territory	375	91	5	2	473	222	106	5	0	333
Total	1 290	709	448	902	3 349	795	728	455	880	2 858
Total in United States	915	618	443	900	2 876	573	622	450	880	2 525

The columns in order, beginning at the left, contain the name of the State or Territory, number of dip results from other than Coast and Geodetic Survey observations up to 1885, Coast Survey results up to 1885, Coast Survey results for 1885 to 1896, and since 1896; and the horizontal intensity results are classified in the same way in the last four columns.

Results from Other Sources.

Since the collection of 1885 very few dip or intensity results have been obtained from outside sources. A notable exception is the Magnetic Survey of Maryland made in the years 1896–1899, by Dr. L. A. Bauer, under the auspices of the Maryland Geological Survey, the entire instrumental outfit being loaned by the Coast and Geodetic Survey and part of the expenses in 1899 being defrayed by that organization. The three magnetic elements were determined at over one hundred stations scattered over the State, but grouped more closely where marked local disturbances were found. The results of this survey have been published by the Maryland Geological Survey under the title "Second Report on the Magnetic Survey of Maryland." *

Magnetic Observatories.

The Coast and Geodetic Survey has in operation four magnetic observatories at which the variations of declination and horizontal intensity are recorded photographically. One, Cheltenham, is also provided with a vertical intensity variometer and the others will be similarly equipped. At each of these observatories the absolute values of the three magnetic elements are determined at least once a week. The one at Baldwin, Kans., has been in continuous operation since July, 1900; at Cheltenham, Md., since April, 1901; and at Sitka, Alaska, and near Honolulu, T. H., since December, 1901.

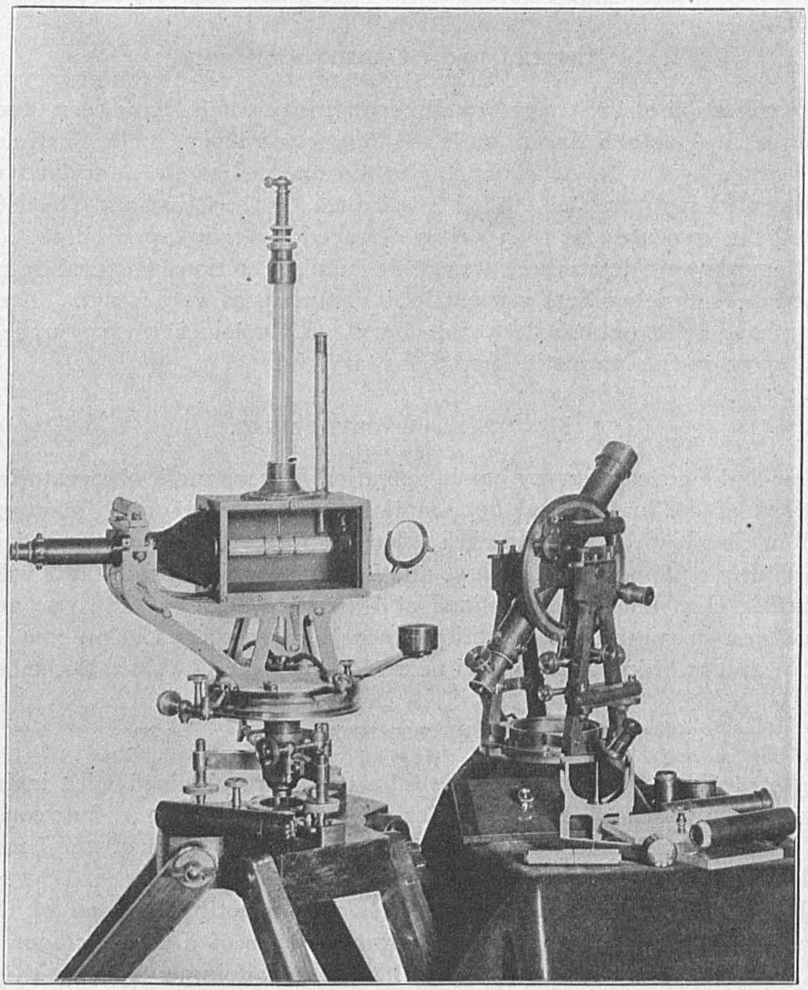
Instruments.

The greater part of the results here tabulated were obtained with instruments of the type shown in the plate opposite. The magnetometer is one of four constructed in the Coast and Geodetic Survey instrument shop in 1892. It is of the Lamont model with such modifications and improvements as have been suggested by experience. Among these may be mentioned the cloth hood connecting the end of the reading telescope with the magnet house, thus avoiding the use of a glass window; the long shank to the stirrup in which the magnet hangs, thus doing away with the need of a balancing ring to preserve horizontality of the magnet; the octagonal form of the magnet and stirrup, making it possible to suspend the magnet with scale horizontal without delay. The magnetometer may be quickly removed from its base and the small theodolite substituted for use in determining the latitude, true meridian, and local mean time. These instruments were originally supplied with wooden deflection bars, but experiments showed that changes in length of bar, due to moisture, were too great to secure the desired accuracy of results. Accordingly, in the spring of 1901, the wooden bars were replaced by bars of brass of such shape as to bring the deflecting magnet on a level with the suspended magnet without the use of a rider.

* Maryland Geological Survey, special publication, vol. v, part 1. Baltimore, 1902.

The dip circle is of the Kew design, pointings being made on the end of the needle by means of two microscopes fixed rigidly to a frame carrying two verniers. By the aid of these verniers the angle of dip is read off on the graduated circle directly to minutes.

No. 1.



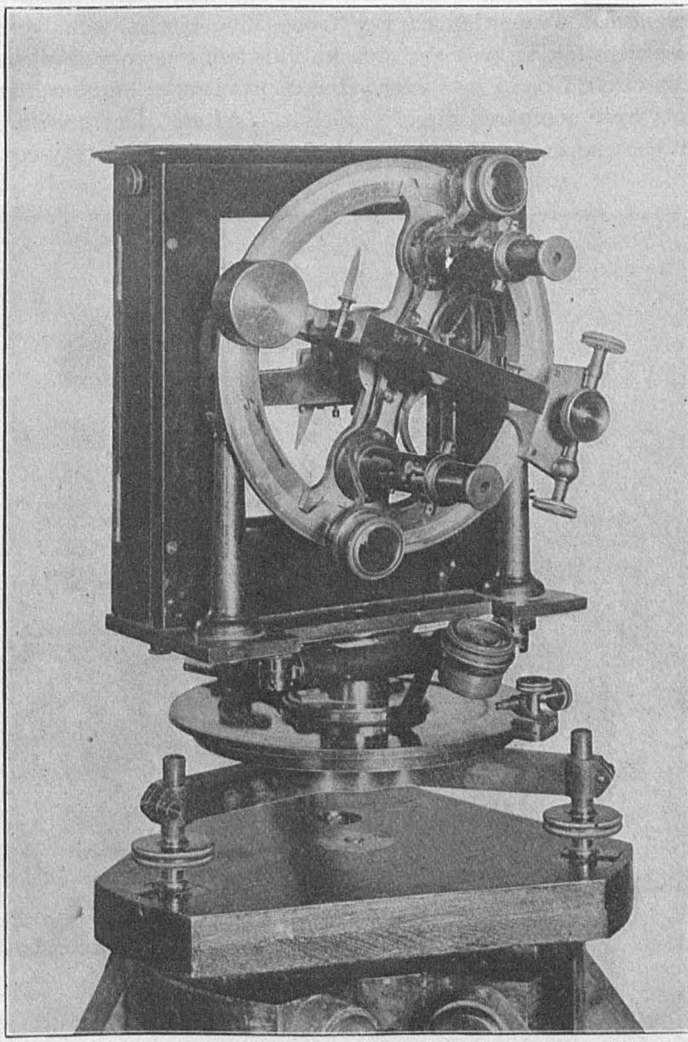
Magnetometer No. 20.

METHODS OF OBSERVING.

The horizontal intensity was determined in the usual way by combining observations of oscillations and deflections, so arranged as to eliminate as far as possible changes in the value of *H* during the observations. The present practice is to begin with a set of oscillations, follow with two sets of deflections at two distances, and conclude with another set of oscillations.

Dip was determined with two needles, their polarities being reversed in the middle of the set. If the results by the two needles differed by more than 5′ observations were repeated. For more detailed directions for the measurement of terrestrial magnetism the reader is referred to Appendix No. 8, Report for 1881. A new edition is in preparation which will contain various modifications in the arrangement of observations and computations suggested by recent experience.

No. 2.



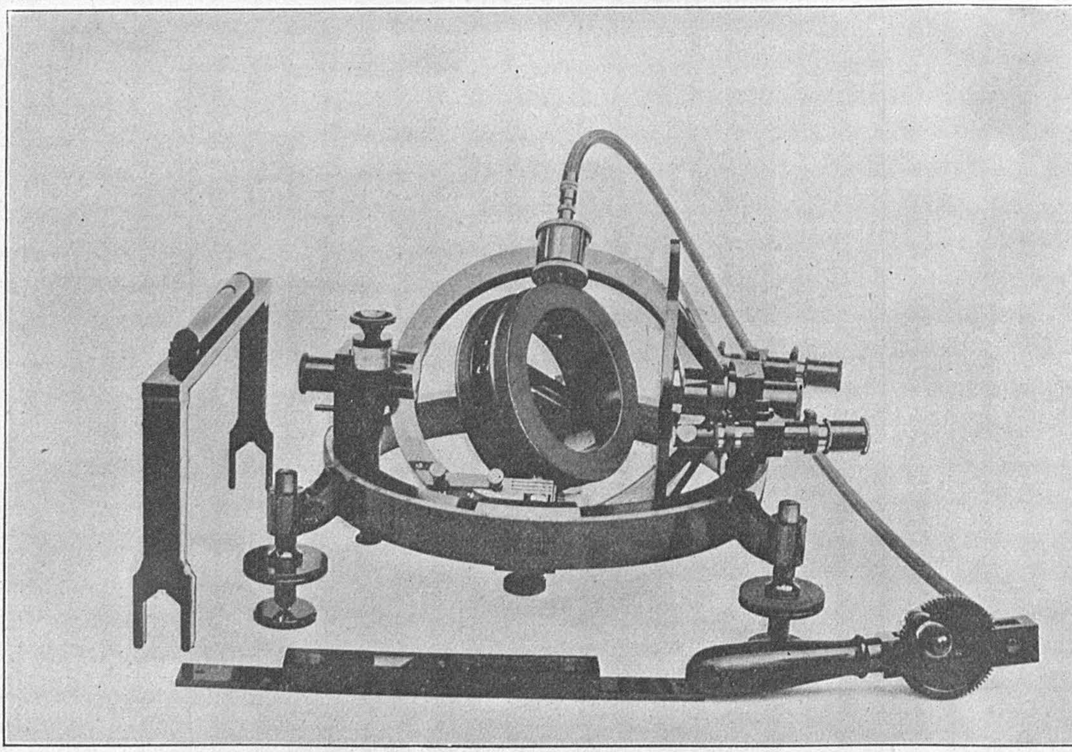
Kew Dip Circle.

Comparison of Dip Circles.

Recent investigations have shown that observations made at the same place with different dip circles will not, in general, give the same results. In spite of the reversals of face of circle, face of needle and polarity, there remains an error peculiar to each circle and more especially to each needle. With a view to increasing the accuracy of the dip results, it was determined to investigate this source of error. Accordingly, a comparison of the various dip circles of the Coast and Geodetic Survey was begun in the spring of 1900, and has been continued as time and opportunity offered or changes in instruments required.*

In most cases two or more dip circles have been compared by means of simultaneous observations, the observation stations being interchanged systematically so as to eliminate local differences. Thus, March 2–7, 1900, five circles were compared simultaneously, five observers taking part and five stations being occupied in rotation with each instrument. Dip circle No. 23 was adopted as a provisional standard and most of the other instruments were compared directly with it. After it had been used in numerous comparisons, it became evident that results by it were sufficiently constant to render

No. 3



Schulze Earth Inductor.

simultaneous observations unnecessary. Some of the later results were therefore obtained by observing with the circle to be compared, and finding the difference between the resulting dip and the value obtained with No. 23 at some other time, allowance being made for diurnal variation. Subsequently an earth inductor made by Schulze, of Potsdam, was installed at the Cheltenham Magnetic Observatory, and this, in view of its satisfactory agreement with the earth inductor belonging to the Wild-Edelmann field magnetometer, purchased by the Survey for the Honolulu Magnetic Observatory, was

* In the fall of 1899 Dr. Bauer compared a set of Coast and Geodetic Survey magnetic instruments with various observatory standards in Europe. See Journal "Terrestrial Magnetism and Atmospheric Electricity," Vol. VI, p. 31.

adopted as the Coast and Geodetic Survey standard dip instrument for the present tables. Comparisons between it and dip circle No. 23 showed a difference of less than half a minute. From Table III it will be seen that the two earth inductors of different construction and by different makers agreed with each other within 0′.2. The standard adopted furthermore practically represents a mean of the 15 dip instruments of several varieties, as shown in the table. Since these comparisons a large observatory earth inductor of Wild-Edelmann pattern, exhibited at the Paris Exposition in 1900, has been acquired and recently installed in the Cheltenham Magnetic Observatory. It is expected that this will be the final standard dip instrument, and that the portable Schulze inductor will be the intermediate instrument by means of which the comparisons between the standard instrument and the field instruments will be effected in the regions where the field instruments are being used. These two earth inductors will probably agree so closely that no further correction will be needed to the results here presented.

The results of the comparisons made at various times and places are given in the following table. The figures in the third and fourth columns indicate the instruments and needles used. Thus 23.34 means that observations were made with dip circle 23, using needles 3 and 4.

TABLE NO. II.—*Dip circle comparisons.*

Place.	Date.	First circle.	Second circle.	Difference, First—Second.	No. of sets.	Remarks.
	1900.					
Washington	Jan. 24–Feb. 7	56.12	5677.12	−0.23	10	
Do.	Mar. 19, 20	56.12	5677.12	−0.06	6	Axle of needle 2 of 56 refastened
Do.	Mar. 2–7	23.34	56.12	−1.27	10	
Do.	Do.	23.34	5676.12	−4.38	10	
Do.	Do.	23.34	5678.12	−4.11	10	
Do.	Apr. 5–7	23.34	18.34	−1.39	10	Needles 3 and 4 of 20 used in 18
Do.	Do.	23.34	56.I II	−1.71	10	Needles 1 and 2 of 20 used in 56
Do.	Do.	23.34	5677.12	−2.94	10	
	Do.	23.34	4655.12	−0.47	10	
Do.	May 9, 10	23.34	12.12	+4.61	6	
Do.	Do.	23.34	21.12	+8.05	6	Between the two comparisons, 21 was used in Alaska
Do.	Aug. 17–27	23.34	21.12	+7.49	12	
Do.	Aug. 30, 31	23.34	5678.34	−0.58	6	
Do.	Aug. 30, Sept. 1, 4	23.34	1.1	+0.80	6	
Sitka, Alaska	Sept. 21–29	5678.1234	21.12	+6.2	2	
Baldwin, Kans.	July–Dec	5676.13	12.12	+6.4	5	5676 adjusted in July
Do.	Nov. 5, 12	5677.12	12.12	+9.5	2	
Do.	Dec. 8	5678.12	12.12	+9.3	4	5678 used in Alaska and Hawaiian Islands since August comparison

TABLE No. II.—*Dip circle comparisons*—Continued.

Place.	Date.	First circle.	Second circle.	Difference, First—Second.	No. of sets.	Remarks.
	1900.					
Washington, D. C.	Dec. 13, 14	23.34	5676.13	— 4.65	6	Needles in 5676 unsatisfactory
Do.	Dec. 20	23.34	5677.12	— 1.60	2	
Do.	Dec. 22, 26	23.34	21.12	+ 6.4	2	21 to Alaska again since August
	1901					
Do.	Jan. 15, 16	23.34	56.13	— 0.10	6	
Do.	Do.	23.34	20.12	+ 0.7	6	Unsatisfactory
Cheltenham, Md.	Feb. 9, 18	1.1	5677.1	+ 2.8	6	
Washington, D. C.	Mar. 27	23.34	15.12	— 0.4	3	
Do.	Apr., May	23.34	5677.12	— 3.5	3	
Do.	Feb., Apr., May	23.34	20.12	+ 5.3	4	Do.
Baldwin, Kans.	May 15–18	5678.12	20.12	+ 4.7	3	
Do.	Aug. 6, 9, 13	5678.12	15.12	+ 2.4	5	
Cheltenham, Md.	June 13	1.1	24.12	+11.4	3	Do.
Washington, D. C.	June 12, 22	23.34	24.12	+10.2	4	Do.
Cheltenham, Md.	Oct. 14, 16	23.34	1.1	— 0.55	2	
Do.	Oct. 19–26	23.34	EI 22	+ 0.20	10	Earth inductor No. 22
Do.	Nov. 12, 13.	23.34	25.48	— 4.28	4	Slight changes in 25 between these two comparisons
Washington, D. C.	Nov. 22	EI 22	25.48	— 3.21	2	
Do.	Dec. 5, 6	23.34	EI 1	+ 0.32	6	Earth inductor No. 1
Do.	Dec. 7, 9	23.34	24.12	+ 6.96	7	
	1902					
Baldwin, Kans.	Feb	5678.12	4655.12	+ 1.7	4	
Washington, D. C.	Apr. 21–26	23.34	18.12	+ 0.78	9	New Dover needles in No. 18
Do.	Apr. 21–30	23.34	18.34	+ 4.2	4	Old needles of No. 21 in No. 18
Do.	May, June, Aug.	23.34	15.24	+ 0.5	6	
Do.	June 27	23.34	24.12	+ 7.0	1	
Do.	June, July, Sept.	23.34	21.12	+ 4.0	7	
Honolulu Observatory.	Jan.-Mar.	56.1234	EI 22	+ 1.2	14	
Sitka Observatory.	Jan.-July	20.12	25.48	— 3.6	31	
Cheltenham Observatory.	Mar.-July	1.1	EI 1	+ 0.44	35	

CORRECTIONS TO DIP CIRCLES.

The importance of these comparisons is at once apparent when it is seen that there is a range of nearly 15′ in the results with different circles. Various causes probably combine to produce these differences, such as impurities in the brass parts of the instruments and imperfections or irregularities in the pivots of the needles. We may expect also to find that in some cases the difference between two circles or needles changes as the dip changes and different parts of the pivots are brought into play. While the above observations present some evidence in that direction, there is not enough to reach a definite conclusion. As the larger differences are confirmed by repeated comparisons, however, there appears to be sufficient justification for attempting to reduce all dip results to the same standard by applying corrections based on the above comparisons.

This has been done for all observations since January, 1900, the corrections used being tabulated below:

TABLE No. III.—*Corrections to dip circles on the Schulze earth inductor.*

Circles		Pattern.	Correction.	Used between
			′	
23.34		Kew-Casella*	−0.4	1900 Jan. and 1902 June
E I 22		Wild-Edelmann	−0.2	1901 Oct. and 1902 June
1.1		Barrow	−0.4	1900 Jan. and 1902 June
12.12		Robinson-Barrow	+4.2	Do
15.12		Kew-Casella*	−0.8	1901 Sept. and 1901 Dec.
15.24		Do.	+0.5	1902 Jan. and 1902 June
18.34	old	Do.	−1.8	1900
18.12	new	Do.*	+0.4	1902 Apr. and 1902 June
20.12	old	Do.	+0.3	1900 Jan. and 1901 Feb.
20.12	new	Do.	+0.0	1901 Apr. and 1902 June
21.12		Do.	+7.2	1900 Apr. and 1900 Aug.
21.12		Do.	+7.0	1900 Aug. and 1900 Dec.
21.12		Do.	+6.0	1901 Jan. and 1902 June
24.12		Moureaux-Chasselon	+6.6	1901 June and 1902 June
25.48		Eschenhagen-Tesdorpf	−3.6	1901 Nov. and 1902 June
56.12		Kew-Casella	−1.9	1900 Jan. and 1900 May
56.13		Do.	−0.5	1900 May and 1901 June
56.1234		Do.	−1.4	1901 July and 1902 June
4655.12		Do.	−0.9	1900 Jan. and 1902 June
5676.12		Do.	−4.8	1900 Jan. and 1900 June
5676.13		Do.	−5.0	1900 June and 1901 May
5677.12		Do.	−2.4	1900 Jan. and 1901 May
5678.12		Do.	−4.5	1900 Jan. and 1902 June
5678.23		Do.	−1.9	1900 Mar. and 1900 May
5678.34		Do.	−1.0	1900 May and 1900 Aug.
5678.1234		Do.	−0.8	1900 Sept. and 1900 Oct.

* Needles by Dover.

ACCURACY OF RESULTS.

An examination of the above comparisons of dip circles shows that dip results uncorrected for instrumental error may be in error by 5′ or even more. As to error of observation purely, the same comparisons show that in general the probable error of a single set (mean of two needles) does not exceed 1′. It may therefore be said roughly that dip results up to 1899 are uncertain by 5′ and those since that time are probably within 2′ of the truth.

In the work of the Coast and Geodetic Survey prior to the beginning of a detailed magnetic survey of the United States it was considered satisfactory if the probably error of a resulting value of horizontal intensity did not exceed one part in five hundred. With the introduction of brass deflection bars and improved methods of observation the uncertainty has been reduced to 1/1000, and with more accurate determination of instrumental constants resulting from the intercomparison of different instruments, it may be still further reduced to 1/2000, or even less. These figures refer to a result from two sets of oscillations with two sets of deflections between, the whole operation occupying about an hour. Some further increase in accuracy can be attained by applying corrections for diurnal variation as the result of the continuous observations at magnetic observatories.

A comparison of the results of horizontal intensity observations made at the same station with the different instruments (especially at Washington, D. C., Cheltenham, Md., and Baldwin, Kansas) bears out the above estimated uncertainty of one part in one thousand. In the case of magnetometers Nos. 10, 20, and 21, however, the results were found to be systematically too small as compared with the other magnetometers, and all observations since April 1901 with those three instruments have therefore been corrected as follows:

No. 10	$+0.003H$
No. 20	$+0.003H$
No. 21	$+0.008H$

The trouble with magnetometer No. 21 (Moureaux-Chasselon magnetometer) was traced to impurities in the brass of which the magnet house is constructed, the time of vibration of the magnet differing materially when suspended in a magnetometer having a wooden magnet house. Similarly the large correction given in Table III for dip circle No. 24 (small Moureaux-Chasselon dip circle) was traced to impurities in the brass of the base and foot screws.

The above corrections constitute all that is warrantable, at present, toward reducing all intensity results to the same standard. As opportunity offers for further comparisons, however, it is intended to deduce for each instrument a systematic correction for reducing results by it to a standard instrument. The detailed results of the comparisons of the various dip instruments and magnetometers and their critical discussion will form the subject of a separate appendix by the Inspector of Magnetic Work for a future Report of the Superintendent.

Arrangement of Table.

The values of dip and horizontal intensity here presented are arranged by States alphabetically, the results for each State being given in the order of increasing latitudes.

The latitude and longitude are in most cases the result of solar observations made with the small theodolite which forms a part of the magnetometer. With this type of instrument the latitude may, under favorable conditions, be determined within half a minute and the longitude within one minute of arc. In default of observations the geographical position was scaled from the best available map, either the U. S. Geological Survey topographic sheets, Post Route map, or Rand & McNally State map. In such cases only the even minute of latitude or longitude is given.

The horizontal intensity is expressed in gammas (γ), 100 000 γ being equal to one unit of intensity in the C. G. S. system.

To save space, the designation of dip circles and needles has been contracted as follows: 21.12 in the column headed dip circle indicates that observations were made with dip circle No. 21 using needles 1 and 2.

In giving the date, the month and day have been converted to fraction of a year by means of the following table:

Jan. 0	0.00	Apr. 1	0.25	July 2	0.50	Oct. 1	0.75
Jan. 18	0.05	Apr. 20	0.30	July 20	0.55	Oct. 19	0.80
Feb. 6	0.10	May 8	0.35	Aug. 7	0.60	Nov. 7	0.85
Feb. 24	0.15	May 26	0.40	Aug. 25	0.65	Nov. 25	0.90
Mar. 14	0.20	June 13	0.45	Sept. 13	0.70	Dec. 13	0.95

Table of dip and intensity observations made between January, 1897, and June 30, 1902.

ALABAMA.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observer.
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Evergreen	31 25.5	86 56.6	1900.40	62 09.9	26294	19	5678.34	D. L. Hazard
Union Springs	32 08.7	85 42.5	1900.41	62 48.6	25940	19	5678.34	Do.
Montgomery	32 21.5	86 18.0	1900.41	62 51.0	26133	19	5678.34	Do.
Birmingham	33 31	86 49.4	1900.42	64 15.0	25341	19	5678.34	Do.
Cullman	34 09.8	86 49.9	1900.43	65 17.3	24389	19	5678.34	Do.
Decatur	34 36.8	86 59.4	1900.43	65 29.5	24157	19	5678.34	Do.
Huntsville	34 42.5	86 35.1	1900.44	66 03.9	23836	19	5678.34	Do.

ALASKA.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
	° ′	° ′		° ′				
Dutch Harbor	53 53.6	166 32.1	1900.80	66 59.2	20675	4	18.34	J. F Pratt
McLean Arm	54 48	132 05	1900.70	73 27.4			21.12	W. Weinrich
Metlakatla	55 06.9	131 34.2	1900.70	74 09.2			21.12	Do.
Dolomi	55 08	132 03	1900.70	74 17.3			21.12	Do.
Chasina Point 1	55 17	132 02	1900.70	74 34.9			21.12	Do.
Chasina Point 2	55 17	132 02	1900.71	74 35.6			21.12	Do.
Ketchikan	55 21	131 38	1900.81	74 11.2			21.12	Do.
Skowl Point	55 26	132 16	1900.71	74 42.3			21.12	Do.
Karta Bay	55 35	132 34	1900.71	74 03.0			21.12	Do.
Wrangell	56 28.3	132 22.7	1900.71	74 46.8	15360	7	21.12	Do.
St. George Island	56 36.2	169 32.5	1897.69	69 54.1	18766	19	4655	G. R. Putnam
Sitka and vicinity								
Parade Ground	57 02.9	135 20.4	1900.73	74 46.4	15464	19	5678.12/34	L. A. Bauer
Parade Ground	57 02.9	135 20.4	1900.73	74 49.0	15434	7	21.2	W. Weinrich
Parade Ground	57 02.9	135 20.4	1901.50	74 45.5	15443	17	20.12	J. A. Fleming
Parade Ground	57 02.9	135 20.4	1902.29	74 45.6	15462	17	25.48	W. Weinrich
Block House D	57 02.9	135 20.2	1900.73	74 49.4	15451	19	5678.12/34	L. A. Bauer
Block House D	57 02.9	135 20.2	1900.73	74 50.5	15448	7	21.12	W. Weinrich
Block House D	57 02.9	135 20.2	1901.44	74 42.8	15450	17	20.12	J. A. Fleming
Swanson Property	57 02.9	135 20.2	1900.76		15400	19		L. A. Bauer
Swanson Property	57 02.9	135 20.2	1901.44	74 45.6	15381	17	20.12	J. A. Fleming
Swanson Property	57 02.9	135 20.2	1901.50	74 46.0	15390	17	20.12	Do.
Magnetic Obs'y*	57 02.9	135 20.2	1902.25	74 48.3	15410	17	25.48	H. M. W. Edmonds
Indian Park No. 1			1901.43	74 45.9	15444	17	20.12	J. A. Fleming
Indian Park No. 2			1901.43	74 44.5	15443	17	20.12	Do.
Indian Park No. 3			1901.43	74 43.6	15437	17	20.12	Do.
Government Res. 1			1901.44	74 44.8	15423	17	20.12	Do.
Government Res. 2			1901.44	74 43.0	15424	17	20.12	Do.
Government Res. 3			1901.44	74 48.3	15411	17	20.12	Do.
Experiment Farm 1			1901.42	74 48.2	15421	17	20.12	Do.
Experiment Farm 2			1901.42	74 44.8	15416	17	20.12	Do.
Experiment Farm 3			1901.42	74 47.3	15422	17	20.12	Do.
Public Garden			1901.44	74 43.0	15461	17	20.12	Do.
Japonski Island			1901.47	74 40.2	15472	17	20.12	Do.
Watsons Point			1901.51	74 45.6	15454	17	20.12	Do.
Cross Mountain			1901.53	74 48.2	15394	17	20.12	Do.
Jamestown Bay			1901.52	74 43.2	15432	17	20.12	Do.
St. Paul Island	57 07.2	170 16.4	1897.52	70 24.2	18379	19	4655	G. R. Putnam
Killisnoo	57 27.9	134 33.8	1900.74	76 24.6			21.12	W. Weinrich
Spasskaia Island	58 07.8	135 15.5	1900.76	75 35.8			21.12	Do.
Juneau Island	58 16.4	134 22.5	1900.78	75 45.2			21.12	Do.
Juneau	58 18	134 24	1900.76	75 12.9			5678.12	L. A. Bauer
Dixon Harbor	58 22	136 51	1900.75	75 40.3			21.12	W. Weinrich
Dundas Bay	58 22	136 22	1900.76	75 30.0			5678.12	L. A. Bauer
Bartlett Bay S	58 27.3	135 51.7	1900.74	75 53.1			21.12	W. Weinrich
Bartlett Bay N	58 28.1	135 52.5	1900.74	75 46.0			21.12	Do.
Wm. Henry Bay	58 43.1	135 13.2	1900.77	75 58.6			21.12	Do.
Lynn Canal								
Battery Point 4	59 11.9	134 21.1	1900.77	76 07.1			21.12	Do.
Battery Point 1	59 12.2	134 21.0	1900.77	79 03.2			21.12	Do.
Battery Point 3	59 12.2	134 21.5	1900.77	77 03.2			21.12	Do.
Battery Point 2	59 12.7	134 21.7	1900.77	79 59.4			21.12	Do.
Upper, Chilkat River	59 23.7	135 54.0	1900.46	74 06.3	16262	7	21.12	O. B. French
Porcupine Creek	59 25.4	136 15.6	1900.50	76 14.4	14093	7	21.12	Do.
Kokinhenic Island	60 18.1	145 03.0	1898.47	75 19.4	14803	17	23	H. P. Ritter
Orca	60 34.7	145 41.2	1898.40	75 23.5	14698	17	23	Do.
Kun	61 50.7	165 33.8	1899.55	73 34.6	15790	11	4655.12	G. R. Putnam
Bright	62 11.0	163 58.1	1899.69	73 41.8			4655.12	Do.
Black (Kripniyuk)	62 20.1	165 19.4	1898.68	73 33.7	15754	11	4655	Do.
Kwiklokchun	62 34.1	164 51.0	1898.62	73 48.0	15762	11	4655	Do.
Head of Apoon	62 54.4	164 00.5	1899.59	74 13.2			4655.2	Do.
Pastoliak	63 02.8	163 13.0	1898.64	74 28.6			4655	Do.
St. Michael	63 28.8	162 01.4	1898.55	74 55.7	14797	11	4655	Do.
St. Michael	63 28.8	162 01.4	1900.50	74 44.1	14917	10	15.12	E. R. Frisby
Port Clarence	65 16.6	166 46.1	1900.74	75 47.3	13866	4	18.34	J. F. Pratt

*Mean of weekly observations, January to June, in the absolute house of the Sitka magnetic observatory; identical with the station "Swanson Property."

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

ARIZONA.

[No observations.]

ARKANSAS.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observer.
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Camden	33 35.0	92 50.4	1901.33	63 29.2	25724	18	56.13	W. Weinrich
Monticello	33 36.6	91 45.6	1901.31	63 44.8	25582	18	56.13	Do.
Murfreesboro	34 03.5	93 42.4	1901.35	63 49.9	25531	18	56.13	Do.
Pine Bluff	34 14.7	92 00.8	1901.33	64 20.6	25199	18	56.13	Do.
Malvern	34 21.6	92 48.8	1901.36	63 44.5	25939	18	56.13	Do.
Little Rock	34 47.0	92 17.9	1901.37	64 45.1	24785	19	56.13	Wallis & Weinrich
Searcy	35 15.3	91 45.2	1901.38	65 36.0	24404	19	56.13	W. Weinrich
Newport	35 36.4	91 15.7	1901.48	66 15.8	23799	19	56.13	Do.
Batesville	35 46.6	91 39.2	1901.47	66 19.6	23802	19	56.13	Do.
Jonesboro	35 49.3	90 43.4	1901.44	66 36.0	23740	19	56.13	Do.
Evening Shade	36 04.3	91 38.4	1901.45	66 32.1	23584	19	56.13	Do.
Walnut Ridge	36 03.8	90 58.6	1901.39	66 30.6	23743	19	56.13	Do.
Paragould	36 05.0	90 32.0	1901.41	66 34.0	23670	19	56.13	Do.
Corning	36 24.7	90 34.9	1901.40	67 04.9	23126	19	56.13	Do.

CALIFORNIA.

Ventura	34 17.0	119 18	1897.02	59 37.4	27002	17	23.34	H. P. Ritter
Saugus	34 24.5	118 33	1897.03	59 50.0	26912	17	23.34	Do.
Santa Barbara	34 24.6	119 41.5	1897.02	59 38.6	26842	17	23.34	Do.
Palmdale	34 35	118 07	1897.05	59 55.8	26836	17	23.34	Do.
Los Olivos	34 40	120 07	1897.01	59 47.4	26790	17	23.34	Do.
Santa Maria	34 57.5	120 26	1897.00	59 44.1	26909	17	23.34	Do.
Mojave	35 03	118 10	1897.05	60 26.5	26618	17	23.34	Do.
Port Harford	35 10.4	120 45.3	1896.98	60 27.2	26653	17	23.34	Do.
Caliente	35 18	118 38	1897.06	60 39.0	26461	17	23.34	Do.
Asphalto	35 19	119 36	1897.08	60 30.8	26532	17	23.34	Do.
Santa Margarita	35 23	120 37	1896.98	60 00.5	26710	17	23.34	Do.
Delano	35 47	119 16	1897.09	61 51.5	25863	17	23.34	Do.
Bradley	35 51.0	120 48	1896.96	60 42.4	26361	17	23.34	Do.
San Lucas	36 08	121 01	1896.95	60 56.0	26186	17	23.34	Do.
Huron	36 13	120 06	1897.11	61 22.9	26107	17	23.34	Do.
Visalia	36 21	119 17	1897.10	61 16.4	26289	17	23.34	Do.
Soledad	36 25.5	121 20	1896.94	61 13.6	26019	17	23.34	Do.
Salinas	36 40.3	121 40	1896.93	61 27.9	25932	17	23.34	Do.
Fresno	36 44.5	119 48	1897.13	61 48.0	25636	17	23.34	Do.
Mendota	36 46	120 22	1897.14	61 38.6	26077	17	23.34	Do.
Hollister	36 50.8	121 28	1896.89	61 40.8	25735	17	23.34	Do.
Santa Cruz	36 57	122 02	1896.92	61 32.2	25770	17	23.34	Do.
Madera	36 59	120 03	1897.16	62 22.8	25151	17	23.34	Do.
Volta	37 07	120 56	1897.15	61 41.8	25939	17	23.34	Do.
San Jose	37 16.3	121 53	1896.89	61 41.9	26295	17	23.34	Do.
Merced	37 18	120 28	1897.17	63 12.5	24893	17	23.34	Do.
Mount Hamilton	37 20.5	121 38.3	1900.93	61 44.8	25662	19	5678.12	L. A. Bauer
Modesto	37 38	120 59	1897.19	62 57.4	25137	17	23.34	H. P. Ritter
Altamont	37 45	121 40	1897.20	62 26.8	25360	17	23.34	Do.
Presidio, San Francisco	37 47.5	122 27.3	1898.17	62 26.5	25126	17	23.34	Do.
Stockton	37 58	121 17	1897.22	63 06.0	25175	17	23.34	Do.
San Rafael	37 58.6	122 32.9	1897.68	62 22.2	25237	17	23.34	Do.
Milton	38 03	120 51	1897.21	63 17.9	24671	17	23.34	Do.
Fairfield	38 14.6	122 02.5	1897.73	62 43.3	25124	17	23.34	Do.
Napa	38 16.6	122 14.6	1897.49	63 00.0	24570	17	23.34	Do.
Napa	38 16.6	122 14.6	1898.05	63 04.3	24574	17	23.34	Do.
Santa Rosa	38 26.8	122 43.0	1897.46	62 52.7	24990	17	23.34	Do.
Sacramento	38 33.4	121 29.1	1897.79	63 44.0	24475	17	23.34	Do.
Woodland	38 40.2	121 46.9	1898.03	63 05.0	25008	17	23.34	Do.
Placerville	38 45.0	120 47.8	1897.77	63 01.6	25171	17	23.34	Do.
Auburn	38 54.8	121 03.5	1897.75	63 16.3	24850	17	23.34	Do.
Ukiah	39 08.0	123 12.6	1897.71	63 20.4	24660	17	23.34	Do.
Marysville	39 08.7	121 36.1	1897.80	63 47.8	24432	17	23.34	Do.
Colusa	39 11.7	122 01.9	1898.00	63 40.6	24676	17	23.34	Do.
Nevada City	39 17.3	121 02.4	1897.74	64 55.5	23617	17	23.34	Do.
Oroville	39 30.4	121 34.2	1897.82	64 01.4	24315	17	23.34	Do.
Willows	39 31.0	122 12.2	1897.98	63 51.6	24491	17	23.34	Do.
Red Bluff	40 11.5	122 14.6	1897.84	64 49.0	23862	17	23.34	Do.
Redding	40 35.6	122 24.4	1897.96	64 58.0	23774	17	23.34	Do.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

COLORADO.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Conejos	37 05.5	106 01	1899.89	64 45.8	24800	19	5678.12	J. A. Fleming
Springfield	37 24.3	102 36.5	1900.88	65 56.1	24032	17	4655.12	W. C. Dibrell
Lamar	38 05.2	102 36.7	1900.87	66 47.6	23232	17	4655.12	Do.
Pueblo	38 13.9	104 38	1899.88	66 40.6	23430	19	5678.12	J. A. Fleming
Sheridan Lake	38 28.1	102 16.9	1900.86	66 55.6	23178	17	4655.12	W. C. Dibrell
Cheyenne Wells	38 49.2	102 20.4	1900.85	67 14.1	22923	17	4655.12	Do.
Burlington	39 18.4	102 16.5	1900.85	67 37.7	22676	17	4655.12	Do.
Gerdts	39 42.5	102 40.5	1900.84	68 25.1	22201	17	4655.12	Do.
Denver	39 46.3	104 54.5	1899.87	67 36.5	22565	19	5678.12	J. A. Fleming
Yuma	40 07.6	102 41.2	1900.83	68 18.3	22206	17	4655.12	W. C. Dibrell
Akron	40 09.6	103 13.2	1900.83	68 29.4	22014	17	4655.12	Do.
Sterling	40 37.2	103 13.0	1900.83	69 10.1	21648	17	4655.12	Do.

CONNECTICUT.

[No observations.]

DELAWARE.

Dagsboro	38 32.9	75 15.6	1899.49	70 13.0	20290	18	56	J. A. Fleming
Seaford	38 38.3	75 36.7	1899.49	70 12.9	20440	18	56	Do.
Harrington	38 55.1	75 34.9	1899.48	70 29.9	19994	18	56	Do.
Dover	39 09	75 31.3	1897.35	70 25.4	19976	7	21	O. B. French
Bombay Hook	39 21.5	75 31.0	1899.48	70 45.4	19722	18	56	J. A. Fleming
Newark	39 41.0	75 44.5	1899.48	71 04.0	19728	18	56	Do.

DISTRICT OF COLUMBIA.*

Washington C. & G. S. Mag'c house	38 53.2	77 00.5	1898.32	69 53.6	20457	19	5677	E. Smith and R. L. Faris
			1899.41	69 59.3	20413	10	15	H. H. Pritchett
			1899.48	69 54.1	20378	19	5677	H. W. Vehrenkamp
			1899.56	69 55.4	20253	3	18	D. L. Hazard
			1900.36		20380	7		J. B. Baylor
			1901.18		20322	20		Wallis and Leffingwell
			1901.24		20291	10		W. F. Wallis
			1901.26		20365	20		Do.
			1901.33		20370	19		D. L. Hazard
			1901.35		20332	17		J. A. Fleming
			1901.43		20385	18		W. F. Wallis
			1901.48		20346	18		Do.
			1901.48		20333	21		Do.
			1901.75		20316	11		J. W. Miller
			1901.89		20325	22		W. Weinrich
			1902.02		20339	21		W. F. Wallis
			1902.31		20330	21		Do.
			1902.41	69 55.5	20359	11	15.24	E. D. Preston
			1902.48		20349	10		S. A. Deel

FLORIDA.

Cedar Keys	29 08.3	83 01.7	1900.35	59 57.4	27318	19	5678.23	D. L. Hazard
Palatka	29 38	81 37.7	1900.33	60 40.4	26906	19	5678.23	Do.
Gainesville	29 39.3	82 19.3	1900.34	60 47.5	26936	19	5678.23	Do.
St. Augustine	29 54.0	81 18.7	1900.32	61 02.9	26718	19	5678.23	Do.
Perry	30 06.5	83 34.8	1900.36	61 04.6	26910	19	5678.23	Do.
Lake City	30 11.3	82 38.4	1900.30	61 01.6	26958	19	5678.23	Do.
Baldwin	30 18.2	81 58.2	1900.30	61 25.0	26522	19	5678.23	Do.
Jacksonville	30 19.9	81 39.3	1900.31	61 30.3	26361	19	5678.23	Do.
Pensacola Navy-Yard	30 29.9	87 15.9	1900.39	60 49.8	27198	19	5678.23	Do.
Tallahassee	30 26.0	84 17.7	1900.37	61 09.8	26817	19	5678.23	Do.
Madison	30 28.7	83 25.0	1900.29	61 20.5	26627	19	5678.23	Do.
Fernandina	30 40.1	81 27.2	1900.32	61 48.2	26271	19	5678.23	Do.
De Funiak Springs	30 43.0	86 07.0	1900.38	61 19.8	26856	19	5678.23	Do.
Marianna	30 46.7	85 13.4	1900.37	61 50.9	26562	19	5678.23	Do.

*Numerous additional dip observations have been made at this station in comparing different instruments. The normal value for 1902 is 69° 56′.0.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

GEORGIA.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Thomasville	30 49.6	83 58.6	1900.28	61 36.1	26604	19	5678.23	D. L. Hazard
Pelham	31 07.4	84 09.4	1900.27	62 02.7	26368	19	5678.23	Do.
Cedar Point	31 29.8	81 20.8	1902.05	62 36.1	25748	11	21.12	O. B. French
Albany	31 33.9	84 08.2	1900.27	62 36.7	26148	19	5678.23	D. L. Hazard
Oglethorpe	32 17.3	84 03.8	1900.26	63 11.4	25646	19	5678.23	Do.
Macon	32 49.1	83 36.8	1900.25	63 52.7	25252	19	5678.23	Do.
Milledgeville	33 04.5	83 16.2	1900.24	64 39.1	24733	19	5678.23	Do.
Warrenton	33 23.0	82 40.4	1900.24	64 40.4	24582	19	5678.23	Do.
Augusta	33 27.9	81 57.3	1900.23	64 42.2	24503	19	5678.23	Do.

HAWAIIAN ISLANDS.

HAWAII								
Kilauea	19 24.8	155 15.7	1900.87	37 10.2			5678.12	L. A. Bauer
Hilo	19 44.0	155 04.0	1900.04	38 56.4	.30010	10	15.12	E. R. Frisby
MAUI								
Lahaina	20 52.0	156 40.9	1900.10	38 55.1	29839	10	15.12	Do.
Kahului	20 54.0	156 27.9	1899.96	38 53.4	29851	10	15.12	Do.
OAHU								
Diamond Head	21 16	157 48	1900.88	39 26			5678.12	L. A. Bauer
Waikiki	21 16.4	157 49.7	1899.94	36 26.8	29946	10	15.12	E. R. Frisby
Honolulu	21 18.0	157 51.5	1899.93	39 46.8	29610	10	15.12	Do.
Sisal, D	21 19.1	158 03.9	1901.65	40 21.7	29303	19	56.13	J. A. Fleming
Sisal, J	21 19.1	158 03.7	1901.69	40 13.4	29330	19	56.1234	Do.
Puuloa Point	21 19.2	157 58.4	1900.89	39 46.9	29364	19	5678.12	L. A. Bauer
Sisal, C	21 19.2	158 04.0	1901.65	40 23.1	29332	19	56.123	J. A. Fleming
Sisal, F	21 19.2	158 03.8	1901.67	40 16.7	29325	19	56.12	Do.
Sisal, G	21 19.2	158 03.8	1901.68	40 17.6	29313	19	56.1234	Do.
Sisal, H	21 19.2	158 03.7	1901.68	40 19.4	29252	19	56.1234	Do.
Variation observatory	21 19.2	158 03.8	1901.92	40 13.3	29319	19	56.13	Do.
Absolute observatory*	21 19.2	158 03.8	1902.25	40 14.7	29245	22	EI 22	Do.
Absolute observatory*	21 19.2	158 03.8	1902.25		29294	19		Do.
Sisal, A	21 19.3	158 04.2	1900.86	40 25.1	29297	19	5678.12	L. A. Bauer
Sisal, A	21 19.3	158 04.2	1901.64	40 25.0	29342	19	56.13	J. A. Fleming
Sisal, E	21 19.3	158 03.8	1901.66	40 16.4	29238	19	56.13	Do.
Sisal, B	21 19.4	158 04.2	1900.88	40 12.5			5678.12	L. A. Bauer
Sisal, K	21 19.4	158 03.7	1901.70	40 20.3	29164	19	56.1234	J. A. Fleming
Sisal, L	21 19.4	158 03.8	1901.71	40 21.8	29222	19	56.1234	Do.
Honouliuli 1	21 20.2	158 01.6	1900.86	38 51.1			5678.12	L. A. Bauer
Honouliuli 2	21 20.2	158 01.6	1900.86	39 07.2			5678.12	Do.
Kahuku	21 42.6	157 59.3	1900.83	40 51.1	29298	19	5678.12	Do.

IDAHO.

[No observations.]

ILLINOIS.

McLeansboro	38 06	88 32	1900.93	68 44.6	21952	20	5677.12	W. F. Wallis
Nashville	38 20	89 22	1900.92	69 20.1	21526	20	5677.12	Do.
Danville	40 07.1	87 35.3	1900.83	70 50.1	20202	8	1.1	O. B. French
Chicago	41 55.8	87 37.2	1900.86	72 32.9	18580	11	5676.13	W. G. Cady

INDIANA.

Evansville	37 59	87 28	1900.94	69 01.8	21672	20	5677.12	W. F. Wallis
Paoli	38 32.5	86 27.3	1900.72	69 26.1	21302	8	1.1	W. C. Dibrell
Madison	38 41.7	85 27.1	1900.71	69 56.3	20734	8	1.1	Do.
Bloomfield	39 01.8	86 55.6	1900.73	69 56.4	20854	8	1.1	Do.
Greensburg	39 24.7	85 29.0	1900.70	70 22.3	20438	8	1.1	Do.
Martinsville	39 24.9	86 24.0	1900.70	70 21.4	20496	8	1.1	Do.
Terre Haute	39 29.6	87 23.4	1900.74	70 16.9	20540	8	1.1	Do.
Indianapolis	39 47.4	86 11.9	1900.69	70 48.0	20074	8	1.1	Do.

* Mean of weekly observations, January to June.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

INDIANA—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Richmond	39 50.4	84 53.3	1900.68	70 57.1	19915	8	1.1	W. C. Dibrell
Crawfordsville	40 03	86 51.8	1900.75	70 56.6	20016	8	1.1	Do.
Hartford City	40 28.7	85 22.8	1900.76	71 27.8	19374	8	1.1	Do.
Kokomo	40 30.7	86 05.0	1900.76	71 08.4	19762	8	1.1	Do.
Fort Wayne	41 06.0	85 08.2	1900.77	72 00.6	19286	8	1.1	Do.
Warsaw	41 11.7	85 52.3	1900.78	71 56.1	19048	8	1.1	Do.
South Bend	41 39.9	86 14.5	1900.79	72 05.9	18985	8	1.1	Do.
Michigan City	41 42.4	86 58.2	1900.88	72 15.1	18816	11	5676.12	W. G. Cady

INDIAN TERRITORY.

[No observations.]

IOWA.

Keokuk	40 23.0	91 23.0	1900.50	70 37.0	20368	20	5677.12	W. F. Wallis
Keokuk	40 23.0	91 23.0	1900.79	70 34.7	20384	20	5677.12	Do.
Corydon	40 44.1	93 19.2	1900.78	71 02.6	20054	20	5677.12	Do.
Burlington	40 47.8	91 07.5	1900.51	71 21.9	19742	20	5677.12	Do.
Fairfield	40 59.8	91 59.4	1900.51	71 10.3	19974	20	5677.12	Do.
Red Oak	41 01.0	95 11.3	1900.76	70 26.6	20548	20	5677.12	Do.
Osceola	41 01.4	93 45.2	1900.77	71 22.2	19731	20	5677.12	Do.
Creston	41 03.0	94 19.2	1900.77	71 03.8	20097	20	5677.12	Do.
Council Bluffs	41 14	95 51.6	1900.69	71 04.8	19933	20	5677.12	Do.
Washington	41 15.3	91 41.8	1900.52	71 30.4	19434	20	5677.12	Do.
Oskaloosa	41 15.5	92 43.5	1900.53	71 42.3	19327	20	5677.12	Do.
Oskaloosa	41 18.1	92 39.3	1900.53	71 37.4	19312	20	5677.12	Do.
Atlantic	41 22	94 57.8	1900.74	71 07.0	19899	20	5677.12	Do.
Menlo	41 30.6	94 23.2	1900.75	71 22.8	19668	20	5677.12	Do.
Logan	41 38.7	95 47.2	1900.71	70 53.4	20156	20	5677.12	Do.
Newton	41 42	93 04.0	1900.54	71 33.4	19407	20	5677.12	Do.
Marengo	41 46.4	92 03.8	1900.55	71 51.3	19293	20	5677.12	Do.
Onawa	42 01.0	96 04.4	1900.72	71 16.9	20048	20	5677.12	Do.
Carroll	42 02	94 49.7	1900.73	71 37.8	19422	20	5677.12	Do.
Boone	42 02.2	93 54.3	1900.63	71 48.0	19444	20	5677.12	Do.
Anamosa	42 07.2	91 15.3	1900.55	72 11.2	18933	20	5677.12	Do.
Ida Grove	42 20.6	95 26.9	1900.72	71 53.6	19362	20	5677.12	Do.
Eldora	42 21.3	93 05.2	1900.62	72 08.0	19006	20	5677.12	Do.
Dubuque	42 29	90 40.0	1900.56	72 50.4	18223	20	5677.12	Do.
Waterloo	42 29.0	92 21.9	1900.58	72 36.4	18506	20	5677.12	Do.
Manchester	42 29.2	91 27.0	1900.57	73 07.1	18073	20	5677.12	Do.
Fort Dodge	42 29.5	94 12.4	1900.64	72 17.5	18846	20	5677.12	Do.
Fonda	42 34.6	94 50.0	1900.68	72 18.6	18877	20	5677.12	Do.
Hampton	42 43.8	93 11.4	1900.62	72 35.2	18726	20	5677.12	Do.
Cherokee	42 45.2	95 34.3	1900.67	72 06.6	19454	20	5677.12	Do.
Lemars	42 48	96 09.8	1900.67	72 23.6	18599	20	5677.12	Do.
West Union	42 54	91 50.4	1900.58	73 33.3	17724	20	5677.12	Do.
Charles City	43 02.6	92 41.4	1900.60	72 58.8	18289	20	5677.12	Do.
Emmetsburg	43 04.4	94 42.0	1900.65	72 32.6	18598	20	5677.12	Do.
Garner	43 04.8	93 35.7	1900.61	72 51.3	18444	20	5677 12	Do.
Hartley	43 09.5	95 29.2	1900.66	72 11.6	18968	20	5677.12	Do.
Perkins	43 10.7	96 11.2	1900.66	72 17.8	18932	20	5677.12	Do.
Decorah	43 18.2	91 48.9	1900.59	73 42.9	17526	20	5677.12	Do.
Northwood	43 26.9	93 15.5	1900.60	73 17.2	18077	20	5677.12	Do.

KANSAS.

Liberal	37 02	100 54.3	1900.89	65 59.9	23915	17	4655.12	W. C. Dibrell
Richfield	37 16.1	101 46.3	1900.88	65 58.4	23903	17	4655.12	Do.
Burlington	38 12	95 47.6	1900.47	67 28.9	22950	3	5676.13	C. K. Edmunds
Garnett	38 15.8	95 16.9	1900.47	68 17.7	22280	3	5676.13	Do.
Lyndon	38 37	95 41.2	1900.46	68 52.0	21832	3	5676.1	Do.
Ottawa	38 37.5	95 15.9	1900.46	68 41.2	21946	3	5676.13	Do.
Baldwin Observatory	38 47.0	95 10.0	1900.56		22011	11		W. C. Bauer
Baldwin Observatory	38 47.0	95 10.0	1900.86	68 39.7	21961	20	5677.12	W. F. Wallis
Baldwin Observatory	38 47.0	95 10.0	1900.94	68 35.1	21985	19	5678.12	L. A. Bauer
Baldwin Observatory	38 47.0	95 10.0	1901.37	68 34.2	21960	17	20.12	J. A. Fleming
Baldwin Observatory	38 47.0	95 10.0	1901.37	68 31.6	21981	17	20.12	Do.
Baldwin Observatory	38 47.0	95 10.0	1901.61	68 37.6	21954	11	15.12	J. M. Kuehne
Baldwin Observatory*	38 47.0	95 10.0	1902.25	68 36.3	21973	20	{ 5678.12 { 4655.12	} Various

*Mean of weekly observations, January to June.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

KANSAS—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Olathe	38 49.2	85 01.3	1901.62	68 37.2	22004	11	15.12	J. M. Kuehne
Holton	39 28.5	95 44.0	1900.59	69 02.6	21606	11	5676.13	W. C. Bauer
Marysville	39 50.5	96 39	1900.60	69 07.8	21652	11	5676.13	Do.
Hiawatha	39 51.3	95 31.5	1900.65	69 33.5	21035	11	5676.13	J. W. Miller

KENTUCKY.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
Williamsburg	36 44.6	84 09.1	1900.47	68 17.5	22178	19	5678.34	D. L. Hazard
Russellville	36 50.2	86 53.2	1901.56	67 32.5	23123	19	56.13	W. Weinrich
Paducah	37 03.7	88 36.9	1901.50	67 49.9	22646	19	56.3	Do.
Princeton	37 06.9	87 53.2	1901.51	67 45.6	22610	19	56.3	Do.
Greenville	37 12.6	87 10.9	1901.55	68 19.6	22174	19	56.13	Do.
Livingston	37 20	84 14	1900.47	68 37.0	21949	19	5678.34	D. L. Hazard
Jackson	37 32.8	83 22.6	1900.48	68 55.0	21351	19	5678.34	Do.
Morganfield	37 42.3	87 53.5	1901.52	68 38.5	21958	19	56.3	W. Weinrich
Richmond	37 44.6	84 18.0	1900.48	69 29.1	21023	19	5678.34	D. L. Hazard
Owensboro	37 45.8	87 04.6	1901.54	68 32.9	22102	19	56.13	W. Weinrich
Hawesville	37 54.0	86 44.6	1900.95	69 02.0	21586	20	5677.12	W. F. Wallis
Mount Sterling	38 03.5	83 59	1900.49	69 47.9	21182	19	5678.34	D. L. Hazard
Morehead	38 10.1	83 26.6	1900.49	69 29.8	21234	19	5678.34	Do.
Grayson	38 19.2	82 58	1900.50	69 41.6	21226	19	5678.34	J. W. Miller

LOUISIANA.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
New Orleans	29 54	90 08	1901.29		27938	18		W. Weinrich
Alexandria	31 19.8	92 25.3	1901.30	61 06.2	27177	18	56.13	Do.
Columbia	32 06.1	92 03.2	1901.31	62 08.2	26530	18	56.13	Do.

MAINE.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
Kittery Point	43 05.0	70 42.8	1898.86	73 43.8	16870	19	5677.12	E. Smith

MARYLAND.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
Cheltenham	38 42.8	76 50	1899.74	70 16.1	20129	3	18	J. A. Fleming
Cheltenham	38 44.0	76 52	1899.75	70 18.8	20050	3	18	Do.
Cheltenham obsy.	38 44.0	76 50.5	1901.45	70 16.3	20168	21	24.12	W. F. Wallis
Cheltenham obsy.	38 44.0	76 50.5	1901.81	70 21.6	20175	22	EI 22	Do.
Cheltenham obsy.	38 44.0	75 50.5	1901.87	70 23.6	20180	25	25.48	Do.
Cheltenham obsy.	38 44.0	76 50.5	1901.93	70 22.5	20198	11	21.12	Do.
Cheltenham obsy.	38 44.0	76 50.5	1901.95	70 20.0	20197	21	24.12	Do.
Cheltenham obsy.*	38 44.0	76 50.5	1902.25	70 22.6	20194	8	EI 1	Various
Cheltenham obsy.	38 44.0	76 50.5	1902.47	70 17.2	20203	21	24.12	W. F. Wallis
Cheltenham	38 44.2	76 51	1899.73	70 23.6	19997	3	18	J. A. Fleming
Cheltenham	38 44.3	76 49	1899.75	79 22.0	19992	3	18	Do.
Cheltenham	38 44.3	76 51	1899.74	70 23.4	20042	3	18	Do.
Cheltenham	38 44.4	76 51	1899.72	70 21.4	19975	3	18	Do.
Cheltenham	38 45.2	76 51	1899.74	70 22.5	19958	3	18	Do
Centerville	38 49.1	76 51.6	1900.32	70 19.6			56.13	L. A. Bauer
Linden	39 00.5	77 03.1	1899.37	70 42.6	19775	18	56	Do.
Linden	39 00.5	77 03.1	1899.52	70 44.3	19739	18	56	Do.
Linden	39 00.5	77 03.1	1900.55	70 38.6	19778	18	56.13	Bauer & Dawson
Linden	39 00.5	77 03.1	1901.42	70 37.1	19739	18	18.34	L. A. Bauer
Linden	39 00.5	77 03.1	1901.44	70 43.8	19676	21	24.12	Do.
Seneca	39 04.3	77 20.7	1899.56	70 53.6			5677	H. W. Vehrenkamp
Hunting Hill	39 05.8	77 12.5	1899.55	70 00.6	19858	19	5677	Do.
Derwood	39 07.2	77 09.5	1899.55	70 17.2	20386	19	5677	Do.
Quince Orchard	39 07.2	77 15.4	1899.55	71 01.3	19668	19	5677	Do.
Gaithersburg	39 08.1	77 11.2	1898.34	70 38.3	19877	19	5677	E. Smith
Gaithersburg	39 08.1	77 11.2	1899.37	70 26.2	19915	18	56	L. A. Bauer
Gaithersburg 1	39 08.2	77 12.5	1899.53	70 42.2	19770	19	5677	H. W. Vehrenkamp
Gaithersburg 1	39 08.2	77 12.5	1899.52	70 48.5	19792	18	56	J. A. Fleming
Gaithersburg 2	39 08.2	77 12.5	1899.52	70 48.6	19743	19	5677	H. W. Vehrenkamp
Gaithersburg 2	39 08.2	77 12.5	1899.53	70 49.8	19690	18	56	J. A. Fleming
Gaithersburg 3	39 08.2	77 12.5	1899.52	70 47.6	19771	19	5677	H. W. Vehrenkamp

* Mean of weekly absolute observations, January to June.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

MARYLAND—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observer.
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Gaithersburg 4*	39 08.2	77 12.5	1901.38	70 45.4	19788	10	5677.12	D. L. Hazard
Redland	39 08.5	77 08.6	1899.54	70 23.4	20094	19	5677	H. W. Vehrenkamp
Waring	39 09.6	77 15.1	1899.53	71 46.5	18806	19	5677	Do.
Cross Roads II	39 09.8	77 09.3	1899.54	70 39.4	20184	19	5677	Do.
Middlebrook	39 10.7	77 14.2	1899.53	70 40.6	19828	19	5677	Do.
Cross Roads I	39 11.4	77 11.6	1899.54	70 42.6	20131	19	5677	Do.
Dickerson	39 13.5	77 25.2	1900.25	70 48.9	19658	17	5677.12	Fleming & Thompson
Corunna	39 16.6	79 22.6	1900.41	70 30.0	20118	17	4655.12	W. M. Brown
Lisbon	39 20.1	77 04.1	1899.37	71 23.6	19719	18	56	L. A. Bauer
Betterton	39 21.9	76 03.9	1899.47	71 18.4	19312	18	56	Bauer & Fleming
Sykesville	39 22.3	76 57.7	1899.37	70 53.3	20039	18	56	L. A. Bauer
Oakland	39 24.5	79 24.6	1899.43	70 34.6	20096	18	56	Do.
Swanton	39 27.0	79 12.3	1899.44	70 40.4	20058	18	56	Do.
Reisterstown	39 27.8	76 50.0	1899.38	70 41.8	20193	18	56	Do.
Libertytown	39 29.0	77 13.9	1899.38	70 50.2	19765	18	56	Do.
Havre de Grace	39 32.4	76 05.1	1899.47	70 58.5	19391	18	56	Bauer & Fleming
McHenry	39 33.4	79 21.2	1899.43	70 43.6	19944	18	56	L. A. Bauer
Accident	39 37.6	79 19.0	1899.43	70 46.3	19867	18	56	Do.
New Germany	39 37.9	79 07.2	1899.44	70 50.8	19873	18	56	Do.
Hagerstown	39 38.1	77 44.9	1900.44	70 56.1	19670	18	56	J. A. Fleming
Parkton	39 39.0	76 40.0	1899.45	70 58.4	19555	18	56	L. A. Bauer
Taneytown	39 39.5	77 10.7	1899.38	71 01.0	19629	18	56	Do.
Manchester	39 39.6	76 52.8	1899.38	70 59.2	19681	18	56	Do.
Rising Sun	39 41.5	76 03.3	1899.47	71 12.7	19585	18	56	Do.
Grantsville	39 41.6	79 09.1	1899.43	70 51.8	19889	18	56	Do.
Calvert	39 41.8	75 57.7	1899.47	71 02.8	19528	18	56	Do.

MASSACHUSETTS.

Worcester	42 16.7	71 48.5	1898.89	73 20.0	17318	19	5677.12	E. Smith
Worcester, Tech.	42 16.7	71 48.5	1898.89	73 18.4	17387	19	5677.12	Do.
Williamstown	42 42.4	73 12.5	1898.85	73 28.4	17278	19	5677.12	Do.
Plum Island	42 48.1	70 48.8	1898.87	73 37.8	16960	19	5677.12	Do.

MICHIGAN.

Sturgis	41 48.4	85 26.0	1900.78	72 26.0	18632	8	1.1	W. C. Dibrell
Kalamazoo	42 19.8	85 34.3	1900.89	73 00.6	18233	11	5676.13	W. G. Cady
Detroit	42 20.4	82 57.6	1900.90	72 57.9	17988	11	5676.13	Do.

MINNESOTA.

Heron Lake	43 49.1	95 18.2	1900.79	73 15.6	18025	11	5676.13	J. W. Miller
Mantorville	44 05.0	92 46.0	1900.81	73 36.5	17497	11	5676.13	Miller and Cady
Mankato	44 10.9	93 59.2	1900.80	73 31.0	17747	11	5676.13	Do.
Lake Benton	44 17.2	96 17.9	1900.79	73 39.6	17366	11	5676.13	J. W. Miller
Granite Falls	44 49.5	95 33.0	1900.78	73 37.8	17688	11	5676.13	Do.
St. Paul	44 59.7	93 09.9	1900.82	74 39.7	16726	11	5676.13	Miller and Cady
Benson	45 20.	95 36.4	1900.70	74 26.3	17100	11	5676.13	J. W. Miller
St. Cloud	45 35.1	94 10.6	1900.75	75 01.9	16442	11	5676.13	Do.
Alexandria	45 54.6	95 24.3	1900.77	75 18.8	16048	11	5676.13	Do.
Breckenridge	46 17.0	96 35.2	1900.70	75 21.1	15762	11	5676.13	Do.
Brainerd	46 21.0	94 12.9	1900.74	75 17.8	15945	11	5676.13	Do.
Wadena	46 27.9	95 08.8	1900.73	75 17.6	15940	11	5676.13	Do.
Detroit City	46 50.3	95 51.8	1900.72	75 26.0	15722	11	5676.13	Do.
Glyndon	46 52.4	96 35	1900.71	75 41.7	15714	11	5676.13	Do.
Walker	47 06.8	94 36.0	1900.74	76 10.1	15064	11	5676.13	Do.
Crookston	47 48.7	96 36.8	1900.71	76 14.3	14982	11	5676.13	Do.

MISSISSIPPI.

Brookhaven	31 34.9	90 26.8	1901.24	61 46.8	26726	18	56.13	W. Weinrich
Ellisville	31 36.6	89 12.0	1901.27	62 01.9	26533	18	56.13	Do.
Jackson	32 20.0	90 11.1	1901.23	63 10.1	25804	18	56.13	Do.

*A small magnetic observing house on the grounds of the International Geodetic Association latitude station. Magnetic observations were made here once a week from November, 1899, to April, 1900. For a year after that date eye readings of declination were made daily.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

MISSISSIPPI—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Forest	32 21.6	89 28.0	1901.25	62 44.8	26137	18	56.13	W. Weinrich
Meridian	32 23.2	88 44.2	1901.26	62 47.0	26173	18	56.13	Do.
Yazoo City	32 51.4	90 21.3	1901.22	62 58.5	26051	18	56.13	Do.
Winona	33 29.8	89 43.3	1901.21	63 47.9	25523	18	56.13	Do.
West Point	33 36.3	88 39.0	1901.20	64 05.5	25297	18	56.13	Do.
Tupelo	34 15.8	88 43.4	1901.18	64 35.7	25008	18	56.13	Do.
Oxford	34 22.1	89 32.2	1901.18	65 00.1	24876	18	56.13	Do.
Holly Springs	34 47.0	89 25.6	1901.16	65 30.4	24444	18	56.13	Do.

MISSOURI.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
St. Louis	38 38.4	90 16.0	1900.92	69 24.4	21284	20	5677.12	W. F. Wallis
Harrisonville	38 39.2	94 18.4	1900.89	68 33.9	22140	20	5677.12	Do.
Hermann	38 42.6	91 24.6	1900.91	69 14.4	21455.	20	5677.12	Do.
Sedalia	38 42.7	93 13.6	1900.89	68 43.9	22067	20	5677.12	Do.
Kansas City	39 05.6	94 32.9	1900.83	69 07.1	21845	20	5677.12	Do.
Macon	39 45.2	92 26.7	1900.81	70 01.9	20785	20	5677.12	Do.
Chillicothe	39 47.4	93 33.1	1900.82	70 10.6	20708	20	5677.12	Do.
Palmyra	39 47.8	91 31.7	1900.80	70 08.4	20724	20	5677.12	Do.
Lancaster	40 30.9	92 31.4	1900.79	70 29.6	20526	20	5677.12	Do.

MONTANA.

[No observations.]

NEBRASKA.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
Superior	40 01.8	98 02	1900.62	69 10.4	21598	11	5676.13	W. C. Bauer
Lincoln	40 49.2	96 42.3	1900.66	70 26.6	20533	11	5676.13	J. W. Miller
York	40 52.5	97 34	1900.61	70 12.3	20860	11	5676.13	W. C. Bauer
Chappell	41 06	102 27.7	1900.81	69 23.1	21300	17	4655.12	W. M. Brown
Ogallala	41 08	101 42.7	1900.81	69 53.5	20816	17	4655.12	Do.
Sidney	41 09.4	102 59.6	1900.81	69 31.5	21227	17	4655.12	Do.
St. Paul	41 12.4	98 27	1900.62	70 28.6	20647	11	5676.13	W. C. Bauer
Kimball	41 14.5	103 38.2	1900.82	69 30.7	21183	17	4655.12	W. M. Brown
Omaha, High School Grounds	41 15.8	95 56.5	1900.60	71 06.4			4655.12	Do.
Omaha, P. H. Cemetery	41 16.2	95 57.6	1900.60	71 10.0	19821	17	4655.12	Do.
Omaha, P. H. Cemetery	41 16.2	95 57.6	1900.70	71 08.6	19814	20	5677.12	W. F. Wallis
Omaha, south of cemetery	41 16.2	95 57.6	1900.70	71 10.4	19816	20	5677.12	Do.
Broken Bow	41 23.0	99 36.2	1900.70	70 06.6	20730	17	4655.12	W. M. Brown
Schuyler	41 25.8	97 03.5	1900.61	71 01.8	19942	17	4655.12	Do.
Gandy	41 27.6	100 26.9	1900.72	70 03.0	20897	17	4655.12	Do.
Hartman	41 29.2	102 20.7	1900.80	69 47.9	20922	17	4655.12	Do.
Tryon	41 33.6	100 58.0	1900.72	70 09.9	20758	17	4655.12	Do.
Harrisburg	41 33.7	103 45.0	1900.79	69 52.3	20939	17	4655.12	Do.
T. 19 R. 37	41 38.2	101 32.3	1900.73	70 05.7	20730	17	4655.12	Do.
Bridgeport	41 39.6	103 05.3	1900.79	69 50.6	20864	17	4655.12	Do.
Albion	41 41.4	97 59.4	1900.61	70 40.9	20239	17	4655.12	Do.
Burwell	41 45.5	99 11.6	1900.66	70 41.1	20218	17	4655.12	Do.
Gering	41 49.3	103 40.3	1900.78	69 58.7	20707	17	4655.12	Do.
Bartlett	41 52.3	98 33.0	1900.65	71 04.0	19847	17	4655.12	Do.
Brewster	41 56.2	99 49.5	1900.71	70 44.1	20230	17	4655.12	Do.
Hyannis	41 59	101 46.1	1900.73	70 28.8	20407	17	4655.12	Do.
Thedford	41 59.1	100 30.6	1900.70	70 44.8	20241	17	4655.12	Do.
School section 36	42 00	99 21	1900.66	70 57.5	19993	17	4655.12	Do.
Mullen	42 02.4	101 00.4	1900.70	70 38.8	20304	17	4655.12	Do.
Alliance	42 05.8	102 51.1	1900.70	70 16.3	20525	17	4655.12	Do.
Neligh	42 08	98 01.5	1900.62	71 01.4	20036	17	4655.12	Do.
Hewitt	42 15.3	103 58.8	1900.78	70 33.1	20587	17	4655.12	Do.
Marsland	42 26.4	103 16.5	1900.77	70 31.8	20359	17	4655.12	Do.
Spring Lake Ranch	42 26.4	102 04.3	1900.76	70 31.1	20384	17	4655.12	Do.
O'Neill	42 27.3	98 39.0	1900.63	71 13.8	20309	17	4655.12	Do.
Keystone Ranch	42 28	102 48	1900.77	70 37.3	20314	17	4655.12	Do.
Kennedy	42 31.3	100 50.3	1900.68	71 12.5	19829	17	4655.12	Do.
Ainsworth	42 33.0	99 52.2	1900.67	71 12.6	19826	17	4655.12	Do.
Newport	42 35.8	99 20.2	1900.63	71 18.2	19728	17	4655.12	Do.
Harrison	42 40.8	103 52.8	1900.77	70 36.9	20179	17	4655.12	Do.
Rushville	42 42.8	102 28.6	1900.75	70 52.2	20023	17	4655.12	Do.
Spring View	42 48.9	99 44.6	1900.67	71 31.1	19528	17	4655.12	Do.
Valentine	42 52.4	100 33.7	1900.68	71 32.8	19436	17	4655.12	Do.
Merriman	42 54.6	101 43.5	1900.75	71 34.2	19516	17	4655.12	Do.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

NEVADA.

[No observations.]

NEW HAMPSHIRE.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Hanover	43 42.3	72 17.3	1898.83	74 28.4	16263	19	5677.12	E. Smith

NEW JERSEY.

[No observations.]

NEW MEXICO.

Carlsbad	32 25.7	104 14.7	1901.91	60 19.2	27522	10	15.12	E. D. Preston
Carlsbad	32 25.7	104 14.7	1902.08	60 17.4	27521	10	15.24	Do.
Carlsbad	32 25.7	104 14.7	1902.09		27548	11		Do.
McMillan	32 39.6	104 21.6	1902.10	60 41.3	27162	11	15.24	Do.
Hope	32 48.5	104 45.2	1902.26	60 45.8	27176	11	15.24	Do.
Stegman	32 51.4	104 24.7	1902.27	60 52.2	27083	11	15.24	Do.
Alamogordo	32 54.4	105 59.1	1902.21	60 10.2	27450	11	15.24	Do.
Upper Penasco	32 54.6	105 29.4	1902.24	60 26.5	27502	11	15.24	Do.
Lower Penasco	32 54.8	105 14.6	1902.25	60 32.7	27266	11	15.24	Do.
Tularosa	33 05.4	106 02.1	1902.23	60 31.9	27074	11	15.24	Do.
Hagerman	33 07.6	104 17.6	1902.11	61 07.3	26957	11	15.24	Do.
Hagerman	33 07.6	104 17.6	1902.29	61 08.2	26970	11	15.24	Do.
Mescalero	33 11.2	105 47.6	1902.22	60 37.3	27199	11	15.24	Do.
Picacho	33 21.4	105 09.0	1902.15	61 30.9	26776	11	15.24	Do.
Roswell	33 24.4	104 31.7	1901.92	61 24.9	26791	10	15.12	Do.
Roswell	33 24.4	104 31.7	1902.12	61 22.9	26830	11	15.24	Do.
Lincoln	33 31.0	105 24.2	1902.16	61 30.9	26794	11	15.24	Do.
Capitan	33 34.6	105 34.8	1902.18	61 57.3	26462	11	15.24	Do.
Campbell	33 37.3	104 14.8	1902.14	61 36.5	26746	11	15.24	Do.
Fort Craig	33 38.0	107 00	1899.96	61 02.9	26772	19	5677	J. A. Fleming
Carrizozo Ranch	33 41.7	105 53.0	1902.20	61 21.6	26801	11	15.24	E. D. Preston
White Oaks	33 45.8	105 43.9	1902.19	61 33.3	26678	11	15.24	Do.
Kenna	33 53.1	103 47.4	1902.13	62 06.1	26421	11	15.24	Do.
Socorro	34 04.6	106 53	1899.95	61 32.2	26508	19	5677	J. A. Fleming
Portales	34 12	103 20	1901.93	62 45.7	26008	10	15.12	E. D. Preston
Albuquerque	35 06.4	106 39	1899.93	62 42.2	25917	19	5677	J. A. Fleming
Grant	35 10.2	107 51	1899.94	62 45.2	25546	19	5677	Do.
Fort Wingate	35 29.0	108 32	1899.94	63 00.9	25697	19	5677	Do.
East Las Vegas	35 34.9	105 14	1899.97	63 49.6	25368	19	5677	Do.
Santa Fe	35 41.1	105 56.8	1899.92	63 36.6	25430	19	5677	Do.
Springer	36 21.9	104 36	1899.98	64 10.2	25280	19	5677	Do.
Clayton	36 27.3	103 10	1899.99	64 59.2	24350	19	5677	Do.
Tres Piedras	36 41.5	105 57	1899.92	64 20.9	24805	19	5677	Do.
Lumberton	36 57.4	106 55	1899.91	64 37.8	24622	19	5677	Do.

NEW YORK.

[No observations.]

NORTH CAROLINA.

Southport	33 55.0	78 00.9	1898.59	65 41.8	23770	20	5676	J. B. Baylor
Wilmington	34 14.2	77 57	1898.58	66 16.0	23318	20	5676	Do.
Whiteville	34 19.4	78 42	1899.90	65 49.3	23768	20	5676	Do.
Burgaw	34 32.0	77 55	1899.52	66 32.5	23337	20	5676	Do.
Elizabethtown	34 35.7	78 32	1899.89	66 22.0	23279	20	5676	Do.
Lumberton	34 36.0	78 58	1899.88	66 01.7	23654	20	5676	Do.
Beaufort	34 43.1	76 40.1	1898.31	66 27.1	23082	19	5678	C. C. Yates
Jacksonville	34 44.5	77 22	1898.56	66 25.5	23294	20	5676	J. B. Baylor
Laurinburg	34 47.0	79 28	1899.86	66 30.2	23319	20	5676	Do.
Rockingham	34 54.5	79 46	1899.57	66 25.3	23281	20	5676	Do.
Kenansville	34 58.0	77 58	1899.51	66 56.7	22909	20	5676	Do.
Monroe	34 58.3	80 34	1899.58	66 10.7	23654	20	5676	Do.
Clinton	35 00.2	78 19	1899.50	66 50.5	22987	20	5676	Do.
Hayesville	35 01.8	83 49	1900.71	66 13.4	23893	18	56.13	Do.
Fayetteville	35 03.4	78 52	1899.41	66 48.0	23132	20	5676	Do.
Trenton	35 03.5	77 21	1900.85	66 51.2	22843	18	56.13	Do.
Murphy	35 05.0	84 03	1898.73	66 52.5	23335	20	5676	Do.
Newbern	35 06.8	77 03	1898.52	67 07.3	22741	20	5676	Do.
Bayboro	35 08.0	76 45	1898.53	67 00.8	22842	20	5676	Do.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

NORTH CAROLINA—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observer.
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Franklin	35 10.9	83 23	1898.74	66 24.2	23302	20	5676	J. B. Baylor
Charlotte	35 12.7	80 51	1899.61	66 33.8	23138	20	5676	Do.
Brevard	35 14	82 44	1898.78	66 15.1	23565	20	5676	Do.
Columbus	35 14.8	82 10	1900.77	66 24.1	23449	18	56.13	Do.
Kinston	35 15.5	77 35	1899.38	67 04.0	22868	20	5676	Do.
Cape Hatteras L. H.	35 16.0	75 32	1898.45	67 09.0	22457	20	5676	Do.
Shelby	35 17.0	81 33	1899.63	66 43.1	23352	20	5676	Do.
Dallas	35 19.1	81 13	1900.78	66 31.6	23196	18	56.13	Do.
Hendersonville	35 19.2	82 28	1900.76	66 21.3	23572	18	56.13	Do.
Carthage	35 19.7	79 25	1899.55	66 45.7	23039	20	5676	Do.
Robbinsville	35 19.7	83 47	1900.70	66 33.6	23464	18	56.13	Do.
Webster	35 21	83 14	1898.76	66 48.1	23258	20	5676	Do.
Albemarle	35 21.5	80 12	1900.82	66 41.1	23307	18	56.13	Do.
Rutherfordton	35 21.6	81 57	1899.64	66 44.4	23392	20	5676	Do.
Troy	35 21.7	79 52	1899.77	66 39.6	23332	20	5676	Do.
Lillington	35 22.2	78 47	1899.92	66 48.0	22967	20	5676	Do.
Goldsboro	35 23.0	77 59	1899.40	67 01.6	22906	20	5676	Do.
Swanquarter	35 23.7	76 19	1898.46	67 14.2	22582	20	5676	Do.
Concord	35 23.7	80 35	1899.65	67 08.8	22637	20	5676	Do.
Bryson City	35 25	83 27	1898.71	66 36.1	23407	20	5676	Do.
Snowhill	35 28.0	77 37	1899.48	67 08.1	23168	20	5676	Do.
Lincolnton	35 28.0	81 16	1899.61	66 47.4	23226	20	5676	Do.
Waynesville	35 29.6	82 59	1900.69	66 51.9	23171	18	56.13	Do.
Smithfield	35 31.7	78 21	1899.43	66 12.2	23766	20	5676	Do.
Washington	35 32.8	77 03	1898.48	67 16.7	22512	20	5676	Do.
Chicamicomico	35 34.7	75 28	1898.44	67 21.0	22558	20	5676	Do.
Asheville	35 35.4	82 32	1898.67	66 57.8	23218	20	5676	Do.
Greenville	35 36.2	77 22	1898.50	67 19.9	22610	20	5676	Do.
Salisbury	35 39.0	80 32	1898.63	67 13.0	22615	20	5676	Do.
Newton	35 40.3	81 13	1900.79	66 53.4	23118	18	56.13	Do.
Marion	35 40	82 01	1898.64	66 39.9	23376	20	5676	Do.
Ashboro	35 42.0	79 49	1899.75	67 13.0	22817	20	5676	Do.
Pittsboro	35 43.0	79 11	1899.54	67 10.9	22927	20	5676	Do.
Morganton	35 43.6	81 41	1900.67	66 59.5	23104	18	56.13	Do.
Wilson	35 44.0	77 55	1899.37	67 34.5	22610	20	5676	Do.
Statesville	35 46.7	80 53	1899.67	67 14.4	23032	20	5676	Do.
Marshall	35 47.3	82 40	1898.69	67 04.9	23089	20	5676	Do.
Raleigh	35 47.5	78 36	1899.44	67 11.0	22778	20	5676	Do.
Williamston	35 50.1	77 02	1899.93	67 39.5	22323	20	5676	Do.
Lexington	35 50.1	80 16	1900.83	67 08.5	22830	18	56.13	Do.
Plymouth	35 51.7	76 44	1898.36	67 34.4	22348	20	5676	Do.
Mocksville	35 53.1	80 34	1900.81	66 48.3	23102	18	56.13	Do.
Tarboro	35 53.5	77 37	1899.34	67 58.2	22180	20	5676	Do.
Lenoir	35 53.7	81 32	1900.66	67 12.6	23022	18	56.13	Do.
Chapelhill	35 54.2	79 03	1898.23	67 50.2	22116	20	5676	Do.
Burnsville	35 54.5	82 17	1900.73	67 16.2	22910	18	56.13	Do.
Manteo	35 54.8	75 40	1898.44	67 33.6	22268	20	5676	Do.
Columbia	35 55	76 15	1899.26	67 26.4	22544	20	5676	Do.
Taylorsville	35 55.4	81 10	1900.80	67 09.9	22886	18	56.13	Do.
Windsor	35 55.9	76 59	1898.37	67 38.6	22490	20	5676	Do.
Rockymount	35 56.3	77 48.4	1900.41	67 39.0	22312	18	56.13	J. A. Fleming
Nashville	35 58.3	77 58	1899.36	67 44.0	22019	20	5676	J. B. Baylor
Bakersville	36 00.6	82 09	1900.74	67 22.0	22877	18	56.13	Do.
Durham	36 03.1	78 55	1898.27	67 41.6	22647	20	5676	Do.
Louisburg	36 03.2	78 19	1899.95	67 40.8	22368	20	5676	Do.
Graham	36 03.5	79 24	1899.97	67 12.0	23081	20	5676	Do.
Greensboro	36 03.9	79 49	1899.73	67 56.8	22272	20	5676	Do.
Edenton	36 04	76 36	1898.38	67 48.9	22209	20	5676	Do.
Hillsboro	36 04.5	79 05	1898.28	68 30.6	21968	20	5676	Do.
Winston-Salem	36 05.8	80 15	1899.69	67 28.5	22656	20	5676	Do.
Yadkinville	36 08.1	80 39	1900.61	67 27.5	22710	18	56.13	Do.
Wilkesboro	36 08.6	81 09	1899.71	67 40.1	22653	20	5676	Do.
Hertford	36 11	76 28	1899.25	67 53.4	22146	20	5676	Do.
Boone	36 13.4	81 41	1900.65	67 51.1	22357	18	56.13	Do.
Elizabeth City	36 17.7	76 13	1898.40	68 03.8	22074	20	5676	Do.
Oxford	36 18.5	78 38	1898.32	67 48.6	22372	20	5676	Do.
Halifax	36 18.8	77 38	1899.33	67 54.6	22188	20	5676	Do.
Camden	36 18.9	76 12	1900.88	67 58.3	22012	18	56.13	Do.
Henderson	36 21.6	78 22	1899.94	67 54.7	22192	20	5676	Do.
Roxboro	36 22.6	78 59	1898.30	67 58.4	22066	20	3676	Do.
Jackson	36 23.0	77 29	1899.31	68 02.5	22165	20	5676	Do.
Gatesville	36 23.2	76 48	1899.28	68 09.7	22219	20	5676	Do.
Winton	36 23.6	76 59	1899.29	68 13.4	22196	20	5676	Do.
Wentworth	36 23.6	79 47	1899.74	67 46.3	22440	20	5676	Do.
Jefferson	36 23.7	81 28	1900.64	67 44.7	22356	18	56.13	Do.
Warrenton	36 24.1	78 09	1898.34	68 02.0	22056	20	5676	Do.
Yanceyville	36 24.1	79 22	1900.58	67 55.1	22088	18	56.13	Do.
Danbury	36 26.4	80 12	1900.60	67 54.5	22163	18	56.13	Do.
Currituck	36 26.8	76 01	1898.41	68 17.6	21866	20	5676	Do.
Mountairy	36 30	80 37	1899.70	67 58.0	22263	20	5676	Do.
Sparta	36 31.4	81 09	1900.62	67 47.0	22356	18	56.13	Do.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

NORTH DAKOTA.

[No observations.]

OHIO.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Portsmouth	38 44.6	82 58.7	1900.51	70 35.6	20094	19	5678.34	J. W. Miller
Cincinnati	39 08.4	84 25.3	1899.64		20559	19		H. W. Vehrenkamp
Athens	39 19.7	82 05.9	1898.44	70 35.5	20172	19	5677	E. Smith
Chillicothe	39 20.3	82 58.7	1900.52	70 31.1	20252	19	5678.34	J. W. Miller
Marietta	39 25.4	81 28.2	1898.45	70 48.2	20090	19	5677	E. Smith
Washington	39 33.5	83 24.7	1900.53	70 28.4	20256	19	5678.34	J. W. Miller
Dayton	39 46.5	84 15.4	1900.49	70 56.5	19949	20	5677.12	Fleming & Wallis
Columbus	39 59.0	83 01.2	1900.48	70 37.4	20212	20	5677.12	Do.
Newark	40 03.7	82 25.7	1900.48	70 54.2	20000	20	5677.12	Do.
Bellefontaine	40 22.0	83 46	1900.53	71 22.4	19300	19	5678.34	J. W. Miller
Tuscarawas	40 24.4	81 24.5	1900.48	71 35.8	19184	20	5677.12	Fleming & Wallis
Marion	40 34.2	83 07.4	1900.54	71 40.9	19224	19	5678.34	J. W. Miller
Ashland	40 48.1	82 20	1900.55	72 13.0	18814	19	5678.34	Do.
Akron	41 05.3	81 33	1900.57	72 07.6	18750	19	5678.34	Do.
Warren	41 15	80 50	1900.59	72 27.8	18384	19	5678.34	Do.
Cleveland	41 30.4	81 41.5	1900.57	72 29.6	18496	19	5678.34	Do.
Jefferson	41 44.2	80 47.8	1900.58	72 36.0	18496	19	5678.34	Do.

OKLAHOMA.

Mangum	34 52.0	99 30.9	1900.93	63 30.1	25815	17	4655.12	W. C. Dibrell
Cheyenne	35 37	99 39.7	1900.92	64 38.4	24914	17	4655.12	Do.
Perry	36 16.3	97 20.0	1901.63	65 42.5			15.12	J. M. Kuehne
Woodward	36 26.9	99 22.7	1900.91	65 45.0	24105	17	4655.12	W. C. Dibrell
Beaver	36 49.1	100 30.3	1900.90	65 45.1	24038	17	4655.12	Do.

OREGON.

Portland	45 31.4	122 42.2	1900.89	68 39.5	21375	4	21.12	W. Weinrich

PENNSYLVANIA.

Gettysburg	39 51.9	77 14.2	1901.80	71 00.4	19594	11	21.12	J. W. Miller
Waynesburg	39 54	80 10.4	1901.88	71 09.6	19714	11	21.12	Do.
Uniontown	39 54	79 43	1901.89	71 13.9	19562	11	21.12	Do.
Westchester	39 55.3	75 35.4	1901.76	71 07.3	19438	11	21.12	Do.
Chambersburg	39 55.9	77 38.9	1900.44	71 12.6	19476	18	56.13	Fleming & Dibrell
York	39 59.4	76 45.0	1901.79	71 16.1	19330	11	21.12	J. W. Miller
Somerset	40 01	79 04.8	1901.89	71 13.4	19508	11	21.12	Do.
Bedford	40 01	78 30.6	1901.90	70 53.8	19818	11	21.12	Do.
Lancaster	40 02.8	76 18.4	1901.76	71 08.0	19363	11	21.12	Do.
Fannettsburg	40 03.3	77 48.1	1900.45	71 18.5	19426	18	56.13	Fleming & Dibrell
Hatboro	40 10.6	75 04.9	1900.50	71 28.7	19181	18	56.13	W. C. Dibrell
Washington	40 11	80 16	1901.87	71 46.7	19161	11	21.12	J. W. Miller
Carlisle	40 13.3	77 11.7	1901.81	71 39.0	19188	11	21.12	Do.
Harrisburg	40 15.5	76 53.3	1901.78	71 40.0	19025	11	21.12	Do.
Greensburg	40 17.4	79 34.8	1901.86	71 36.8	19130	11	21.12	Do.
Reading	40 17.9	75 56.0	1900.49	71 42.6	18999	18	56.13	W. C. Dibrell
Andersonburg	40 20.7	77 27.1	1900.45	71 35.3	19154	18	56.13	Fleming & Dibrell
Lebanon	40 21.0	76 25	1901.77	71 30.9	19083	11	21.12	J. W. Miller
Newport	40 27.3	77 07.3	1900.45	71 55.1	18804	18	56.13	Fleming & Dibrell
Ebensburg	40 29.0	78 43.5	1901.85	71 44.5	18908	11	21.12	J. W. Miller
Huntingdon	40 29.2	78 01.2	1900.46	71 35.9	19195	18	56.13	Fleming & Dibrell
Altoona	40 30.7	78 23.4	1900.47	71 44.3	19174	18	56.13	W. C. Dibrell
Lewistown	40 36.3	77 33.9	1900.46	71 52.7	18866	18	56.13	Fleming & Dibrell
Indiana	40 39	79 12	1901.85	71 52.6	18947	11	21.12	J. W. Miller
Pottsville	40 41.2	76 12.4	1900.49	71 51.5	18774	18	56.13	W. C. Dibrell
Middleburg	40 48.4	77 03.3	1901.81	72 01.2	18693	11	21.12	J. W. Miller
Ingleby	40 49.1	77 25.5	1900.48	71 53.3	18878	18	56.13	W. C. Dibrell
Bellefonte	40 55.0	77 47.1	1900.47	71 57.3	18835	18	56.13	Do.
Bellefonte	40 55.0	77 47.1	1901.83	72 01.0	18810	11	21.12	J. W. Miller
Lewisburg	40 56.4	76 52.4	1900.48	72 03.0	18680	18	56.13	W. C. Dibrell
Clearfield	41 02.6	78 25.6	1901.84	72 12.1	18630	11	21.12	J. W. Miller
Lockhaven	41 09.3	77 25.9	1901.83	72 07.2	18661	11	21.12	Do.
Williamsport	41 14	77 02	1901.82	72 05.5	18701	11	21.12	Do.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
PHILIPPINE ISLANDS.								
	° ′	° ′		° ′	γ			
Masbate, Masbate	12 22	123 37	1902.33	11 27.0	37643	18	5677.3	J. S. Hill
Manila, Luzon	14 35.5	120 58.6	1902.39	16 13.2			5677.12/34	C. C. Yates
PORTO RICO.								
Ponce	18 01	66 36.5	1901.44	48 34.1	30210	11	21.12	W. C. Dibrell
Aibonita	18 07.7	66 15.8	1901.46	49 18.5	29666	11	21.12	Do.
Vieques Island	18 08.2	65 26.6	1901.38	49 16.0	29444	11	21.12	Do.
Culebra	18 18.8	65 17.0	1901.43	46 18.2	30113	11	21.12	Do.
San Juan	18 27.8	66 08.2	1901.04	49 48.2	29454	11	21.12	Do.
San Juan	18 27.8	66 08.2	1901.47	49 45.9			21.12	Do.
RHODE ISLAND.								
Boston Neck	41 27.1	71 26.4	1899.60	72 47.5	17687	3	18.12	D. L. Hazard
McSparran	41 29.8	71 27.4	1899.65	72 36.6	17640	3	18.12	Do.
SOUTH CAROLINA.								
Woods	32 23.2	80 40.7	1902.27	63 37.8	25225	10	21.12	O. B. French
Bay Point	32 29.6	80 20.5	1902.25	64 12.9	24954	10	21.12	Do.
Charleston	32 46.4	79 48.8	1902.35	64 08.3	24957	10	21.12	Do.
Live Oak	33 03.3	79 31.0	1902.34	64 25.1	24678	10	21.12	Do.
Columbia	33 59.9	81 02.0	1900.22	65 23.7	23905	19	5678.23	D. L. Hazard
Pelham	34 52.0	82 13.3	1896.90	65 54.9	23784	20	21	W. C. Hodgkins
Greers	34 56.6	82 13.1	1896.90	65 58.7	23780	20	21	Do.
Wofford	34 57.5	81 56.1	1896.92	66 02.4	23656	20	21	Do.
Flint Rock	34 59.0	82 13.0	1896.91	66 00.0	23773	20	21	Do.
Gold Mine	35 01.9	82 12.9	1896.92	66 17.7	23561	20	21	Do.
Gowensville	35 06.8	82 12.8	1896.89	66 13.8	23609	20	21	Do.
Talent	35 09.0	82 12.7	1896.93	66 17.0	23572	20	21	Do.
Block House	35 12.0	82 12.6	1896.88	66 19.8	23475	20	21	Do.
SOUTH DAKOTA.								
Sioux Falls	43 32.6	96 43.5	1900.66	72 40.9	18279	11	5676.13	J. W. Miller
Huron	44 21.1	98 14.0	1900.67	73 07.5	18143	11	5676.13	Do.
Redfield	44 52.6	98 31.0	1900.67	74 02.8	17189	11	5676.13	Do.
Watertown	44 55.2	97 06.3	1900.68	74 06.0	17302	11	5676.13	Do.
Gettysburg	45 01.6	99 57.8	1900.68	73 26.6	17748	11	5676.13	Do.
TENNESSEE.								
Chattanooga	35 01.4	85 18.0	1900.44	65 52.1	24202	19	5678.34	D. L. Hazard
Memphis	35 07.8	90 04.3	1901.15	65 34.1	24348	18	56.13	W. Weinrich
Knoxville	35 57.0	83 55.6	1900.45	66 36.3	23416	19	5678.34	D. L. Hazard
Lebanon North Base	36 12.8	86 18.4	1898.25	66 48.3	23459	3	12.	A. H. Buchanan
Careyville	36 18	84 13	1900.46	67 45.4	22698	19	5678.34	D. L. Hazard
TEXAS.								
Cotulla	28 26.8	99 14	1901.98	56 26.3	29386	10	15.2	E. D. Preston
Carrizo Springs	28 30	99 51	1902.00	56 08.1	29514	10	15.2	Do.
Eagle Pass	28 43.6	100 30	1901.95	56 39.6	29315	10	15.2	Do.
Eagle Pass	28 43.6	100 30	1902.02	56 39.1	29361	10	15.2	Do.
Victoria	28 47.9	97 00.1	1901.72	57 47.2	28680	10	15.12	J. M. Kuehne
Karnes City	28 52.8	97 53.6	1901.74	57 19.6	29066	10	15.12	Do.
Pearsall	28 55	99 09	1901.97	57 10.2	29030	10	15.2	E. D. Preston
Edna	28 57.7	96 40.4	1901.72	57 55.2	28822	10	15.12	J. M. Kuehne
Cuero	29 05.6	97 16.6	1901.69	57 40.4	28861	10	15.12	Do.
Lindenau	29 07.6	97 22.3	1901.72	57 43.6	28833	10	15.12	Do.

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

TEXAS—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments. Mag'r.	Instruments. Dip circle.	Observer.
	° ′	° ′		° ′	γ			
Uvalde	29 13	99 48	1901.85	57 35.6	28867	10	15.12	E. D. Preston
Hondo	29 19	99 05	1901.83	57 41.1	28819	10	15.12	Do.
Brackettville	29 18.8	100 25	1901.87	57 23.4	28898	10	15.12	Do.
Del Rio	29 22.2	100 52	1901.89	57 16.8	29210	10	15.12	Do.
Hallettsville	29 27.4	96 56.7	1901.71	58 13.3	28594	10	15.12	J. M. Kuehne
Gonzales	29 30.0	97 26.4	1901.70	58 11.5	28689	10	15.12	Do.
Bandera	29 44	99 05.2	1901.47	58 15.8	28719	20	4655.12	F. M. Little
Kerrville	30 01	99 08	1901.47	59 02.7	27914	20	4655.12	Do.
Rock Springs	30 01	100 12	1901.49	58 19.1	28667	20	4655.12	Do.
Marathon	30 13.6	103 16	1902.02	58 17.1	28353	10	15.22	E. D. Preston
Fredericksburg	30 15	98 53.0	1901.47	59 02.2	28341	20	4655.12	F. M. Little
Austin	30 15.0	97 45.4	1901.36	59 09.6	28211	20	4655.12	Wallis & Little
Austin B	30 17.0	97 43.0	1901.80	59 13.9	28174	10	15.12	E. D. Preston
Marfa	30 19.8	104 01	1902.04	58 03.9	28480	10	15.22	Do.
Alpine	30 22.2	103 40	1901.94	58 48.3	27884	10	15.12	Do.
Alpine	30 22.2	103 40	1902.03	58 44.0	27970	10	15.22	Do.
Junction City	30 28.6	99 53.4	1901.51	58 51.3	28253	20	4655.12	F. M. Little
Sonora	30 35.0	100 39.9	1901.54	59 00.1	28409	20	4655.12	Do.
Valentine	30 35	104 30	1902.06	58 06.7	28559	10	15.22	E. D. Preston
Ozona	30 43.0	101 13.8	1901.54	59 16.4	28132	20	4655.12	F. M. Little
Llano	30 44	98 41	1901.45	59 34.3	28071	20	4655.12	Do.
Mason	30 45	99 14	1901.46	59 13.4	28206	20	4655.12	Do.
Eldorado	30 52.0	100 39.2	1901.53	59 40.1	27905	40	4655.12	Do.
Menardville	30 54	99 51.4	1901.52	59 23.6	27864	20	4655.12	Do.
Lampasas	31 01	98 11	1901.35	60 06.6	27532	20	4655.12	Wallis & Little
Belton	31 03.5	97 28.2	1901.34	60 00.8	27642	20	4655.12	Do.
Kent	31 04.2	104 14.2	1902.06	58 52.0	28285	10	15.22	E. D. Preston
Brady	31 07.5	99 21.0	1901.44	59 40.1	28051	20	4655.12	F. M. Little
San Saba	31 11.1	98 43	1901.45	60 09.5	27724	20	4655.12	Do.
Sherwood	31 17	100 48.4	1901.55	59 36.4	28024	20	4655.12	Do.
Pecos	31 26.0	103 33	1901.90	59 23.7	27815	10	15.12	E. D. Preston
San Angelo	31 27.8	100 26.4	1901.56	59 52.9	27918	20	4655.12	F. M. Little
Paint Rock	31 30.2	99 55.0	1901.41	60 18.2	27585	20	4655.12	Do.
Groesbeck	31 31.5	96 31.0	1901.33	60 39.4	27490	20	4655.12	Wallis & Little
Ballinger	31 44.8	99 58.0	1901.40	60 17.3	27525	20	4655.12	F. M. Little
Guadalupe	31 48.9	103 54.6	1902.07	59 33.6	27881	10	15.22	E. D. Preston
Coleman	31 49.7	99 25.0	1901.30	60 42.4	27414	20	4655.12	Wallis & Little
Coleman	31 49.7	99 25.0	1901.39	60 43.4	27447	20	4655.12	F. M. Little
Coleman	31 49.7	99 25.0	1901.60	60 43.9	27428	20	4655.12	Do.
Sterling City	31 50.6	100 59.5	1901.61	60 27.8	27392	20	4655.12	Do.
Garden City	31 51.5	101 28.8	1901.62	60 19.9	27345	20	4655.12	Do.
Robert Lee	31 53.8	100 28.9	1901.61	60 22.3	27513	20	4655.12	Do.
Stephenville	32 12.7	98 12.4	1901.31	61 20.0	27113	20	4655.12	Wallis & Little
Big Springs	32 15.2	101 28.4	1901.62	60 45.5	27155	20	4655.12	F. M. Little
Colorado	32 23.4	100 52.2	1900.96	61 16.0	26952	17	4655.12	W. C. Dibrell
Colorado	32 23.4	100 52.2	1901.64	61 14.8	26904	20	4655.12	F. M. Little
Kaufman	32 34.7	96 19.3	1901.32	61 57.9	26734	20	4655.12	Wallis & Little
Snyder	32 42.6	100 55.7	1901.65	61 01.6	27125	20	4655.12	F. M. Little
Albany	32 43.3	99 18.5	1901.66	61 43.3	26936	20	4655.12	Do.
Roby	32 44.7	100 22.1	1901.65	61 42.5	26613	20	4655.12	Do.
Anson	32 45.2	99 53.7	1901.66	61 48.9	26570	20	4655.12	Do.
Breckenridge	32 45.8	98 53.4	1901.67	61 31.6	26880	20	4655.12	Do.
Palo Pinto	32 46	98 17.1	1901.68	62 00.4	26439	20	4655.12	Do.
Mineral Wells	32 48.5	98 05.6	1901.69	61 55.0	26668	20	4655.12	Do.
Graham	33 04.5	98 35.2	1901.70	62 14.5	26376	20	4655.12	Do.
Aspermont	33 07.3	100 13.2	1900.95	61 41.5	26706	17	4655.12	W. C. Dibrell
Aspermont	33 07.3	100 13.2	1901.72	61 41.9	26706	20	4655.12	F. M. Little
Haskell	33 09.7	99 42.6	1901.71	62 04.2	26590	20	4655.12	Do.
Clairemont	33 09.7	100 44.8	1901.72	61 50.4	26531	20	4655.12	Do.
Throckmorton	33 11.1	99 09.8	1901.71	62 08.8	26469	20	4655.12	Do.
Jacksboro	33 13.2	98 08.7	1901.69	62 28.1	26344	20	4655.12	Do.
Texarkana	33 26.2	94 03.4	1901.34	63 10.8	25936	18	56.13	W. Weinrich
Benjamin	33 34.4	99 47.5	1901.74	62 45.2	25907	20	4655.12	F. M. Little
Seymour	33 35.7	99 16.0	1900.94	62 37.3	26012	17	4655.12	W. C. Dibrell
Seymour	33 35.7	99 16.0	1901.75	62 43.1	26016	20	4655.12	F. M. Little
Dickens	33 37.3	100 49.6	1901.73	62 13.5	26394	20	4655.12	Do.
Guthrie	33 37.4	100 19.4	1901.74	62 24.9	26097	20	4655.12	Do.
Gainesville	33 37.1	97 09	1900.04	63 01.2	26312	19	5677	J. A. Fleming
Henrietta	33 49.2	98 12	1900.03	62 55.0	26003	19	5677	Do.
Vernon	34 09.4	99 17.8	1900.01	62 59.8	25911	19	5677	Do.
Vernon	34 09.4	99 17.8	1900.94	63 01.7	25913	17	4655.12	W. C. Dibrell
Memphis	34 44.8	100 32	1900.01	63 22.0	25800	19	5677	J. A. Fleming
Amarillo	35 13.9	101 51	1900.00	63 58.4	25426	19	5677	Do.

UTAH.

[No observations.]

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

VERMONT.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observer.
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Brattleboro	42 48.6	72 34.4	1898.84	73 36.2	17070	19	5677	E. Smith
Rutland	43 36.7	72 59.3	1898.80	74 10.4	16599	19	5677	Do.
Montpelier	44 15.0	72 32.3	1898.82	74 30.2	16192	19	5677	Do.
Burlington	44 28.7	73 11.8	1898.81	74 33.9	16266	19	5677	Do.

VIRGINIA.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Mag'r.	Dip circle.	Observer.
Bristol	36 36.2	82 10.5	1898.35	67 47.8	22360	19	5677.12	E. Smith
Stuart	36 39.4	80 15.9	1901.78	67 47.0	22446	21	24.12	W. F. Wallis
Emporia	36 40.3	77 32	1897.40	68 10.5	21758	20	5676.12	J. B. Baylor
Old Town	36 40.5	80 56.9	1902.48	68 19.5	21852	11	15.24	E. D. Preston
Martinsville	36 42.0	79 52.4	1901.77	67 53.7	22301	21	24.12	W. F. Wallis
Abingdon	36 42.5	81 58.5	1897.58	67 50.0	22376	20	5676.12	O. B. French
Houston	36 46.0	78 55.7	1897.57	68 09.9	22038	20	5676.12	Do.
Hillsville	36 47.2	80 43.8	1902.47	68 27.3	21760	11	15.24	E. D. Preston
Chatham	36 49.6	79 22.9	1901.81	68 17.2	21843	21	24.12	W. F. Wallis
Marion	36 49.6	81 31.4	1898.36	68 06.3	22138	19	5677.12	E. Smith
Norfolk	36 52.4	76 16	1897.39	68 38.9	21560	20	5676.12	J. B. Baylor
Wytheville	36 57.0	81 03.9	1898.37	68 23.8	21854	19	5677.12	E. Smith
Rocky Mount	36 59.9	79 53.1	1901.76	68 33.8	21762	21	24.12	W. F. Wallis
Pulaski	37 03.5	80 47.4	1902.46	68 34.3	21624	11	15.24	E. D. Preston
Smithville	37 03.8	78 39.9	1901.87	68 27.5	21698	21	24.12	W. F. Wallis
Dinwiddie	37 04.9	77 34.6	1901.90	68 39.6	21605	21	24.12	Do.
Tazewell	37 07.3	81 31.1	1898.38	68 24.9	21852	19	5677.12	E. Smith
Christiansburg	37 08	80 23.9	1897.59	68 42.1	21592	20	5676.12	O. B. French
Nottoway	37 08.2	78 05.7	1901.88	68 33.6	21563	21	24.12	W. F. Wallis
Petersburg	37 13.8	77 23.4	1901.89	68 45.9	21285	21	24.12	Do.
Cape Charles	37 15.8	76 01.6	1900.41	69 08.6	21028	17	5676.12	J. B. Baylor
Rustburg	37 17.1	79 05.7	1901.74	68 18.7	22069	21	24.12	W. F. Wallis
Farmville	37 18.4	78 24.6	1901.83	68 40.8	21485	21	24.12	Do.
Salem	37 20.0	80 06.0	1900.41	68 58.8	21304	20	5677.12	J. D. Thompson
Bedford City	37 20.4	79 31.3	1901.75	69 14.7	20964	21	24.12	W. F. Wallis
Bedford City	37 20.4	79 31.3	1902.43	69 14.6	21006	11	15.24	E. D. Preston
Pearisburg	37 20.7	80 44.5	1902.46	68 44.1	21593	11	15.24	Do.
Charles City	37 21.4	77 03.2	1901.66	68 45.3	21281	21	24.12	W. F. Wallis
Amelia	37 21.4	77 59.0	1901.86	68 49.2	21397	21	24.12	Do.
West Appomattox	37 22.0	78 50.1	1901.81	68 35.6	21837	21	24.12	Do.
W. Appomattox S. M.	37 22.0	78 50.1	1901.82	68 30.9			24.12	Do.
Appomattox	37 22.6	78 47.7	1901.82	69 02.6	21465	21	24.12	Do.
Lynchburg	37 24.6	79 09	1901.73	68 56.2	21345	21	24.12	Do.
Fincastle	37 29.5	79 52.9	1902.44	69 10.0	21109	11	15.24	E. D. Preston
Cumberland	37 30.6	78 14.6	1901.84	68 55.0	21406	21	24.12	W. F. Wallis
New Castle	37 30.9	80 06.3	1902.45	68 57.7	21263	11	15.24	E. D. Preston
New Kent	37 31.0	76 59.1	1901.64	69 04.1	21130	21	24.12	W. F. Wallis
Richmond	37 32.6	77 28	1897.36	69 03.4	21238	20	5676.12	J. B. Baylor
Richmond	37 32.6	77 28	1901.63	69 05.0	21160	21	24.12	W. F. Wallis
Powhatan	37 32.8	77 54.9	1901.85	68 55.4	21269	21	24.12	Do.
Buckingham	37 33.6	78 32.4	1901.67	68 45.5	21720	21	24.12	Do.
Amherst	37 35.6	79 03.1	1901.73	69 20.8	21128	21	24.12	Do.
Natural Bridge	37 38.0	79 32.4	1900.32	69 12.6	21086	20	5677.12	Brown & Thompson
Goochland	37 40.8	77 53.7	1901.66	69 05.6	21135	21	24.12	W. F. Wallis
Accomac	37 41.1	75 42	1897.38	69 25.9	20883	20	5676.12	J. B. Baylor
Lovingston	37 45.9	78 52.6	1901.71	69 30.4	20856	21	24.12	W. F. Wallis
Lexington	37 47.3	79 26.8	1897.60	69 32.0	20916	20	5676.12	O. B. French
Covington	37 47.6	79 59.0	1900.33	69 11.0	21110	20	5677.12	J. D. Thompson
Palmyra	37 51.4	78 16.3	1901.68	69 03.2	21370	21	24.12	W. F. Wallis
Palmyra N. M.	37 51.4	78 16.3	1901.68	69 12.8			24.12	Do.
Goshen	37 59.1	79 30.4	1900.48	69 25.8	20875	17	4655.12	W. M. Brown
Milford	38 01.2	77 22.0	1900.34	69 22.2			23.3	J. B. Baylor
Louisa	38 01.5	78 00.5	1901.70	69 25.1	21028	21	24.12	W. F. Wallis
Charlottesville	38 02.6	78 30.3	1897.55	69 41.0	20724	20	5676.12	O. B. French
Charlottesville	38 02.6	78 30.2	1900.32	69 39.0	20548	20	5677.12	Brown & Thompson
Charlottesville	38 02.6	78 29.7	1901.70	69 42.0	20618	21	24.12	W. F. Wallis
Greenwood	38 03.4	78 47.1	1900.33	69 33.1	20768	17	4655.12	W. M. Brown
Warm Springs	38 03.4	79 44.6	1900.48	69 25.0	20980	17	4655.12	Do.
Staunton	38 08.8	79 04.2	1900.41	69 39.3	20702	17	4655.12	Brown & Thompson
Orange	38 14.5	78 06.2	1900.34	71 31.3	19612	17	4655.12	W. M. Brown
Burketown	38 17.6	78 56.2	1900.49	69 45.3	20612	17	4655.12	Do.
Standardsville	38 17.7	78 26.8	1900.51	69 49.7	20594	17	4655.12	Do.
Fredericksburg	38 18.2	77 27.4	1900.35	69 47.9	20611	17	4655.12	Do.
Madison	38 22.8	78 15.4	1900.51	69 49.3	20620	17	4655.12	Do.
Elkton	38 24.5	78 37.0	1900.51	69 50.9	20517	17	4655.12	Do.
Monterey	38 24.6	79 35.0	1900.44	69 37.4	20787	17	4655.12	Do.
Stafford	38 24.6	77 24.0	1900.62	69 45.1	20596	8	12.12	J. W. Miller
Harrisonburg	38 27.0	78 51.9	1900.49	69 49.2	20536	17	4655.12	W. M. Brown
Culpeper	38 28.6	77 59.1	1897.54	70 20.2	19948	20	5676.12	O. B. French

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

VIRGINIA—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observer.
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Culpeper	38 28.8	77 59.1	1900.31	70 17.2	19918	20	5677.12	Brown & Thompson
Calverton	38 37.9	77 41.1	1900.34	70 23.0			56.13	J. A. Fleming
Luray	38 40.0	78 27.0	1900.53	70 06.1	20322	17	4655.12	W. M. Brown
Alwington	38 42.2	77 46.6	1900.34	70 10.6	20446	18	23.34	L. A. Bauer
Washington	38 42.7	78 09.9	1900.52	70 14.3	20238	17	4655.12	W. M. Brown
Manassas	38 45.0	77 29.5	1900.30	70 12.4	20332	20	5677.12	Brown & Thompson
Fairfax Court-House	38 50.6	77 18.5	1897.52	70 09.0	20470	20	5676.12	O. B. French
Fairfax Court-House	38 50.6	77 18.5	1900.62	70 03.4	20442	8	12.12	J. W. Miller
Woodstock	38 52.5	78 31.6	1897.62	70 16.8	20288	20	5676.12	O. B. French
Cherrydale	38 53.8	77 06.7	1896.74	70 42.0	19990	11	5677.12	E. D. Preston
Cherrydale	38 53.8	77 06.7	1897.45	70 40.2	19958	11	5677.12	Do.
Cherrydale	38 53.8	77 06.7	1898.61	70 40.2	19940	19	5677.12	Do.
Cherrydale	38 53.8	77 06.7	1899.70	70 37.8	19750	3	18	Do.
Cherrydale	38 53.8	77 06.7	1900.48	70 37.9	19944	8	12.12	Do.
Rectortown	38 54.2	77 52.7	1900.39	70 22.3	20137	17	4655.12	W. M. Brown
Front Royal	38 55.2	78 11.7	1900.52	70 14.7	20211	17	4655.12	Do.
Strasburg	38 58.9	78 21.2	1900.39	70 21.8	20162	17	4655.12	Do.
Leesburg	39 06.9	77 34.0	1897.48	70 26.0	20043	11	5677.12	C. H. Sinclair
Leesburg	39 06.9	77 34.0	1900.61	70 29.5	20033	8	12.12	J. W. Miller
Round Hill	39 08	77 46.4	1897.48	70 43.3	19949	11	5677.12	C. H. Sinclair
Round Hill	39 08	77 46.4	1900.40	70 32.7	19950	8	12.12	J. W. Miller
Winchester	39 10.4	78 10.0	1900.40	70 30.9	20018	17	4655.12	W. M. Brown

WASHINGTON.

Seattle	47 36.5	122 20.0	1900.86	70 53.6			21.12	W. Weinrich
Seattle	47 39.6	122 18.4	1900.90	70 54.6	19074	4	21.12	Do.
Everett	47 58	122 13	1900.88	71 07.7	18938	4	21.12	Do.
Mount Vernon	48 23.6	122 21.2	1900.88	71 20.4	18858	4	21.12	Do.
San Juan Island	48 27.8	122 58.1	1897.65	71 11.0	19092	4	18	J. J. Gilbert
New Whatcom	48 44.1	122 29.4	1900.87	71 31.0	18704	4	21.12	W. Weinrich

WEST VIRGINIA.

Princeton	37 22.2	81 07.2	1900.41	68 50.2	21471	20	5676.12	J. D. Thompson
Welch	37 26	81 35.0	1900.42	68 32.6	21818	20	5676.12	Do.
Baileysville	37 36	81 40.1	1900.43	68 55.7	21560	20	5677.12	Do.
Hinton	37 40	80 53	1900.34	68 51.5	21424	20	5677.12	Do.
Williamson	37 40	82 16	1900.44	68 54.2	21614	20	5677.12	Do.
Oceana	37 42	81 38	1900.43	69 09.0	21342	20	5677.12	Do.
Alderson	37 43.0	80 39.3	1898.42	69 01.6	21491	19	5677.12	E. Smith
Beckley	37 47	81 12	1900.35	69 02.8	21293	20	5677.12	J. D. Thompson
Lewisburg	37 48	80 27	1900.34	69 09.0	21161	20	5677.12	Do.
Logan	37 51	81 59	1900.45	69 13.0	21074	20	5677.12	Do.
Dunlow	38 02.3	82 25.6	1898.39	69 23.0	21203	19	5677.12	E. Smith
Fayetteville	38 03	81 06	1900.36	69 19.6	20999	20	5677.12	J. D. Thompson
Madison	38 04	81 48	1900.45	69 13.3	21183	20	5677.12	Do.
Marlinton	38 13	80 06	1900.45	69 30.1	20962	17	4655.12	W. M. Brown
Wayne	38 13.1	82 26.1	1898.40	69 32.0	21162	19	5677.12	E. Smith
Hamlin	38 17	82 06	1900.46	69 31.8	21166	20	5677.12	J. D. Thompson
Summersville	38 17	80 51	1900.36	69 44.8	20820	20	5677.12	Do.
Charleston	38 21.2	81 37.5	1898.43	69 40.8	20984	19	5677.12	E. Smith
Charleston	38 21.2	81 37.5	1900.37	69 32.4	20946	20	5677.12	J. D. Thompson
Camden on Gauley	38 22	80 35	1900.47	69 37.3	20946	17	4655.12	W. M. Brown
Huntington	38 25.5	82 27.0	1898.41	70 10.8	20671	19	5677.12	E. Smith
Clay	38 28	81 05	1900.37	69 51.4	20685	20	5677.12	J. D. Thompson
Addison	38 28	80 24	1900.47	69 46.1	20782	17	4655.12	W. M. Brown
Mingo	38 29	80 03	1900.46	69 49.4	20617	17	4655.12	Do.
Winfield	38 32.1	81 55	1900.38	69 51.7	20757	20	5677.12	J. D. Thompson
Travellers Repose	38 32	79 47	1900.45	69 54.7	20597	17	4655.12	W. M. Brown
Cave	38 33	79 27	1900.44	69 53.3	20564	17	4655.12	Do.
Franklin	38 39	79 20	1900.44	69 59.3	20498	17	4655.12	Do.
Pickens	38 39.0	80 12.7	1898.51	70 02.7	20718	19	5677.12	E. Smith
Sutton	38 39.2	80 42.8	1898.49	69 54.4	20818	19	5677.12	Do.
Brushyrun	38 50	79 15	1900.43	70 07.9	20369	17	4655.12	W. M. Brown
Beverly	38 50.5	79 53.4	1898.58	70 00.6	20468	19	5677.12	E. Smith
Ripley	38 49.7	81 43	1900.40	70 14.6	20482	20	5677.12	J. D. Thompson
Glebe	38 59	79 13	1900.43	70 13.2	20332	17	4655.12	W. M. Brown
Buckhannon	38 59.1	80 14.3	1898.50	70 05.8	20582	19	5677.12	E. Smith
Weston	39 02.0	80 28.5	1898.51	70 12.8	20610	19	5677.12	Do.
Moorefield	39 04	78 58	1900.42	70 24.0	20170	17	4655.12	W. M. Brown
Hendricks	39 03.6	79 37.8	1898.58	70 17.6	20284	19	5677.12	E. Smith

Table of dip and intensity observations made between January, 1897, and June 30, 1902—Continued.

WEST VIRGINIA—Continued.

Station.	Latitude.	Longitude.	Date of observation.	Dip.	Horizontal intensity.	Instruments.		Observe
						Mag'r.	Dip circle.	
	° ′	° ′		° ′	γ			
Philippi	39 08.1	80 03.2	1898.57	70 12.0	20418	19	5677.12	E. Smith
Falls	39 10	79 07	1900.42	20 27.4	20146	17	4655.12	W. M. Brown
Harrisville	39 11.2	81 03.2	1898.47	70 19.3	20370	19	5677.12	E. Smith
Parkersburg	39 16.1	81 33.6	1898.46	70 36.4	20254	19	5677.12	Do.
Clarksburg	39 16.9	80 19.6	1898.48	70 29.0	20324	19	5677.12	Do.
Charlestown	39 17	77 51	1900.24	70 40.0	19742	17	5677.12	Fleming & Thompson
West Union	39 18.2	80 48	1900.39	70 35.6	20174	20	5677.12	J. D. Thompson
Romney	39 21.0	78 43.4	1900.24	70 37.5	19968	17	5677.12	Fleming & Thompson
Grafton	39 22.4	80 01.1	1898.56	70 25.6	20355	19	5677.12	E. Smith
Martinsburg	39 27	77 58	1900.24	70 28.2	19980	17	5677.12	Fleming & Thompson
Keyser	39 26.9	78 59.4	1898.59	70 41.4	19982	19	5677.12	E. Smith
Kingwood	39 28.5	79 41.2	1900.23	70 29.3	20205	17	5677.12	Fleming & Thompson
Paw Paw	39 32.1	78 26.2	1899.45	70 47.0	19806	18	56	L. A. Bauer
Morgantown	39 37.5	79 57.1	1900.22	70 52.3	19963	17	5677.12	J. A. Fleming
Morgantown	39 37.5	79 57.1	1900.47	70 53.4	19973	20	5677.12	Fleming & Wallis
Wheeling	40 03.5	80 44.4	1898.55	71 35.2	19379	19	5677.12	E. Smith

WISCONSIN.

Prairie du Chien	43 04.0	91 08.6	1900.84	73 05.6	18240	11	5676.13	W. G. Cady
Madison	43 04.5	89 25.3	1900.85	73 45.8	17828	11	5676.13	Do.
La Crosse	43 49.9	91 13.7	1900.83	73 47.3	17333	11	5676.13	Do.

WYOMING.

[No observations.]

BRITISH COLUMBIA.

Union Spit	49 40	124 55	1900.68	71 30.4			21.12	W. Weinrich
Comox	49 40	124 55	1900.83	71 30.1			21.12	Do.

APPENDIX No. 7.

REPORT 1902.

HAWAIIAN GEOGRAPHIC NAMES.

COMPILED BY

W. D. ALEXANDER,

Assistant, United States Coast and Geodetic Survey.

CONTENTS.

PREFACE.

The importance of securing uniformity in geographic nomenclature in all portions of the territory of the United States at the earliest practicable date being constantly felt in this office, Prof. W. D. Alexander, Assistant United States Coast and Geodetic Survey, was instructed to compile the following list and glossary for the Territory of Hawaii. The brief biographical sketch of Professor Alexander is inserted to show his peculiar fitness for this task, and it is believed that he is the most reliable living authority on the subject.

He was born at Honolulu, Hawaii, April 2, 1833, soon after the arrival of his family in the islands, his father, Rev. W. P. Alexander, having gone to the islands in 1832 as a missionary.

He was educated in the mission school at Punahoa, near Honolulu, and at Harrisburg, Pa., and graduated at Yale College as salutatorian in 1855 with the degree of A. M. He was a tutor at Beloit College, Wisconsin, in 1856, and a teacher in an academy at Vincennes, Ind., in 1857.

He returned to the islands in 1858 and held various positions of trust and importance, as follows: Professor of Greek, Oahu College; president Oahu College, 1864–1871; surveyor-general Hawaiian Islands, 1872–1901; member of privy council, 1884; member of board of education, 1887–1900; commissioner to International Meridian Conference at Washington, D. C., 1884; Fellow Royal Geographic Society, 1892; commissioner from the Provisional Government to the United States, 1893; member of Astronomical Society of the Pacific; Assistant United States Coast and Geodetic Survey, February 1, 1901.

He is the author of the following publications: A Brief History of the Hawaiian People; History of the Later Years of the Hawaiian Monarchy and of the Revolution; Brief Hawaiian Grammar; Introduction to L. Andrews' Hawaiian Dictionary; Ancient Systems of Land Tenure in Polynesia; Relations between Hawaii and Spanish America; Proceedings of the Russians on Kauai; The Uncompleted Treaty of Annexation, 1854.

His intimate acquaintance with the subject as surveyor-general of the islands for a term of twenty-nine years and his lifelong familiarity with the language make him a recognized authority, and the Survey is fortunate in being able to publish this contribution from his pen.

EDITOR.

WASHINGTON, D. C., *April 5, 1902.*

HAWAIIAN GEOGRAPHIC NAMES.

THE PRONUNCIATION OF HAWAIIAN WORDS.

The consonants in general are sounded as in English. No distinction was formerly made between the sounds of *K* and *T*, or between those of *L* and *R*. The sound of the letter *W* generally approximates to that of *V* between two vowels. *A* is sounded as in f*a*ther, *E* as in th*ey*, *I* as in mar*i*ne, *O* as in n*o*te, *U* as *oo* in m*oo*n. *Ai* when sounded as a diphthong resembles the English *ay* or the Italian *ai*, and *au* the English *ou* as in l*ou*d.

Besides the sounds mentioned above, there is in many words a slight gutteral break between two vowels, where the Polynesian *K* has been dropped, as in *i'a* for *ika*, a fish.

Every word and every syllable must end in a vowel, and no two consonants ever occur without a vowel sound between them. The accent of about five-sixths of the words in the language is on the penult. A few of the proper names are accented on the final syllable, as Puako', Mana', etc.

ISLANDS

Names	Area square miles	Names	Area square miles	Names	Area square miles
Hawaii	4 015	Lanai	139	Molokini	0. 2
Kahoolawe	[a] 69	Maui	728	Niihau	97
Kauai	547	Molokai	261	Oahu	598

DISTRICTS

ISLAND OF HAWAII

Hamakua	North Kohala	North Kona
Hilo	South Kohala	South Kona
Ka-u, south extremity		Puna

ISLAND OF MAUI

Eastern Division

Hamakualoa	Honuaula	Kipahulu
Hamakuapoko	Kahikinui	Koolau
Hana, eastern extremity	Kaupo	Kula

Western Division

Kaanapali	Lahaina	Wailuku

[a] Approximate.

DISTRICTS—Continued

ISLAND OF MOLOKAI

Kaluakoi, the western section	Kona, on the south side	Koolau, on the north side

ISLAND OF OAHU

Ewa	Koolauloa	Waianae
Kona	Koolaupoko	Waialua

ISLAND OF KAUAI

Halelea, north side	Koolau	Puna
Kona, south side	Na Pali	Waimea

CHANNELS

Alalakeiki, between Maui and Kahoolawe
Alenuihaha, between Maui and Hawaii
Auau, between Lanai and Maui
Kaieiewaho, between Oahu and Kauai
Kai o Kalohi, between Molokai and Lanai
Kaiwi, between Oahu and Molokai
Kumukahi, between Kauai and Niihau
Pailolo, between Maui and Molokai

BAYS AND HARBORS

ISLAND OF HAWAII

Name	District	Name	District
Hakalau Bay	North Hilo	Keokea Landing	North Kohala
Hilo Bay	Hilo	Laupahoehoe Landing	North Hilo
Honaunau Bay	South Kona	Maulua Bay	North Hilo
Honuapo Landing	Ka-u	Mahukona Harbor	North Kohala
Honoipu Landing	North Kohala	Milolii Landing	South Kona
Honomú Landing	North Hilo	Okoe Landing	South Kona
Kaalualu Landing	Ka-u	Onomea Bay	North Hilo
Kahoiawa Bay	North Kona	Ookala Landing	North Hilo
Kailua Bay	North Kona	Poho iki Landing	Puna
Kauhakó Bay	South Kona	Puakó Bay	South Kohala
Kawaihae Landing	South Kohala	Punaluu Landing	Ka-u
Kealakekua Bay	South Kona	Waipio Landing	Hamakua
Keauhou Landing	Puna	Papaikou Landing	North Hilo
Keauhou Bay	North Kona		

ISLAND OF KAUAI

Hanalei Bay	Halelea	Lawai Bay	Kona
Hanamaulu Bay	Puna	Nawiliwili Bay	Puna
Hanapepe Bay	Kona	Wahiawa Bay	Kona
Koloa Bay	Kona	Waimea Bay	Waimea

ISLAND OF LANAI

Awalua Landing	North end	Manele Harbor	South end

BAYS AND HARBORS—Continued

ISLAND OF MAUI

Name	District	Name	District
Honokahua Bay	Kaanapali	La Perouse Bay	Honuaula
Honolua Bay	Kaanapali	Maalaea Bay	Wailuku
Huelo Landing	Hamakualoa	Makena Anchorage	Honuaula
Kahakuloa Bay	Kaanapali	Mokae Landing	Hana
Kahului Bay	Wailuku	Mokulau Landing	Kaupo
Kapueokahi Harbor	Hana	Napili Bay	Kaanapali
Keanae Landing	Koolau	Nuu Landing	Kaupo
Lahaina Roadstead	Lahaina		

ISLAND OF MOLOKAI

Halawa Bay	Kona	Kamalo Landing	Kona
Kalaeloa Landing	Kona	Kaunakakai Harbor	Kona
Kalaupapa Landing	Koolau	Pelekunu Bay	Koolau
Kalawao Landing	Koolau	Pukoo Landing	Kona

ISLAND OF OAHU

Hanauma Harbor	Kona	Koolau Bay	Koolaupoko
Honolulu Harbor or Kou	Kona	Moanalua Bay	Kona
Kahana Bay	Koolauloa	Pearl Lochs	Ewa
Kaiaka Bay	Waialua	Waialae Bay	Kona
Kalihi Entrance	Kona	Waialua Bay	Waialua
Kaneohe Bay	Koolaupoko	Waimea Bay	Koolauloa

CAPES AND POINTS

ISLAND OF HAWAII

Name	District	Name	District
Akakoa Point	Kohala	Keawekaheka	South Kona
Alia Point	Hilo	Keikiwaha	North Kona
Hanamalo Point	South Kona	Kumukahi	Puna
Kaiwi Point	North Kona	Laupahoehoe	North Hilo
Ka lae Point	Kau	Leleiwi	Hilo
Kamilo	Kau	Lae Loa	South Kona
Kauhola	Kohala	Lae Mano	North Kona
Kauluoa	South Kona	Palemano	South Kona
Kauna	Kau	Upolu	Kohala
Keahole	North Kona		

ISLAND OF KAHOOLAWE

Kealaikahiki

ISLAND OF KAUAI

Kahala	Puna	Kawelikoa	Puna
Kailiu	Napali	Kokole	Waimea
Kalaehonu	Halelea	Makahuena	Kona
Kaowahi	Halelea	Mamaloa	Kona
Kapuhi	Halelea	Puu Poa	Halelea
Kawai	Puna	Ukula	Kona

ISLAND OF LANAI

Kaena Point	Kaa	Wahie Point	Paomai
Paakai Point	Palawai		

CAPES AND POINTS—Continued.

ISLAND OF MAUAI

Name	District	Name	District
Apole Point	Kaupo	Makaakini Point	Kaupo
Hakuhee Point	Kaanapali	Makaluapuna Point	Kaanapali
Hawea Point	Kaanapali	Makoloaka Point	Koolau
Ke Lae o ka Ilio	Kaupo	Papaka Point	Honuaula
Kamanawa Point	Kaupo	Pauwalu Point	Koolau
Kapukaulua Point	Hana	Pohaku Eaea Point	Kahikinui
Kauiki Head Point	Hana	Puehu Point	Hamakualoa
Keanae Point	Koolau	Puu Koae Point	Kaanapali
Kekaa Point	Kaanapali	Puu Makawana Point	Kaanapali
Lipoa Point	Kaanapali	Puunoa Point	Lahaina
Makaaikuloa Point	Kipahulu	Puu Olai	Honuaula

ISLAND OF MOLOKAI

Ka-puu-poi	Kona	Ka-lae-o-ka-laau	Kaluakoi
Ka-lae-loa	Kona	Ka-lae-milo	Koolau
Ka-lae-o-ka-hiu	Koolau	Ka-lae-o-ka-pahu	Koolau
Ka-lae-o-ka-ilio	Kaluakoi	Ka-leina-o-papio	Koolau

ISLAND OF NIIHAU

Kawahoa Point	SE.	Pahau Point	SW.
Kona Point	W.	Puuwai	NW.
Oku Point	NE.		

ISLAND OF OAHU

Kaena Point	Waialua	Lahilahi Point	Waianae
Kahuku Point	Koolauloa	Laie Point	Koolauloa
Kalaeloa Point	Ewa	Leahi Point	Kona
Kaneilio Point	Waianae	Makapuu Point	Kona
Kawaihoa Point	Kona	Mokapu Point	Koolaupoko
Lae-o-ka-Oio Point	Koolauloa		

RIVERS AND STREAMS

ISLAND OF HAWAII

Name	District	Name	District
Ahole	Hilo	Nanue	Hilo
Aleamai	Hilo	Niulii	Kohala
Hakalau	Hilo	Ookala	North Hilo
Honokane	Kohala	Opea	Hilo
Honolii	Hilo	Pahoehoe	Hilo
Honopue	Hamakua	Papaikou	Hilo
Kaawalii	North Hilo	Pohakupuka	North Hilo
Kahuwa	Hilo	Pololu	Kohala
Kaiwiki	Hilo	Poopoo	Hilo
Kaiwilahilahi	Hilo	Puumoi	Hilo
Kaupakuea	Hilo	Umauma	Hilo
Kolekole	Hilo	Waikaumalo	Hilo
Kulaimano	Hilo	Wailuku	Hilo
Kulanakii	North Hilo	Waimanu	Hamakua
Laupahoehoe	North Hilo	Wainaku	Hilo
Malamalamaiki	Hilo	Waiolama	Hilo
Maulua	North Hilo	Waipio	Hamakua

RIVERS AND STREAMS—Continued.

ISLAND OF KAUAI

Name	District	Name	District
Aliomanu	Halelea	Lawai	Kona
Anahola	Halelea	Lumahai	Halelea
Hanalei	Halelea	Makaweli	Kona
Hanapepe	Kona	Moloaa	Halelea
Huleia	Puna	Wahiawa	Kona
Kalihi	Halelea	Wailua	Puna
Kapaa	Puna	Waimea	Waimea
Kawaihoolana	Puna	Wainiha	Halelea
Kilauea	Halelea	Waioli	Halelea
Koloa	Kona	Waipaké	Halelea

ISLAND OF MAUI

Name	District	Name	District
Aiea	Koolau	Nahiku	Koolau
Halehaku	Hamakualoa	Nuaailua	Koolau
Hanawi	Koolau	Olualu	Lahaina
Hanahoi	Hamakualoa	Opuola	Koolau
Honokahau	Kaanapali	Paakea	Koolau
Honokahua	Kaanapali	Palauhulu	Koolau
Honokowai	Kaanapali	Pauwela	Hamakualoa
Honolua	Kaanapali	Puumahoe	Koolau
Honomanu	Koolau	Ukumehame	Lahaina
Honopou	Hamakualoa	Wahinepee	Koolau
Kahakuloa	Kaanapali	Waihee	Wailuku
Kailua	Hamakualoa	Waikamoi	Koolau
Wai o Kamilo	Koolau	Waikapu	Wailuku
Kapaula	Koolau	Wailua	Koolau
Kauaula	Lahaina	Wailua 2d	Hana
Kolea	Koolau	Wailuku	Wailuku
Maliko	Hamakualoa		

ISLAND OF OAHU

Name	District	Name	District
Halawa	Ewa	Opaeula	Waialua
Hoaeae	Ewa	Pauoa	Kona
Kahana	Koolauloa	Palolo	Kona
Kailua	Koolaupoko	Waiawa	Ewa
Kaukonahua	Waialua	Waikane	Koolaupoko
Kawailoa	Waialua	Waikele	Ewa
Manoa	Kona	Waimalu	Ewa
Moanalua	Kona	Waimanalo	Koolaupoko
Niuhelewai	Kona	Waimea	Koolauloa
Nuuanu	Kona		

PONDS

Name	Island	Name	Island
Waiau	Hawaii	Kaelepulu	Oahu
Nono	Kauai	Salt Lake	Oahu
Wai Anapanapa	Maui		

ELEVATIONS

ISLAND OF KAUAI

Name	District	Elevation (feet)
Ahualiku	Kona	
Aahoaka	Puna	
Haupu	Kona	2 030
Kahili	Kona	
Kalehua-hakihaki	Waimea	
Kalepa	Puna	
Kilohana	Puna	*1 100
Laaukahi	Kona	
Namahana	Halelea	
Namolokama	Halelea	4 200
Nono	Puna	
Palikea	Napali	
Pohakuau	Napali	
Pohakuawaawa	Napali	
Pohakupili	Puna	
Puu Alani	Kona	
Puu Anahola	Koolau	
Puu Aukai	Kona	
Puu Eu	Koolau	
Puu Kolo	Kona	
Puu Lehu	Waimea	
Puu o Pae	Waimea	
Puu Paka	Halelea	
Puu Ka Pele	Waimea	
Waialeale, Mount		

ISLAND OF OAHU

Name	Elevation (feet)
Awawaloa (Mount Olympus), Manoa Valley	2 447
Diamond Head (Leahi)	761
Hapapa, Waianae Range	2 878
Heleókalá, Waianae Range	1 885
Kaala, Waianae Range, the highest part	4 030
Kailio, Waianae Range	1 967
Kaímukí (Telegraph Hill), Honolulu	291
Kakea (Sugar Loaf), Honolulu	1 468
Kalena, Waianae Range	3 504
Kamaohanui, Waianae Range	3 355
Kanehoa, Waianae Range	2 721
Kauaopu, Waianae Range	1 053
Kawiwi, Waianae Range	2 985
Keaau, Waianae Range	2 270
Koko Head, lower crater	644
Koko Head, upper crater	1 205
Kolekole Puu, Waianae	1 591
Konahuanui, Koolau Range	3 105
Koolau Range above Waipio	2 700
Koolau Range above Wahiawá	2 381
Kumakalii, Waianae Range	2 908
Kuwale, Waianae District	852
Lahilahi Point, Waianae	228
Lanihuli, Koolau Range	2 781
Leahi (Diamond Head)	761
Maelieli, Heeia, Koolaupoko	715
Maili, North Waianae	1 505
Mailiilii, Waianae	729
Makakilo, Honouliuli, Ewa	970
Makapuu Point or Southeast Point, Oahu	665
Manawahua, Waianae Range	2 432
Mauna Kapu, Waianae Range	2 742
Maunauna, Waianae Range	1 768
Mokapu, east of Kaneohe Bay, Koolau	681
Nuuanu Pali Pass, Koolau Range	1 209
Olomana Peak, Kailua, Koolaupoko	1 645
Paheehee, Waianae	652
Palailai, Honouliuli, Ewa	490
Palikea, Waianae Range	3 111
Pohakea, Waianae Range	3 106
Puu o Hulu, Waianae District	856
Puu Kapolei, Honouliuli, Ewa	162
Puu Ki, Kahuku, Koolauloa	643
Puu Ohia (Tantalus), near Honolulu	2 013
Puu Ohulehule, Koolau Range	2 263
Puowaina (Punch Bowl), Honolulu	498
Puu Pane, Waianae Uka	2 441
Salt Lake Crater (Leilono), Moanalua	486
Tantalus (Puu Ohia), near Honolulu	2 013
Ualakaa (Round Top), near Honolulu	1 049
Uau, Aiea, Ewa	1 700
Ulumawao, Kailua, Koolaupoko	992

* Approximate.

ELEVATIONS—Continued

ISLAND OF MAUI

Name	Elevation (feet)	Name	Elevation (feet)
Eke, crater in Waihee	4 500	Páhuoloná, Hana	837
Haleakala: Highest point, Red Hill	10 032	Paupau (Mount Ball), Lahaina	2 254
Haleakala: White Hill or Pakaoao	9 870	Piiholo, Makawao	2 255
Haleakala: Kolekole, southwest	10 012	Pimoe, Honuaula	1 766
Haleakala: Magnetic Peak	10 009	Pohaku, Palaha, Haleakala, northeast	8 101
Haleakala: Haleakala, in Kaupo, south	8 208	Polipoli, Kula	1 051
Haleakala: Hanakauhi, in Koolau, north	8 911	Puu Alaea, Makawao	3 253
Haleakala: Pakihi, east side	8 108	Puu o Ka Haula, Hana	540
Iwi o Pele, Hana	408	Puu Hele, Wailuku	214
Kahakuloa (Puu Koae)	635	Puu Io, Honuaula	2 841
Kapuai o Kamehameha, Hamakualoa	1 149	Puu o Kali, Kula	1 479
Mount Kukui, summit West Maui	5 790	Puu o Kanaloa, Honuaula	213
Keakaamanu, Hana	1 250	Puu Kapuai, Hamakualoa	1 150
Keonenelu, Honoaula	3 942	Puu Koa, Makawao	1 932
Kilea, Oloalu, Lahaina	269	Puu o Koha, Kula	1 051
Kuloli, Hamakualoa	855	Puu Kukai, Koolau	574
Laina (Puu), Lahaina	648	Puu Mahoe, Honuaula	2 685
Launiupoko, Lahaina	808	Puu Nene, Wailuku	186
Lualailua, Kipahulu	1 960	Puu Nianiau, Makawao	6 850
Makahahana, Hana	1 287	Puu Okóholá, Koolau	844
Makaliihanau, Hana	607	Puu Ouli, Honuaula	4 354
Molokini, islet off Honuaula	160	Puu Olai, Honuaula	356
Olopawa, Hana	1 843	Puu Pane, Kula	2 568
Olinda, Makawao	4 043	Puu Pane, Kahikinui	3 988
Pakihi, Haleakala	8 108	Puu o Umi, Hamakualoa	629
		Ulalena, Hamakualoa	2 163
		West Maui, Summit	5 790

ISLAND OF MOLOKAI

Kaapahu in Koolau	3 563	Laina, northwest coast	658
Kalanikaula near Wend	794	Makakupaia, Koolau	2 610
Kalapamoa, central range	4 004	Mauna Loa, west district, Kaluakoi	1 382
Kaluahauoni, central range	3 282	Middle Hill or Kapena Hulu, west central	1 018
Kamakou, central range, summit	4 958	Mokuhooniki, islet, west end	198
Kanapa, northeast coast	1 935	Olokui, north central range	4 600
Kaulahuki, central range	3 749	Puu Alii, central range	4 200
Kaunuohua, central range	4 535	Puu Luahine, west central	1 208
Keolewa, central north coast	2 100	Wailau, central	4 547
Kolekole, Koolau, central	3 951		

ISLAND OF LANAI

Kanepuu	1 800	Puu Manu	2 070
Pohoula	2 026	Summit	3 400
Puu Alii	2 799		

ISLAND OF KAHOOLAWE

Elevation, 1 472 feet

ISLAND OF MOLOKINI

Elevation, 160 feet

ELEVATIONS—Continued

ISLAND OF HAWAII

Name	District	Elevation (feet)	Name	District	Elevation (feet)
Aahuwela	North Hilo	7 747	Keikipaula		6 601
Ahualoa	Hamakua	1 180	Kemole	Hamakua	8 000
Ahua Umi	Kau		Kihe	Hamakua	7 828
Ahumoa	Hamakua	7 034	Kipahoehoe	South Kona	943
Akahipuu	North Kona	2 236	Kilauea Hotel	Puna	*4 000
Akihi	Kau		Kohala Mountains	North Kohala	5 489
Alalá	North Hilo	762	Koholalele	Hamakua	1 428
Anahulu	North Kona	1 523	Kole	Hamakua	9 632
Anuenue	Hamakua	1 611	Kuilei	Hamakua	1 429
Apakuie	Hamakua	5 849	Kuili	North Kona	346
Auhaukeae	North Kona	274	Kulani Hill	Hilo	5 574
Halai	Hilo	347	Lahikiola	North Kohala	3 259
Haleili	South Kona	1 766	Lapa Hapuu	Hilo	4 099
Hanaipoe	Hamakua	5 143	Laumaia	North Hilo	5 145
Heiheiahulu	Puna	1 692	Lilinoe, Mauna Kea	Hamakua	12 996
Hiilawe Falls	Waipio, Hamakua	1 700	Maná	Hamakua	3 505
Hokuula	South Kohala	3 070	Mauna Kea, Summit	Hamakua	13 825
Honokane Head	East Kohala	4 698	Mauna Loa	South Kona	13 675
Honohina	Hilo	712	Milolii	South Kona	932
Hualalai	North Kona	8 269	Moano	Hamakua	6 879
Humuula	North Hilo	1 086	Napuukulua	West Hamakua	5 757
Imiola Church	Waimea, South Kohala	2 742	Nohonaohae	South Kohala	3 253
Kaala	South Kohala	3 979	Nunulu	North Kohala	1 589
Kaao	Hamakua	1 242	Olaa, trig. sta.	Puna	662
Kaholo	Hamakua	906	Onomea	Hilo	465
Kaiholena	Kau	3 824	Omaokoili	Hamakua	7 087
Kalaieha, lat. sta.	North Hilo	6 738	Onouli	North Kona	1 574
Kalapa	South Kona	1 271	Paauhau	Hamakua	1 345
Kalepa	Hamakua	7 678	Pahoehoe	South Kona	736
Kalepeamoa	Hamakua	9 409	Papaaloa	Hilo	918
Kaliu	Puna	1 065	Papaikou	Hilo	304
Kaloaloa	North Hilo	6 634	Papalekoki	Hamakua	11 249
Kaluamakani	Hamakua	7 584	Poliahu, Mauna Kea	Hamakua	13 646
Kalua o Lapauila	South Kona	120	Poopuaa	Hamakua	6 012
Kanoa Pepeekeo	Hilo	910	Punohu	Hamakua	4 325
Kapóho	Puna	437	Puu Ahinui	South Kona	3 968
Kapukaiki	North Kona	1 404	Puu Enuhe	Kau	2 327
Kapulena	Hamakua	904	Puu Hinai	South Kohala	1 443
Kapuna	Kau		Puu Hoomaha	Kau	6 636
Kaukú	Hilo	1 967	Puu Huluhulu	Hamakua	6 637
Kaupakuhale	Hamakua	9 990	Puu Huluhulu	Puna	3 442
Kaupulehu	North Kona	6 143	Puu Hue	North Kohala	2 411
Kawela	Hamakua	938	Puu Io	North Hamakua	4 062
Kea (Mauna)	Hamakua	13 825	Puu Kea	Hamakua	5 722
Keamuku	South Kohala	3 078	Puu Kea	Hamakua	8 566
Keauhou	North Kona	1 067	Puu o Keokeo	Kau	6 870
Keonehehee	Hamakua	11 538			

*Approximate.

ELEVATIONS—Continued

ISLAND OF HAWAII—Continued

Name	District	Elevation (feet)	Name	District	Elevation (feet)
Puu Ki	Kau	3 197	Puu Pili	North Kohala	4 678
Puu Laalaau	North Kona	7 451	Puu Loa	Kohala	4 124
Puu Liolio	Hamakua	1 889	Puu o Uo	South Kona	8 826
Puu Maná	Hamakua	1 633	Puu Ulaula	Kau	10 092
Puu Nahahá	South Kona	767	Puu Waawaa	North Kona	3 824
Puu o Nale	North Kohala	1 797	Uwekahuna, west side Kilauea	Kau	4 089
Puu Ohai	North Hilo	737			
Puu Ohau	South Kona	231	Waiau Lake, Mauna Kea	Hamakua	1 600
Puu Ohohia	South Kona	5 522			
Puu Oo	North Hilo	6 934	Waipio Pali	Hamakua	1 394
Puu Pa	South Kohala	2 671	Waimea Court-House	South Kohala	2 669
Puu Ka Pele	Kau	5 768			

LIST OF LANDS

[Including all the Ahupuaas and large ilis]

ISLAND OF HAWAII

Land	District	Land	District
Aamakao	Kohala	Awininui	Kohala
Aamanu	Hamakua	Haaheo	Hilo
Aemale	Kau	Haakoa	Hilo
Ahalanui	Puna	Haena	Kohala
Ahualoa	Hamakua	Haikú	Hilo
Ahulua	Kohala	Haina	Hamakua
Ainakea	Kohala	Hakalau	Hilo
Alae	Hilo	Halaula	Kohala
Alae	South Kona	Halawa	Kohala
Alaeakila	Hamakua	Haleili	South Kona
Alaeloa	Hilo	Halekaa	Kau
Alakahi	Hilo	Halekii	North Kona
Aleamai	Hilo	Halelua	Kau
Alika	South Kona	Halelua	Kohala
Anaehoomalu	Kohala	Haleohiu	North Kona
Anapuka	South Kona	Halepuaa	Puna
Apua	Puna	Halepuna	Hilo
Apua	Hamakua	Haliilau	Hilo
Apuakohau	Kohala	Hamanamana	North Kona
Au	Hamakua	Hanapai	Hamakua
Auau	Kohala	Hanaula	Kohala
Auhaukeae	North Kona	Hapalapuka	Hamakua
Auhuhu	Hamakua	Haukalua	Hilo
Auhulili	Kau	Haukalua	South Kona
Auliilii	Kau	Haukoi	Hamakua
Awawaiki	Hilo	Hauola	Hamakua
Awakee	North Kona	Hawi'	Kohala
Awalua	Kohala	Heneheneula	Hamakua
Awalua	North Kona	Hianaloli	North Kona
Awapuhi	Hilo	Hihiu	Kohala
Awawaloa	Hilo	Kikiaupea	Kohala
Awini	Kohala	Hilea	Kau

LIST OF LANDS—Continued

ISLAND OF HAWAII—Continued

Land	District	Land	District
Hionaa	Kau	Kahaluu	North Kona
Hionamoa	Kau	Kahaualea	Kau
Hoea	Hamakua	Kahauloa	South Kona
Hokukano	Kau	Kahei	Kohala
Hokukano	North Kona	Kahilipali	Kau
Hokumahoe	Hilo	Kahinano	Hilo
Holualoa	North Kona	Kahoahuna	Hilo
Honalo	North Kona	Kaholo	Hamakua
Honaunau	South Kona	Kahua	Kohala
Honohina	Hilo	Kahua	Hilo
Honoipu	Kohala	Kahua-hookolo	Hilo
Honokahau	North Kona	Kahuai	Kau
Honokaia	Hamakua	Kahue	Kau
Honokane	Kohala	Kahuku	Kau
Honokua	South Kona	Kahuku	Hilo
Honolulu	Puna	Kahului	North Kona
Honomainoa	Hilo	Kaiaakea	Hilo
Honomakau	Kohala	Kaiholena	Kohala
Honomalino	South Kona	Kaihooa	Kohala
Honomú	Hilo	Kaihuiki	Hilo
Honopue	Hamakua	Kailiula	Kau
Honopueo	Kohala	Kailua	North Kona
Honuaino	North Kona	Kaimú	Kau
Honuápo	Kau	Kainehe	Hamakua
Honuaula	North Kona	Kaipuhaa	Kohala
Hookena	South Kona	Kaiwiki	Hilo
Hoopuloa	South Kona	Kaiwiki	Hamakua
Hualua	Kohala	Kaiwilahilahi	Hilo
Hukiaa	Kohala	Kakaalaea	Hamakua
Hulumanai	Puna	Kalahiki	South Kona
Humuula	Hilo	Kalakalaula	Hamakua
Iliiliiloa	Puna	Kalala	Kohala
Ilikahi	South Kona	Kalalau	Hilo
Iliokaloa	Kau	Kalama	South Kona
Iole	Kohala	Kalaoa	North Kona
Iole	Puna	Kalapana	Kau
Kaakepa	Hilo	Kalihi	South Kona
Kaalaala	Kau	Kaloaloa	Hilo
Kaalaiki	Kau	Kaloko	North Kona
Kaala-waikini	Hamakua	Kalona	Kau
Kaalau	Hilo	Kalua	Hamakua
Kaao	Hamakua	Kaluakailio	Hilo
Kaapahu	Hamakua	Kalukalu	South Kona
Kaapoko	Hilo	Kamaee	Hilo
Kaapuhu	Kau	Kamaili	Puna
Kaapuna	South Kona	Kamakama	Kau
Kaauhuhu	Kohala	Kamano	Kohala
Kaawaloa	South Kona	Kamaoa	Kau
Kaawikiwiki	Hamakua	Kamaui	Hamakua
Kahaea	Kau	Kamoamoa	Puna
Kahalii	Hilo	Kamokala	Hamakua

LIST OF LANDS—Continued

ISLAND OF HAWAII—Continued

Land	District	Land	District
Kamouau	Hamakua	Kawala	Kau
Kana	Hamakua	Kawainui	Hilo
Kanahonua	Hamakua	Kawanui	North Kona
Kanaio	Kau	Kawela	Kau
Kanakau	South Kona	Kawela	Hamakua
Kanane	Puna	Keaa	Hamakua
Kanaueue	North Kona	Keaa	Kau
Kanekiki	Puna	Keaau	Kau
Kaohaoha	Hilo	Keahakea	Hamakua
Kaohe	Hamakua	Keahialana	Puna
Kaohe	South Kona	Keahua	Hamakua
Kaohe	Puna	Keahuolú	North Kona
Kaoma	Kohala	Keaiwa	Kau
Kaoma	Hilo	Kealahewa	Kohala
Kapaa	Kohala	Kealakaha	Hamakua
Kapaahu	Kau	Kealakehe	North Kona
Kapaau	Kohala	Kealakekua	South Kona
Kapalaalaea	North Kona	Kealakomo	Puna
Kapapala	Kau	Kealia	South Kona
Kapehu	Hilo	Keauhou	North Kona
Kapena	Hilo	Keauhou	Kau
Kapóho	Puna	Keauohana	Puna
Kapoula	Hamakua	Keehia	Hamakua
Kapua	South Kona	Keei	South Kona
Kapua	Kohala	Keekee	South Kona
Kapulena	Hamakua	Keekee	Puna
Kapunapuna	Kohala	Keekeekai	Kau
Kau	North Kona	Kehena	Kohala
Kau	Kau	Kehena	Puna
Kauaea	Puna	Kekualele	Hamakua
Kaueleau	Puna	Kemau	Hamakua
Kauhakó	South Kona	Keokea	South Kona
Kauhiula	Hilo	Keokea	Puna
Kauhuhuula	Kau	Keonepoko	Puna
Kaukulau	Puna	Keopu	North Kona
Kaulana	North Kona	Keopuka	South Kona
Kaulanamauna	South Kona	Ki	Puna
Kaulekohau	Hamakua	Kiao	Kau
Kauleoli	South Kona	Kiapu	Hilo
Kaumalumalu	North Kona	Kihalani	Hilo
Kaumana	Hilo	Kiilae	South Kona
Kaumoali	Hamakua	Kiiokalani	Kohala
Kaunaloa	Puna	Kikala	Puna
Kaunamano	Hamakua	Kikala	Hilo
Kaunamano	Kau	Kilau	Hilo
Kauniho	Hilo	Kiloa	South Kona
Kaupakuea	Hilo	Kiolakaa	Kau
Kaupalaoa	Kohala	Kiolokú	Kau
Kaupulehu	North Kona	Kipahoehoe	South Kona
Kawahauwahi	Kau	Kipi	Kohala
Kawaihae	Kohala	Koae	Kau

LIST OF LANDS—Continued

ISLAND OF HAWAII—Continued

Land	District	Land	District
Koaeae	Kohala	Lolipali	Kau
Koaie	Kohala	Mahaiula	North Kona
Koaloa	Hilo	Mahaiula	Kau
Koea	Kohala	Mahukona	Kohala
Kohanaike	North Kona	Mahukuolo	Hamakua
Koholalele	Hamakua	Maihi	North Kona
Kokio	Kohala	Makahanaloa	Hilo
Kokoike	Kohala	Makahiupá	Hilo
Kolo	South Kona	Makaka	Kau
Koloaha	Hamakua	Makakupu	Kau
Koomano	Hilo	Makalawena	North Kona
Kopu	Kau	Makanikahio	Kohala
Kou	Kohala	Makapala	Kohala
Kuaia.	Hilo	Makaula	North Kona
Kuamoo	North Kona	Makea	Hilo
Kuhua	Hilo	Makeanehu	Kohala
Kuilei	Hamakua	Makena	Puna
Kukaiau	Hamakua	Makiloa	Kohala
Kukio	North Kona	Makuu	South Kona
Kukuau	Hilo	Makuu	Puna
Kukui	Kau	Malama	Puna
Kukuihaeke	Hamakua	Malamalamaiki	Hilo
Kukuihala	Puna	Malanahae	Hamakua
Kukuikea	Hilo	Manai	Hamakua
Kukuioloa	Kau	Manienie	Hamakua
Kukuiopae	South Kona	Manienie	Kau
Kukuipahu	Kohala	Maniniowali	North Kona
Kukuiwaluhia	Kohala	Manoloa	Hilo
Kula	Puna	Manono	Kau
Kulaikahonu	Hilo	Manowaialee	Hamakua
Kulaimáno	Hilo	Manowaikohau	Hamakua
Kulanakii	Hilo	Manowaiopae	Hilo
Kulihai	Hamakua	Manuká	Kau
Kumu	Kau	Maonakomalie	Hamakua
Kupahu	Puna	Moanalulu	Hilo
Laaloa	North Kona	Maulili	Hilo
Laaumama	Kohala	Maulili	Kohala
Laeapuki	Puna	Maulua	Hilo
Laepaoo	Puna	Maumau	Hilo
Lahokea	Puna	Maunaoni	South Kona
Lahuipuaa	Kohala	Miananai	Kau
Laimi	Hilo	Milolii	South Kona
Lamaloloa	Kohala	Moaula	Kau
Lanihau	North Kona	Moeauoa	North Kona
Lapakahi	Kohala	Mohokea	Kau
Lauhulu	Hilo	Mohowae	Kau
Lauka	Hamakua	Mokuhonua	Hilo
Laupahoehoe	Hamakua	Mokuola, Island	Hilo
Laupahoehoe	Hilo	Mokuoniki	Hilo
Lehuula	North Kona	Mooiki	Hilo
Lepoloa	Hilo	Nakookó	Hamakua

LIST OF LANDS—Continued.

ISLAND OF HAWAII—Continued.

Land	District	Land	District
Nalua	Kau	Papaa	Kohala
Nanawale	Puna	Papaa	Hilo
Nanue	Hilo	Papaaloa	Hilo
Nene	Hilo	Papaanui	Hamakua
Nienie	Hamakua	Papaikou	Kau
Ninole	Hilo	Papaikou	Hilo
Ninole	Kau	Papaki	Hamakua
Niulii	Kohala	Papalele	Hamakua
Niupea	Hamakua	Papohaku	Kau
Niupuka	Hamakua	Paukaa	Hilo
Nohoiki	Kau	Pauku iki	Kau
Nukakaia	Kau	Pauku nui	Kau
Ohiki	North Kona	Pepeekeo	Hilo
Okoe	South Kona	Peleau	Hilo
Olaa	Puna	Pihá	Hilo
Olelomoana	South Kona	Piihonua	Hilo
Omokaa	South Kona	Pohakuhaku	Hamakua
Oneloa	Puna	Pohakuloa	Kohala
Onomea	Hilo	Pohakuloa	Kau
Onouli	South Kohala	Pokakupuka	Hilo
Ookala	Hilo	Pohoiki A	Puna
Ooma	North Kona	Pohoiki B	Puna
Opea	Hilo	Pololu	Kohala
Opihihali	South Kona	Ponahale	Kau
Opihikao	Puna	Ponahawai	Hilo
Opihilala	Hamakua	Poohina	Kau
Opihipau	Kohala	Popoki	Puna
Paako	Hamakua	Popouwela	Kau
Paalaea	Hamakua	Poupou	Puna
Paana	Hilo	Puaa	North Kona
Paauau	Kau	Puaakuloa	Hilo
Paauhau	Hamakua	Puaiki	Kohala
Paauilo	Hamakua	Puakea	Kohala
Paeohe	Hilo	Puakó	South Kohala
Pahinahina	Kohala	Pualaa	Puna
Pahoa	Kohala	Pualaea	Hilo
Pahoehoe	North Kona	Puanui	South Kohala
Pahoehoe A	South Kona	Puanui	Hamakua
Pahoehoe B	South Kona	Puapuaa	North Kona
Pahoehoe	Hilo	Puehuehu	South Kohala
Pahukii	Hamakua	Pueke	South Kohala
Paihaaloa	Hilo	Pueopaku	Hilo
Pakiloa	Hamakua	Puhalanui	Kau
Pakini	Kau	Pulama	Puna
Palauhulu	Kau	Punahelu	Hilo
Palima	Kau	Punahoa	Hilo
Panau iki	Puna	Punaluu	Kau
Panau nui	Puna	Puohai	Hilo
Paoo	Kohala	Puohai A	Hilo
Paopao	Kohala	Puohai B	Hilo
Papa	South Kona	Puopaha	Hamakua

LIST OF LANDS—Continued.

ISLAND OF HAWAII—Continued.

Land	District	Land	District
Puua	Puna	Waikaalulu	Hamakua
Puuanahulu	North Kona	Waikahekahe	Puna
Puueo	Hilo	Waikakuu	South Kon
Puueo	Kau	Waikapu	Hamakua
Puuepa	Kohala	Waikaumalo	Hilo
Puuhune	Hilo	Waikoekoe	Hamakua
Puukala	North Kona	Waikoloa	South Kohala
Puukoa	Kau	Waikoloa	Hamakua
Puukole	Kohala	Wailau	Kau
Puumakaa	Kau	Wailea	Hilo
Puumoi	Hilo	Wailoa	Kau
Puuoehu	Kau	Wailua	Hilo
Puuohua	Hilo	Waimanu	Hamakua
Puuokumau	South Kohala	Waimea	South Kohala
Puuwaawaa	North Kona	Waimuku	Kau
Umauma	Hilo	Wainaku	Hilo
Ulukanu	Hilo	Waiohinu	Kau
Upolu	Kohala	Waiomao	Kau
Waawaa	Puna	Waiopua	Kau
Waiaha	North Kona	Waipio	Hamakua
Waiakahiula	Puna	Waipunalei	Hilo
Waiakea	Hilo	Waipunaula	South Kona
Waialeale	Hamakua	Weha	Hamakua
Waiapuka	Kohala	Weliwelinui	Kau
Waiea	South Kona	Weloká	Hilo
Waika	South Kohala		

ISLAND OF MAUI.

Land	District	Land	District
Aapueo	Kula	Halekini	Koolau
Ahikuli	Wailuku	Halemano	Kipahulu
Ahoa	Lahaina	Haliu	Lahaina
Ahuakeio	Hana	Haliimaile	Hamakuapoko
Ahupau	Kula	Hamoa	Hana
Aki	Lahaina	Hanakaoo	Lahaina
Alaakua	Kaupo	Hanawana	Hamakualoa
Alae	Kula	Hanehoi	Hamakualoa
Alae	Kipahulu	Haneoo	Hamakualoa
Alaeloa	Kaanapali	Haou	Hana
Alaenui	Kipahulu	Heleleikeoha	Koolau
Alamihi	Lahaina	Hianaulua	Koolau
Aleamai	Hana	Hikiaupea	Kaupo
Alena	Kahikinui	Hoalua	Hamakualoa
Alio	Lahaina	Hokuula	Kula
Auhao	Lahaina	Honokalá	Hamakualoa
Aupokopoko	Lahaina	Honokahau	Kaanapali
Auwahi	Kahikinui	Hanokahua	Kaanapali
Haalelehinale	Kaupo	Honokalani	Hana
Hahalawe	Hana	Honokeana	Kaanapali
Hahalehili	Hana	Honokowai	Kaanapali
Haiku	Hamakualoa	Honolua	Kaanapali
Halakaa	Lahaina	Honolulu	Koolau
Halehaku	Hamakualoa	Honomaele	Hana

LIST OF LANDS—Continued.

ISLAND OF MAUI—Continued.

Land	District	Land	District
Honomanu	Koolau	Kaopala	Kaupo
Honopou	Hamakualoa	Kapaula	Koolau
Hookapuna	Hana	Kapewakua	Lahaina
Hoolawa	Hamakualoa	Kapuaikini	Kipahulu
Hopenui	Koolau	Kapunakea	Lahaina
Hualele	Kaupo	Kauau	Kula
Huelo	Hamakualoa	Kauaula	Lahaina
Huilua	Kaupo	Kauamanu	Hana
Hulihana	Hana	Kaukuhalahala	Hana
Ka	Kahikinui	Kaulanamoa	Kaupo
Kaao	Koolau	Kaulolo	Lahaina
Kaalaea	Hamakualoa	Kauluena	Koolau
Kaapahu	Kipahulu	Kaumahalua	Kaupo
Kaehoeho	Kipahula	Kaumakani	Kipahulu
Kaelekû	Hana	Kaunuahane	Honuaula
Kaeo	Honuaula	Kaupakulua	Hamakualoa
Kahalaia	Hamakuapoko	Kawaipapa	Hana
Kahawaihapapa	Kahikinui	Kawaloa	Hana
Kahuai	Kaupo	Kawela	Hana
Kaili	Hana	Keaa	Koolau
Kailua	Kula	Keaa iki	Koolau
Kainehe	Lahaina	Keaaula	Hamakualoa
Kaipapa	Kahikinui	Keahua	Kula
Kakalahale	Kipahulu	Keahuapono	Kaupo
Kakanoni	Kipahulu	Keahuloa	Kaupo
Kakio	Kaupo	Kealahou	Kula
Kakio	Hana	Kealakekua	Hamakuapoko
Kakiweka	Hana	Kealia	Hamakuapoko
Kalaeoaihe	Kaupo	Kealii iki	Hamakualoa
Kalaloa	Koolau	Kealii nui	Hamakuapoko
Kalena	Kipahulu	Keanae	Koolau
Kalepa	Kaupo	Keauhou	Honuaula
Kaliae	Koolau	Kekai	Lahaina
Kalialinui	Kula	Kekuapaawela	Koolau
Kalihi	Honuaula	Keokea	Kula
Kalihi	Koolau	Keoneoio	Honuaula
Kalihi	Hana	Keopuka	Koolau
Kalihi	Kahikinui	Kepio	Kaupo
Kalihi	Kaupo	Kihapuhala	Hana
Kalimaohe	Lahaina	Kikoo	Kipahulu
Kaloi	Honuaula	Kilolani	Lahaina
Kalua	Wailuku	Kipapa	Kaupo
Kamaino	Koolau	Koanawai	Kipahulu
Kamani	Lahaina	Koheo	Kula
Kamaole	Kula	Kohoilo	Kula
Kamehame	Kula	Kolanai	Kahikinui
Kamuku	Kahikinui	Kolea	Koolau
Kanahena	Honuaula	Koloa	Koolau
Kanaio	Honuaula	Kooka	Lahaina
Kaniaula	Kaupo	Kopili	Lahaina
Kaonoulu	Kula	Kou	Kaupo

LIST OF LANDS—Continued.

ISLAND OF MAUI—Continued.

Land	District	Land	District
Kowali	Hana	Mooloa	Honuaula
Kualapa	Honuaula	Mooloa	Koolau
Kuhiwa	Koolau	Moomuku	Honuaula
Kuholilua	Lahaina	Muolea	Hana
Kuhua	Lahaina	Nahanawale	Hana
Kuia	Lahaina	Nahiku	Koolau
Kuiaha	Hamakualoa	Naholokú	Kaupo
Kukoae	Kaupo	Nahuakamalii	Hana
Kukui	Koolau	Nailiilipoko	Kipahulu
Kukuiaeo	Kula	Nakaaha	Kahikinui
Kukuikapu	Lahaina	Nakalii	Koolau
Kukuioolu	Kaupo	Nakaohu	Kahikinui
Kukuiula	Kipahulu	Nakapauku	Kaupo
Kumunui	Kaupo	Nakapehu	Koolau
Lamanui	Kaupo	Nakukuikea	Kahikinui
Lanipo	Kahikinui	Nakula	Kaupo
Lapakea	Lahaina	Naniumalu	Kaupo
Lapalapaiki	Hana	Napahoa	Koolau
Launiupoko	Lahaina	Napili	Kaanapali
Loiloa	Koolau	Napuhaehae	Koolau
Lole	Kaupo	Niniao	Kaupo
Louluape	Kahikinui	Niumalu	Hana
Lualailua	Kahikinui	Nuu	Kaupo
Maalo	Kaupo	Ohia	Hana
Mahinahina	Kaanapali	Oloewa	Hana
Mahulua	Hana	Olowalu	Lahaina
Mailepai	Kaanapali	Omaopio	Kula
Maipalaha	Kaupo	Onau	Honuaula
Makaalae	Hana	Onouli	Hana
Makaeha	Kula	Opaeula	Lahaina
Makaiwa	Koolau	Opana	Hamakualoa
Makakaha	Lahaina	Opikoula	Koolau
Makamoku	Kahikinui	Paauhau	Kaupo
Makapala	Koolau	Paeahu	Honuaula
Makapihi	Koolau	Paehala	Hana
Makapuu	Hana	Paeohi	Lahaina
Makawao	Hamakuapoko	Pahoa	Lahaina
Makila	Lahaina	Paia	Hamakuapoko
Maluaka	Honuaula	Paina	Kaupo
Mamalu	Kaupo	Pakakia	Hana
Manawainui	Kaupo	Pakea	Koolau
Maulili	Kipahulu	Palauea	Honaula
Mehamenui	Kahikinui	Palemo	Hana
Miana	Kaupo	Panaewa	Lahaina
Mikimiki	Kaupo	Panaiau	Hamakuapoko
Moalii	Lahaina	Papaaea	Hamakualoa
Mokae	Hana	Papaahawahawa	Hana
Mokuia	Kaupo	Papaanui	Honuaula
Mokupapa	Hamakualoa	Papaauhau	Hana
Mooiki	Kaupo	Papaka	Honuaula
Mooiki	Honuaula	Papauluana	Kipahulu

LIST OF LANDS—Continued.

ISLAND OF MAUI—Continued.

Land	District	Land	District
Paunau	Lahaina	Puulonalona	Koolau
Pauwela	Hamakualoa	Puumaile	Koolau
Peahi	Hamakualoa	Puumaneoneo	Kaupo
Piapia	Hana	Puunau	Lahaina
Poe	Kaupo	Puunoa	Lahaina
Pohakanele	Hana	Puuomahuka	Hana
Pohoula	Kaupo	Puuomaiai	Kaupo
Pohue	Hana	Puuomaile	Hamakualoa
Polaiki	Lahaina	Puupapaia	Koolau
Polala	Kahikinui	Uaoa	Hamakualoa
Polanui	Lahaina	Uhao	Lahaina
Polapola	Lahaina	Ukumehame	Lahaina
Pólipoli	Wailuku	Ulaino	Koolau
Poloai	Kahikinui	Ulumalu	Hamakualoa
Polua	Kaanapali	Wahikuli	Lahaina
Poopao	Hana	Waiahole	Koolau
Popoiwi	Kaupo	Waiahole	Kaupo
Popoloa	Kipahulu	Waiakoa	Kula
Poponui	Kipihulu	Waianu	Koolau
Puaa	Lahaina	Waiehu	Wailuku
Puaaloa	Lahaina	Waieli	Hana
Puahoowali	Lahaina	Waihee	Wailuku
Puakea	Koolau	Waihonu	Hana
Puakó	Lahaina	Waikapu	Wailuku
Pualaea	Kaupo	Wailamoa	Kipahulu
Puehuehu	Lahaina	Wailaulau	Kahikinui
Puehuehuiki	Lahaina	Wailaulau	Koolau
Pueokahi	Hana	Wailua	Hana
Pukaauhuhu	Kaupo	Wailua iki	Koolau
Pukalani	Kula	Wailua nui	Koolau
Pukuilua	Hana	Wailuku	Wailuku
Pulama	Kaupo	Wainee	Lahaina
Pulehu iki	Kula	Waiohue	Koolau
Pulehu nui	Kula	Waiohuli	Kula
Punaluu	Koolau	Waiokama	Lahaina
Puolua	Hamakualoa	Waiokila	Kaanapali
Puou	Lahaina	Waioni	Koolau
Puuhaoa	Hana	Waiopai	Kahikinui
Puuiki	Hana	Waipahihi	Koolau
Puuiki	Lahaina	Waipao	Honuaula
Puukalaiipu	Koolau	Waipouli	Kaupo
Puukóholá	Hana	Wakiu	Hana
Puulakua	Kaupo	Wananalua	Hana
Puulani	Kaupo		

ISLAND OF KAHOOLAWE.

No lands mentioned in list.

ISLAND OF MOLOKAI.

Ahaino	Kona, south coast	Halawa	At northeast end
Hakaanui	Koolau, north coast	Honomuni	Kona
		Hoolehua	Kona

LIST OF LANDS—Continued.

ISLAND OF MOLOKAI—Continued.

Land	District	Land	District
Iloli	Kona	Kumueli	Kona
Kaamola	Kona	Lupehu	Kona
Kahanui	Kona	Mahulile	Koolau
Kahananui	Kona	Makahakupea	Kona
Kailiula	Kona	Makanalua	Koolau
Kainalu	Kona	Makole	Kona
Kalamaula	Kona	Makolelau	Kona
Kalaupapa	Koolau, north coast	Manawai	Kona
		Mapulehu	Kona
Kalawao	Koolau, north coast.	Moakea	Kona
		Moanui	Kona
Kaluaaha	Kona, south coast	Naiwa	Kona
		Nihoa	Koolau
Kaluakoi	West end, district of itself	Ohia	Kona
		Onoulimaloo	Kona
Kamaló	Kona, central	Onouliwai	Kona
Kamanoni	Kona	Palaau	Kona
Kamiloloa	Kona, central	Papalawa	Koolau
Kapaakea	Kona	Pelekunu	Koolau
Kapualei	Kona	Pohakuloa	Koolau
Kapuaokoolau	Kona	Pohakupili	Kona
Kaulei Ili	Koolau	Polapola	Koolau
Kaunakakai	Kona	Puaahala	Kona
Kawaikapu	Kona	Puaahaunui	Koolau
Kawaluna	Koolau	Puelelu	Kona
Kawela	Kona	Pukoo	Kona
Keawanui	Kona	Punalau	Kona
Keonekuino	Kona	Punaula	Kona
Keopukaloa	Kona	Ualapue	Kona
Keopukauuku	Kona	Waialua	Kona
Kikipua	Koolau	Waikolu	Koolau
Kipu	Koolau	Wailau	Koolau
Kumimi	Kona	Wawaie	Kona

ISLAND OF LANAI.

Land	District	Land	District
Kaa	Lanai	Kealia	Lanai
Kalulu	Lanai	Mahana	Lanai
Kamao	Lanai	Maunalei	Lanai
Kamoku	Lanai	Palawai	Lanai
Kaohi	Lanai	Paomai	Lanai
Kaunolu	Lanai		

ISLAND OF OAHU.

Land	District	Land	District
Aala	Kona	Halelena	Kona
Aiea	Ewa	Helemano	Waialu.
Alewa	Kona	Hamama	Kona
Apowale	Kona	Hamohamo	Kona
Auaukai	Kona	Hanakaoe	Koolauloa
Auwaiolimu	Kona	Haole	Kona
Hakipuu	Koolaupoko	Hauhaukoi	Kona
Halawa	Ewa	Hauula	Koolauloa
Haleaha	Koolauloa	Heeia	Koolaupoko

LIST OF LANDS—Continued.

ISLAND OF OAHU—Continued.

Land	District	Land	District
Hoaeae	Ewa	Kamákelá	Kona
Honolulu	Kona	Kamananui	Waialua
Honouliuli	Ewa	Kamoawaa	Kona
Kaaawa	Koolauloa	Kamoku	Kona
Kaaipu	Kona	Kamooakua	Kona
Kaakaukukui	Kona	Kamooiki	Kona
Kaakopua	Kona	Kamoomuku	Kona
Kaalaa	Kona	Kanalaa	Kona
Kaalaea	Koolaupoko	Kaneloa	Kona
Kaalawai	Kona	Kaneohe	Koolaupoko
Kaaleo	Kona	Kanewai	Kona
Kaauhaloa	Kona	Kaniukukahi	Kona
Kaaumoa	Kona	Kapaakea	Kona
Kaena	Koolauloa	Kapahaha	Kona
Kaena	Waialua	Kapahulu	Kona
Kaelepulu	Koolaupoko	Kapaka	Koolauloa
Kahalauluahine	Kona	Kapalama	Kona
Kahaluu	Koolauloa	Kapalepo	Kona
Kahana	Koolauloa	Kapaloa	Kona
Kahanahaiki	Waianae	Kapano	Koolauloa
Kahapaakai	Kona	Kapiwai	Kona
Kahauiki	Kona	Kapuna	Kona
Kahaumakaawe	Kona	Kauhikio	Kona
Kahawale	Kona	Káukahokú	Kona
Kaheeka	Waialua	Kauluwela	Kona
Kahehuna	Kona	Kaunala	Koolauloa
Kahoiwai	Kona	Kawaihapai	Waialua
Kahookane	Kona	Kawaiiki	Kona
Kahui	Kona	Kawailoa	Waialua
Kahuku	Koolauloa	Kawailoa	Koolaupoko
Kaikahi	Kona	Kawaiolena	Kona
Kailua	Koolaupoko	Kawananakoa	Kona
Kaipapau	Koolauloa	Kawela	Koolauloa
Kaiwiokaihu	Kona	Keaau iki	Waianae
Kalaepohaku	Kona	Keaau nui	Waianae
Kalaheo	Koolaupoko	Kealia	Waialua
Kalamanamana	Kona	Keana	Koolauloa
Kalauao	Ewa	Keauhou	Kona
Kalawahine	Kona	Keawaula	Waianae
Kalehua	Kona	Kekio	Kona
Kalena	Waianae	Keolu	Koolaupoko
Kalia	Kona	Keoneula	Kona
Kalihi	Kona	Kepuhi	Kona
Kaliu	Kona	Kewalo	Kona
Kaloiiki	Kona	Kiki	Kona
Kalokohonu	Kona	Koiuiu	Kona
Kaluaalaea	Kona	Kolowalu	Kona
Kaluahole	Kona	Kuaipaako	Kona
Kaluanui	Koolauloa	Kuaiula	Kona
Kaluaokau	Kona	Kualoa	Koolaupoko
Kaluaolohe	Kona	Kuhimana	Kona

LIST OF LANDS—Continued.

ISLAND OF OAHU—Continued.

Land	District	Land	District
Kukanaka	Kona	Papaakoko	Koolauloa
Kukuio	Kona	Pau	Kona
Kukuluaeo	Kona	Paukoa	Kona
Kuliouou	Kona	Paumalu	Koolauloa
Kumuula	Kona	Pauoa Valley	Kona
Kunawai	Kona	Pawaa	Kona
Kuokalá	Waialua	Piliamoo	Kona
Kuwili	Kona	Poeaki	Kona
Laie	Koolauloa	Poloke	Kona
Laimi	Kona	Pouhuluhulu	Kona
Laukalo	Kona	Puahia	Kona
Luakaha	Kona	Pualoalo	Kona
Makaha	Waianae	Puheemiki	Koolauloa
Makao	Koolauloa	Puiwa	Kona
Makaua	Koolauloa	Pukele	Kona
Makiki Valley	Kona	Punaánaaná	Kona
Makua	Waianae	Punaluu	Koolauloa
Malaekahana	Koolauloa	Pupukea	Koolauloa
Manana iki	Ewa	Puulena	Kona
Manana nui	Ewa	Puuloa	Ewa
Manoa Valley	Kona	Puunui	Kona
Maulekikepa	Kona	Ulupehupehu	Koolauloa
Maunalua	Kona	Uwau	Koolaupoko
Moanalua	Kona	Wáhiawá	Waialua
Mokuleia	Waialua	Waiahole	Koolaupoko
Mookahi	Kona	Waiaka	Kona
Nini	Kona	Waialae	Kona
Niolopá	Kona	Waialee	Koolauloa
Niupaipai	Kona	Waiau	Ewa
Nukunukuaula	Kona	Waiawa	Ewa
Nuu	Kona	Waihee	Koolaupoko
Nuuanu Valley	Kona	Waihí-	Kona
Ohikilolo	Waianae	Waikahalulu	Kona
Oio	Koolauloa	Waikane	Koolaupoko
Olokú	Kona	Waikele	Ewa
Olomana	Koolaupoko	Waikiki, subdistrict	Kona
Olomana	Kona	Wailele	Kona
Opana	Koolauloa	Wailupe	Kona
Paalaa	Waialua	Waimalu	Ewa
Pahipahialua	Koolauloa	Waimanalo	Koolaupoko
Pahoa	Waianae	Waimano	Ewa
Pahupahuapuaa	Kona	Waimea	Koolauloa
Palikea	Kona	Waiomao	Kona
Palolo Valley	Kona	Waiono	Koolauloa
Pamoa	Kona	Waipio	Ewa

ISLAND OF KAUAI.

Land	District	Land	District
Aliomanu	Koolau	Haiku	Puna
Anahola	Koolau	Halaula	Puna
Eleele	Kona	Hanakapiai	Napali
Haena	Halelea	Hanakoa	Napali

LIST OF LANDS—Continued.

ISLAND OF KAUAI—Continued.

Land	District	Land	District
Hanamaulu	Puna	Mahaulepu	Puna
Hanalei	Halelea	Makaweli	Kona
Hanapepe	Kona	Moloaa	Koolau
Homaikawaa	Puna	Namahana	Koolau
Honopu	Napali	Nawiliwili	Puna
Huleia, subdistrict	Puna	Niumalu	Puna
Kaakaaniu	Koolau	Olohena	Puna
Kahili	Koolau	Paa	Kona
Kalaheo	Kona	Papaa A	Koolau
Kalalau	Napali	Papaa B	Koolau
Kalapaki	Puna	Pilaa	Koolau
Kalihikai	Halelea	Pohakuao	Napali
Kalihiwai	Halelea	Wahiawá	Kona
Kamalomalo	Puna	Waiakalua	Koolau
Kapaa	Puna	Waikoko	Halelea
Kealia	Puna	Wailua	Puna
Kikiaola	Kona	Waimea	Kona
Kilauea	Koolau	Wainiha	Halelea
Kipu	Puna	Waioli	Halelea
Koloa	Kona	Waipá	Halelea
Kumukumu	Puna	Waipake	Koolau
Lawai	Kona	Waipouli	Puna
Lepeuli	Koolau	Wawapuhi	Napali
Lumahai	Halelea	Weliweli	Kona

ISLAND OF NIIHAU.

Halawela	Niihau	Pohueloa	Niihau
Kahuku	Niihau	Puahula	Niihau
Kaluahonu	Niihau		

TOWNS, VILAGES, AND HAMLETS.

ISLAND OF HAWAII.

Name	District	Name	District
Ahualoa	Hamakua	Honuapo	Kau
Ainakea	North Kohala	Hookena	South Kona
Alae	South Kona	Kaapahu	Hamakua
Haaheo	Hilo	Kaauhuhu	Hamakua
Haena	Puna	Kaawaloa	South Kona
Hakalau	Hilo	Kahaualea	Puna
Halaula	North Kohala	Kailua	North Kona
Halawa	North Kohala	Kaimú	Puna
Hawí	North Kohala	Kaiwiki	Hilo
Hilea	Kau	Kalaoa	North Kona
Hilo	Hilo	Kalapana	Puna
Holualoa	North Kona	Kalolo	Hamakua
Honaunau	South Kona	Kamaoa	Kau
Honoipu	North Kohala	Kapoho	Puna
Honokaa	Hamakua	Kauaea	Puna
Honokahau	North Kona	Kawaihae	South Kohala
Honomakau	North Kohala	Keahialaka	Puna
Honomú	Hilo	Kealakehe	North Kona

TOWNS, VILLAGES, AND HAMLETS—Continued.

ISLAND OF HAWAII—Continued.

Name	District
Keauhou	North Kona
Kehena	Puna
Koholalele	Hamakua
Kukuihaele	Hamakua
Laupahoehoe	Hilo
Mahukona	North Kohala
Makalawena	North Kona
Makapala	North Kohala
Makuu	Puna
Milolii	South Kona
Napoopoo	South Kona
Niulii	North Kohala
Olaa	Puna
Onomea	Hilo
Ookala	Hilo
Opihikao	
Paauilo	Hamakua
Pahala	Kau
Pahoa	Puna
Papa	South Kona
Papaikou	Hilo
Pepeekeo	Hilo
Pohakupuka	Hilo
Pololú	North Kohala
Puakó	South Kohala
Punaluu	Kau
Puuhue	North Kohala
Puula	Puna
Waiakea	Hilo
Waimanu	Hamakua
Waimea	South Kohala
Waiohinu	Kau
Waipio	Hamakua

ISLAND OF KAUAI.

Name	District
Anahola	Halelea
Haena	Halelea
Hanalei	Halelea
Hanamaulu	Puna
Hanapepe	Kona
Kalalau	Napali
Kalihi	Halelea
Kapaa	Puna
Kealia	Puna
Kekaha	Waimea
Kilauea	Halelea
Koloa	Kona
Lihue	Puna
Makaweli	Kona
Mana	Waimea
Wailua	Puna
Waimea	Waimea
Waioli	Halelea

ISLAND OF LANAI.

Name	District
Palawai	Southern Central
Koele	Northern Central
Halepalaoa	East Coast
Maunalei	East Coast

ISLAND OF MAUI.

Name	District
Alae	Kipahulu
Haiku	Hamakualoa
Halehaku	Hamakualoa
Halemano	Kipahulu
Hamakuapoko	Hamakuapoko
Hana	Hana
Haoú	Hana
Honokahau	Kaanapali
Honokowai	Kaanapali
Huelo	Hamakualoa
Kahakuloa	Kaanapali
Kahului	Wailuku
Kaupakulua	Hamakualoa
Kealahou	Kula
Keanae	Koolau
Keokea	Kula
Kihei	Kula
Lahaina	Lahaina
Makawao	Hamakuapoko
Makena	Honuaula
Mokulau	Kaupo
Muolea	Hana
Nahiku	Koolau
Nuu	Kaupo
Olualu	Lahaina
Paia	Hamakuapoko
Pauwela	Hamakualoa
Puuiki	Hana
Puunene	Wailuku
Spreckelsville	Wailuku
Ukumehame	Lahaina
Ulupalakua	Honuaula
Waihee	Wailuku
Waikapu	Wailuku
Wailuku	Wailuku
Wailua	Koolau

TOWNS, VILLAGES, AND HAMLETS—Continued.

ISLAND OF MOLOKAI.

Name	District	Name	District
Halawa	Kona	Kaunakakai	Kona
Kalae	Kona	Pelekunu	Koolau
Kalaupapa	Koolau	Pukoo	Kona
Kalawao	Koolau	Waialua	Kona
Kaluaaha	Kona	Wailau	Koolau
Kamaló	Kona		

ISLAND OF OAHU.

Name	District	Name	District
Halawa	Ewa	Niu	Kona
Hauula	Koolauloa	Palolo	Kona
Honolulu	Kona	Pearl City	Ewa
Honouliuli	Ewa	Punaluu	Koolauloa
Kahana	Koolauloa	Wahiawa	Waialua
Kahuku	Koolauloa	Waiahole	Koolaupoko
Kailua	Koolaupoko	Waialae	Kona
Kalihi	Kona	Waialua	Waialua
Kaneohe	Koolaupoko	Waianae	Waianae
Laie	Koolauloa	Waiawa	Ewa
Makaha	Waianae	Waikane	Koolaupoko
Makua	Waianae	Waikiki	Kona
Manoa	Kona	Wailupe	Kona
Moanalua	Kona	Waimanalo	Koolaupoko
Moiliili	Kona	Waimea	Koolauloa
Mokuleia	Waialua	Waipahu	Ewa

MEANING OF HAWAIIAN GEOGRAPHIC NAMES.

It is very difficult, if not impossible, to translate most of these names, on account of their great antiquity and the changes which many of them have evidently undergone. It often happens that a word may be translated in different ways by dividing it differently. Many names of places in these islands are common to other groups of islands in the South Pacific, and were probably brought here by the earliest colonists. They have been used for centuries without any thought of their original meaning.

Sometimes they embody names of persons of whom no tradition remains, e. g., *Ka-wai-a-Hao*, "the water of Hao;" *Ka-puu-o-Uo*, "the hill of Uo," etc.

Many names, however, are evidently descriptive, as *Mauna Loa*, "long mountain;" *Mauna Kea*, "the white mountain"—Mont Blanc; *Puu Ulaula*, "red hill;" *Ka-punahou*, "the new spring;" *Ka-lae-loa*, the "long cape;" *Ke-ala-i-Kahiki*, "the way to Tahiti," the west point of Kahoolawe, etc.

The compounds of *Wai*, "water," are numerous, as *Wai-awa*, bitter water; *Wai-manalo*, brackish water; *Wai-aleale*, rippling water; *Wai-oli*, singing water; *Wai-akea*, open water; *Wai-lua*, two waters, etc.

Compounds of *Hono*, an obsolete word for harbor, are also numerous, as *Hono-lulu*, quiet harbor or Fair Haven; *Hono-malino*, calm harbor; *Hono-manu*, bird harbor; *Hono-uliuli*, blue harbor, etc.

In the vicinity of Honolulu the name *Nuu-anu* is compounded of *nuu*, a step or terrace, and *anu*, cool. *Puowaina*, Punchbowl Hill, is said by native pundits to be a contraction of *puu-o-waiho-ana*, "the hill of sacrifice." *Manoa* is the "*broad*" valley;

Palolo, the "clay" valley; *Ka-imu-ki*, "the oven for *ti* root," where the saccharine root of the Cordyline terminalis was cooked for food. *Ka-lihi* means the "outside edge," or boundary valley. *Ka-moo-iliili* is "the pebbly strip."

Hale-a-ka-la is generally translated "House of the Sun," but according to the ancient legend it is the place where the sun was ensnared by the demigod Maui, and the form of the same name applied to a mountain in Waianae, Oahu, is *Hele-a-ka-la*, "the trap of the sun." *Hale-lea*, a district on Kauai, is "house of joy." *Ka-lihi-kai* means "edge of the sea," and *Kai-lua*, "two seas." *Ka-ú*, a district on Hawaii, is "the female breast," and *Ke-ala-ke-kua*, "the way of the gods," who haunted the precipices that overhang that bay. *Ka-wela* is "the hot" (place).

The following is a glossary of the words most frequently occurring in Hawaiian geographic names:

GLOSSARY.

A.

Aa	root
A'á	rough lava
Ahi	fire
Ahina	gray
Ahua	a mound, a heap
'Ai	food, to eat
'Aina	land
Akua	a spirit, a deity
Ala	way
Alae	a mud-hen
Alaea	red ochre
Alalá	a crow
Ale	a wave
Aleale	rippling
Alii	a chief
Ana	a cave
Anaaná	to pray to death
Anae	a young mullet
Anu	cold
Anuenue	a rainbow
Ao	light
Apana	a district
Au	a current, time
Auau	to bathe
Auhau	a tax
Auhuhu	fish poison, Tephrosia piscatoria
Auwana	to wander
Ăwa	a harbor
Awawa	a valley
'Āwa	a plant, Piper methysticum

E.

Ea	a turtle
Eha	pain, sore
Ehoeho	a monument, cairn
Eleele	(adj.) black
Eli	to dig, excavate

H.

Haaheo	(adj.) proud
Haalele	to forsake
Haiki	narrow, close
Haku	lord
Hala	Pandanus tree
Hala	fault, defect
Hale	house
Halulu	to roar, rumble
Hamo	to smear, anoint
Hana	to work
Hau	dew, snow
Hau	a tree, Hibiscus tiliaceus
Hee	to slide
Hee	a squid
Hele	to go
Hele	a trap
Hihiu	(adj) wild
Hiki	to come
Hikina	east
Hina	to fall
Hina	(adj.) gray
Hiu	a fish's tail
Hoa	a friend
Hokú	a star
Hole	to peel, to flay
Holo	to run

GLOSSARY—Continued.

Holua	a sliding place
Hono	a harbor
Honu	a turtle
Honua	land
Hope	(adj.) after, last
Hou	(adj.) new
Hu	to gush out, to spout
Hua	a fruit
Hu'a	sea foam
Hue	small gourd, Lagenaria vulgaris
Huelo	a tail
Huli	to turn
Hulu	hair, feathers
Huna	secret
Hune	(adj.) poor, destitute

I.

Ihe	a javelin
Ihu	nose, break
Iki	little
Ili	skin, a division of land
Iliahi	sandalwood
Iliili	pebbles
Ilio	a dog
Imu	an oven
Ilole	a mouse, rat
Iwa	nine
Iwi	a bone

K.

Ka	(art.) the
Kaa	to roll
Kaao	story, legend
Kahawai	water course
Kahe	to flow
Kahiki	Tahiti
Kahiko	ancient
Kahua	site, foundation
Kahuna	a priest
Kai	sea
Kaikuono	bay
Kala	(adj.) rough, prickly
Kala	end of a house
Kali	to wait
Kama	child
Kamani	a tree, Calophyllum inophyllum
Kapu	taboo
Kapuai	a foot
Kaua	war
Kauhale	village
Kaulana	famous
Kaumaha	heavy
Kea	white
Kee and Kekee	crooked
Kele	muddy
Ke'oke'o	white
Ki	a plant, Cordyline terminalis
Kii	an image
Kini	(adj.) numerous
Kipi	(adj.) rebellious
Ko	sugar cane
Koa	a tree, acacia Koa
Koa	a warrior
Koae	the tropic bird
Koekoe	cold
Kohana	naked
Koheo	stiff
Koholá	a whale
Ko'i	an axe
Koko	blood
Koko	a calabash net
Kole	(adj.) raw, uncooked, red
Kolea	the plover
Koloa	the wild duck
Kolu	three
Komo	to enter
Kopili	a kind of kapa
Kou	a tree, Cordia subcordata
Kowá	a channel
Kowali	a swing rope
Kua	a back, a ridge
Kuhua	(adj.) hard, thick, as a liquid
Kukui	a tree, Aleurites moluccana
Kukuluaeo	stilts, the stilt plover
Kula	dry upland
Kumu	the trunk of a tree
Kunu	cough
Kupua	a magician, wizard

GLOSSARY—Continued.

L.

La	the sun
Laa	(adj.) sacred
Laau	a tree, a plant
Lae	a cape
Lahilahi	(adj.) thin
Lahui	a nation, tribe
Lala	a branch
Lama	a torch, a tree, Maba Sandwicensis
Lani	the sky, heaven
Lapa	a narrow ridge
Lau	a leaf
Lehu	ashes
Lei	a wreath
Lele	to fly, leap
Lena	yellow
Leo	voice
Lepo	dirt
Lihi	edge
Lima	hand
Limu	moss
Liu	bilgewater
Loa	(adj.) long
Loi	a taro patch
Loihi	(adj.) long
Loko	a fish pond
Lua	a pit, crater
Lua	two
Luku	slaughter
Lulu	to sow
Lupe	a kite
Luu	to dive

M.

Maele	
Mahoe	a twin
Mahuka	to run away, desert
Maile	a plant, Alyxia olivæformis
Maka	an eye
Makani	wind
Makau	a fishhook
Maláma	a month
Málama	to take care of
Malino	calm
Maloo	(adj.) dry
Malu	shade
Mana	power
Manawai	a branch of a stream
Manálo	brackish
Manana	
Maneoneo	a beach grass
Maneoneo	to itch
Manienie	(adj.) smooth
Manó	a shark
Manoa	thick, broad
Manu	a bird
Mau	(adj.) perpetual
Mauna	a mountain
Mauu	grass
Meha	lonely
Mo'a	cooked
Moa	a fowl
Moana	ocean
Moe	to lie down
Moho	a wingless bird
Moku	an island, a district
Mokupuni	an island
Moo	a lizard, a narrow strip of land
Muku	(adj.) cut short
Muliwai	a river

N.

Naná	to look
Nené	the wild goose
Niho	a tooth
Niu	a cocoanut tree
Noho	to sit, to remain
Nui	(adj.) great
Nuku	bill of a bird
Nuku	a narrow entrance of a river or harbor
Nuu	a terrace, steps

O.

Ohe	bamboo
Ohia	a tree, the Metrosideros, also the Eugenia
Oio	a procession of ghosts
Ola	life
Olelo	to speak, a word
Olepe	an oyster
Oli	to sing
Olohe	naked
One	sand
Ono	sweet
Oo	ripe
Oo	a bird, Acrulocercus nobilis, from which yellow feathers were taken
Opae	a shrimp
Opipi	a shell fish
Opu	the belly

GLOSSARY—Continued.

P.

Pa	a fence, an enclosure
Paakea	limestone
Pae	to land
Pahoehoe	smooth
Pahu	a stake, a box
Paihi	a place where there is a waterfall only in rainy weather
Pala	a kind of fern
Pala	ripe
Pali	a precipice
Palolo	clay
Papa	a board
Papai	a crab
Pau	(adj.) done, finished
Pauku	a piece
Peahi	to beckon
Piha	(adj.) full
Pii	to ascend
Po	night
Pohaku	a rock
Póho	a dead calm
Pohó	to sink
Pohue	a kind of vine, Ipomea pes-caprae
Poko	(adj.) short
Pola	the platform of a double canoe
Pono	right
Po'o	head
Pou	post
Pua	a flower
Puaa	a hog
Puehu	to scatter
Pueo	an owl
Puhi	an eel
Puhi	to blow
Puka	an opening, a door
Pulehu	to bake
Puna	lime
Pupu	a shell
Puu	a hill

U.

U	the breast of a woman
Ua	rain
Uhane	a ghost
Uhi	a yam
Uhi	to cover
Uka	(adj.) inland
Ula and Ulaula	(adj.) red
Uli and Uliuli	(adj.) blue
Ulu	a breadfruit tree
Umauma	the breast
Upena	a net
Uuku	(adj.) little

W.

Waa	a canoe
Waa	a furrow, channel
Waha	a mouth
Wai	water
Waihu	a gushing fountain
Wailele and Waihi	a waterfall
Wanana	a prophecy
Wela	(adj.) hot
Weliweli	(adj.) terrible
Wiki	(adj.) quick, swift

HAWAIIAN GEOGRAPHIC NAMES ARRANGED ALPHABETICALLY.

The alphabetical list is compiled in the following order:

First, the geographic name; second, the meaning when known, in brackets; third, the geographic feature, in parenthesis; fourth, the district; fifth, the island, in italics; sixth, the elevation.

LIST.

Aahoaka; Puna; *Kauai.*
Aahuwela; [hot robe]; North Hilo; *Hawaii;* elevation, 7 747 feet.
Aala; [fragrant]; (land section); Kona; *Oahu.*
Aamakao; (land section); Kohala; *Hawaii.*
Aamanu; (land section); Hamakua; *Hawaii.*
Aapueo; (land section); Kula; *Maui.*
Aemale; (land section); Ka-u; *Hawaii.*
Ahaino; [bad prayer]; (land section); Kona; South coast; *Molokai.*
Ahalanui; (land section); Puna; *Hawaii.*
Ahikuli; (land section); Wailuku; *Maui.*
Ahinui Puu; [hill of great fire]; South Kona; *Hawaii;* elevation, 3 968 feet.
Ahoa; (land section); Lahaina; *Maui.*
Ahole; (stream); Hilo; *Hawaii.*
Ahuakeio; (land section); Hana; *Maui.*
Ahualiku; Kona district; *Kauai.*
Ahualoa; [long mound]; (land section); Hamakua; *Hawaii.*
Ahualoa; (village); Hamakua; *Hawaii.*
Ahualoa; Hamakua; *Hawaii;* elevation, 1 180 feet.
Ahua Umi; [Umi's cairn]; Ka-u; *Hawaii.*
Ahulua; [two piles of stone]; (land section); Kohala; *Hawaii.*
Ahumoa; Hamakua; *Hawaii;* elevation, 7 034 feet.
Ahupau; (land section); Kula; *Maui.*
Aiea; [a shrub, Nothocastrum]; (land section); Ewa; *Oahu.*
Aiea; (stream); Koolau; *Maui.*
Ainakea; [white land]; (land section); Kohala; *Hawaii.*
Ainakea; (village); North Kohala; *Hawaii.*
Akahipuu; [one hill]; North Kona; *Hawaii;* elevation, 2 236 feet.
Akakoa; (point); *Hawaii.*
Aki; (land section); Lahaina; *Maui.*
Akihi; Ka-u; *Hawaii.*
Alaakua; [path of gods]; (land section); Kaupo; *Maui.*
Alae; [mud hen]; (land section); Hilo; *Hawaii.*
Alae; (land section); South Kona; *Hawaii.*
Alae; (land section); Kipahulu; *Maui.*
Alae; (land section); Kula; *Maui.*
Alae; (village); Kipahulu; *Maui.*
Alae; (village); South Kona; *Hawaii.*
Alaeakila; [alae of Kila]; (land section); Hamakua; *Hawaii.*
Alaea Makawao, Puu; [red ocher hill]; *Maui;* elevation, 3 253 feet.
Alaeloa; [long Alae]; (land section); Hilo; *Hawaii.*
Alaeloa; (land section); Kaanapali; *Maui.*
Alaenui; [great Alae]; (land section); Kipahulu; *Maui.*
Alakahi; (land section); Hilo; *Hawaii.*
Alalá; [crying]; North Hilo; *Hawaii;* elevation, 762 feet.
Alalakeiki; [the crying of children]; (channel); between *Maui* and *Kahoolawe.*
Alamihi; (land section); Lahaina; *Maui.*
Alani, Puu; [hill of alani tree]; Kona; *Kauai.*
Aleamai; (land section); Hana; *Maui.*
Aleamai; (stream); Hilo; *Hawaii.*
Aleamai; (land section); Hilo; *Hawaii.*
Alena; (land section); Kahikinui; *Maui.*
Alenuihaha; [great waves pursuing]; (channel); between *Maui* and *Hawaii.*

Alewa; (land section); Kona; *Oahu.*
Alia; (point); Hilo; *Hawaii.*
Alii, Puu; *Lanai;* elevation, 2 799 feet.
Alii, Puu; [royal hill]; Central Range; *Molokai;* elevation, 4 200 feet.
Alika; (land section); South Kona; *Hawaii.*
Alio; (land section); Lahaina; *Maui.*
Aliomanu; (stream); Halelea; *Kauai.*
Aliomanu; (land section); Koolau; *Kauai.*
Anaehoomalu; (land section); Kohala; *Hawaii.*
Anahola; (village); Halelea; *Kauai.*
Anahola; [fish poison cave]; (land section); Koolau; *Kauai.*
Anahola; (stream); Halelea; *Kauai.*
Anahola, Puu; Koolau; *Kauai.*
Anahulu; [ten days]; North Kona; *Hawaii;* elevation, 1 523 feet.
Anapuka; [cave open to the sea]; (land section); South Kona; *Hawaii.*
Anuenue; [rainbow]; Hamakua; *Hawaii;* elevation, 1 611 feet.
Apakuie; Hamakua; *Hawaii;* elevation, 5 849 feet.
Apole; (point); Kaupo; *Maui.*
Apowale; [to seize]; (land section); Kona; *Oahu.*
Apua; [cup]; (land section); Puna; *Hawaii.*
Apua; [land section]; Hamakua; *Hawaii.*
Apuakohau; (land section); Kohala; *Hawaii.*
Au; [current]; (land section); Hamakua; *Hawaii.*
Auau; [bathing]; (land section); Kohala; *Hawaii.*
Auau; [currents]; (channel); between *Lanai* and *Maui.*
Auaukai; (land section); Kona; *Oahu.*
Auhao; (land section); Lahaina; *Maui.*
Auhaukeae; (land section); North Kona; *Hawaii.*
Auhaukeae; North Kona; *Hawaii;* elevation, 274 feet.
Auhuhu; [a plant used in poisoning fish]; (land section); Hamakua; *Hawaii.*
Auhulili; (land section); Ka-u; *Hawaii.*
Aukai, Puu; Kona; *Kauai.*
Auliilii; (land section); Ka-u; *Hawaii.*
Aupokopoko; [short time]; (land section); Lahaina; *Maui.*
Auwahi; (land section); Kahikinui; *Maui.*
Auwaiolimu; [mossy water ditch]; (land section); Kona; *Oahu.*
Awakee; [crooked harbor]; (land section); North Kona; *Hawaii.*
Awalua; (land section); North Kona; *Hawaii.*
Awalua; [two harbors]; (land section); Kohala; *Hawaii.*
Awalua Landing, north end *Lanai.*
Awapuhi; [ginger]; (land section); Hilo; *Hawaii.*
Awawaiki; [little valley]; (land section); Hilo; *Hawaii.*
Awawaloa; [long valley]; (land section); Hilo; *Hawaii.*
Awawaloa; (Mt. Olympus); Manoa Valley; *Oahu;* elevation, 2 447 feet.
Awini; (land section); Kohala; *Hawaii.*
Awininui; [great Awini]; (land section); Kohala; *Hawaii.*
Diamond Head; (Leahi); *Oahu;* elevation, 761 feet.
Eleele; [black]; (land section); Kona; *Kauai.*
Eke; (crater in Waihee); *Maui;* elevation, 4 500 feet.
Enuhe, Puu; [hill of caterpillars]; Ka-u; *Hawaii;* elevation, 2 327 feet.
Eu, Puu; Koolau; *Kauai.*
Ewa; (district); *Oahu.*
Haaheo; [pride]; (land section); Hilo; *Hawaii.*
Haaheo; (village); Hilo; *Hawaii.*
Haakoa; (land section); Hilo; *Hawaii.*
Haalelehinale; (land section); Kaupo; *Maui.*
Haena; (land section); Halelea; *Kauai.*
Haena; (village); Halelea; *Kauai.*
Haena; (land section); Kohala; *Hawaii.*
Haena; (village); Puna; *Hawaii.*
Hahalawe; (land section); Hana; *Maui.*
Hahalehili; (land section); Hana; *Maui.*
Haikú; (land section); Hilo; *Hawaii.*
Haiku; (village); Hamakualoa; *Maui.*
Haiku; (land section); Puna; *Kauai.*
Haiku; (land section); Hamakualoa; *Maui.*
Haina; (land section); Hamakua; *Hawaii.*
Hakaanui; [great Hakaa]; (land section); Koolau; north coast; *Molokai.*
Hakalau; (land section); Hilo; *Hawaii.*
Hakalau; (stream); Hilo; *Hawaii.*
Hakalau; (village); Hilo; *Hawaii,*
Hakalau Bay; Hilo; *Hawaii.*
Hakipuu; (land section); Koolaupoko; *Oahu.*
Hakuhee; (point); Kaanapali; *Maui.*
Halai; [a calm]; Hilo; *Hawaii;* elevation, 347 feet.
Halakaa; (land section); Lahaina; *Maui.*
Halaula; (land section); Kohala; *Hawaii.*
Halaula; (village); North Kohala; *Hawaii.*
Halaula; [red Hala, Pandanus]; (land section); Puna; *Kauai.*
Halawa; (land section); at northeast end; *Molokai.*
Halawa; (land section); Kohala; *Hawaii.*
Halawa; (land section); Ewa; *Oahu.*
Halawa; (stream); Ewa; *Oahu.*
Halawa; (village); North Kohala; *Hawaii.*
Halawa; (village); Kona; east end; *Molokai.*
Halawa; (village); Ewa; *Oahu.*

Halawa Bay; Kona; *Molokai.*
Halawela; [hot Hala, Pandanus]; (land section); *Niihau.*
Haleaha; [assembly house]; (land section); Koolauloa; *Oahu.*
Haleakala; [house of the sun]; (highest point); *Maui;* elevation, 10 032 feet.
Haleakalá in Kaupo South; *Maui;* elevation, 8 208 feet.
Halehaku; (stream); Hamakualoa; *Maui.*
Halehaku; [master's house]; (land section); Hamakualoa; *Maui.*
Halehaku; (village); Hamakualoa; *Maui.*
Haleili; [bark house]; (land section); South Kona; *Hawaii.*
Haleili; [skin house]; South Kona; *Hawaii;* elevation, 1 766 feet.
Halekaa; (land section); Ka-u; *Hawaii.*
Halekii; [house of images]; (land section); North Kona; *Hawaii.*
Halekini; (land section); Koolau; *Maui.*
Halelea; [house of joy]; (district); *Kauai.*
Halelua; [tomb]; (land section); Kohala; *Hawaii.*
Halelua; (land section); Ka-u; *Hawaii.*
Halelena; [house of turmeric]; (land section); Kona; *Oahu.*
Halemano; [shark's house]; (land section); Kipahulu; *Maui.*
Halemano; (village); Kipahulu; *Maui.*
Haliu; [to turn]; (land section); Lahaina; *Maui.*
Haliimaile; [to spread out maile vines]; (land section); Hamakuapoko; *Maui.*
Haliilau; (land section); Hilo; *Hawaii.*
Haleohiu; [sorcery house]; (land section); North Kona; *Hawaii.*
Halepalaoa; (village); east coast; *Lanai.*
Halepuaa; [hog's house]; (land section); Puna; *Hawaii.*
Halepuna; [coral house]; (land section); Hilo; *Hawaii.*
Hamakua; [the back of the island]; (district); *Hawaii.*
Hamakualoa; [long Hamakua]; (district); *Maui.*
Hamakuapoko; (village); Hamakuapoko; *Maui.*
Hamakuapoko; [short Hamakua]; (district); *Maui.*
Hamama; [open]; (land section); Kona; *Oahu.*
Hamanamana; (land section); North Kona; *Hawaii.*
Hamoa; (land section); Hana; *Maui.*
Hamohamo; [to rub]; (land section); Kona; *Oahu.*
Hana; (district); *Maui.*
Hana; (village); Hana; *Maui.*
Hanahoi; (stream); Hamakualoa; *Maui.*
Hanaipoe; Hamakua; *Hawaii;* elevation, 5 143 feet.
Hanakaoo; (land section); Lahaina; *Maui.*
Hanakauhi, in Koolau North; *Maui;* elevation, 8 911 feet.
Hanakaoe; (land section); Koolauloa; *Oahu.*
Hanakapiai; (land section); Napali; *Kauai.*
Hanakoa; (land section); Napali; *Kauai.*
Hanalei; (stream); Halelea; *Kauai.*
Hanalei; [make a wreath]; (land section); Halelea; *Kauai.*
Hanalei; (village); Halelea; *Kauai.*
Hanalei Bay; Halelea; *Kauai.*
Hanamalo; (point); South Kona; *Hawaii.*
Hanamaulu; (land section); Puna; *Kauai.*
Hanamaulu Bay; Puna; *Kauai.*
Hanamaulu; (village); Puna; *Kauai.*
Hanapai; (land section); Hamakua; *Hawaii.*
Hanapepe; (stream); Kona; *Kauai.*
Hanapepe; [to crush]; (land section); Kona; *Kauai.*
Hanapepé; (village); Kona; *Kauai.*
Hanapepe Bay; Kona; *Kauai.*
Hanaula; (land section); Kohala; *Hawaii.*
Hanauma Harbor; Kona; *Oahu.*
Hanawana; [whispering]; (land section); Hamakualoa; *Maui.*
Hanawi; (stream); Koolau; *Maui.*
Hanehoi; (land section); Hamakualoa; *Maui.*
Haneoo; (land section); Hamakualoa; *Maui.*
Haole; [white]; (land section); Kona; *Oahu.*
Haou; (land section); Hana; *Maui.*
Haoú; (village); Hana; *Maui.*
Hapalapuka; (land section); Hamakua; *Hawaii.*
Hapapa; [shallow soil]; Waianae Range; *Oahu;* 2 878 feet.
Hauhaukoi; (land section); Kona; *Oahu.*
Haukalua; (land section); Hilo; *Hawaii.*
Haukalua; (land section); South Kona; *Hawaii.*
Haukoi; (land section); Hamakua; *Hawaii.*
Hauola; (land section); Hamakua; *Hawaii.*
Haupu; Kona; *Kauai;* elevation, 2 030 feet.
Hauula; [red dew]; (land section); Koolauloa; *Oahu.*
Hauula; (village); Koolauloa; *Oahu.*
Hawaii; (island).
Hawea; (point); Kaanapali; *Maui.*
Hawí; (land section); Kohala; *Hawaii.*
Hawi; (village); North Kohala; *Hawaii.*
Heeia; [slide]; (land section); Koolaupoko; *Oahu.*
Heiheiahulu; [race run by Hulu]; Puna; *Hawaii;* elevation, 1 692 feet.
Hele, Puu; [traveler's hill]; Wailuku; *Maui;* elevation, 214 feet.
Heleleikeoha; [scatter the oha]; (land section); Koolau; *Maui.*

Helemano; [to travel with thousands]; (land section); Waialua; *Oahu.*

Heleókalá; [the snare of the sun]; Waianae Range; *Oahu;* elevation, 1 885 feet.

Heneheneula; (land section); Hamakua; *Hawaii.*

Hianaloli; (land section); North Kona; *Hawaii.*

Hianaulua; (land section); Koolau; *Maui.*

Hihiu; [wild]; (land section); Kohala; *Hawaii.*

Hiilawe Falls, Waipio; Hamakua; *Hawaii;* elevation, 1 700 feet.

Hikiaupea; (land section); Kohala; *Hawaii.*

Hikiaupea; (land section); Kaupo; *Maui.*

Hilea; (village); Hilo; *Hawaii.*

Hilea; [lazy]; (land section); Ka-u; *Hawaii.*

Hilo; [name of an ancient navigator]; (district); *Hawaii.*

Hilo; (town); Hilo; *Hawaii.*

Hilo Bay; Hilo; *Hawaii.*

Hinai Puu; S. Kohala; *Hawaii;* elevation, 1 443 feet.

Hionaa; (land section); Ka-u; *Hawaii.*

Hionamoa; (land section); Ka-u; *Hawaii.*

Hoaeae; (land section); Ewa; *Oahu.*

Hoaeae; (stream); Ewa; *Oahu.*

Hoalua; [two friends]; (land section); Hamakualoa; *Maui.*

Hoea; (land section); Hamakua; *Hawaii.*

Hokukano; (land section); North Kona; *Hawaii.*

Hokukana; (land section); Ka-u; *Hawaii.*

Hokumahoe; [twin stars]; (land section); Hilo; *Hawaii.*

Hokuula; [red star]; South Kohala; *Hawaii;* elevation, 3 070 feet.

Hokuula; [red star]; (land section); Kula; *Maui.*

Holualoa; [long sled]; (land section); North Kona; *Hawaii.*

Holualoa; (village); North Kona; *Hawaii.*

Homaikawaa; [bring the canoe here]; (land section); Puna; *Kauai.*

Honalo; (land section); North Kona; *Hawaii.*

Honaunau; (land section); South Kona; *Hawaii.*

Honaunau; (village); South Kona; *Hawaii.*

Honaunau Bay; South Kona; *Hawaii.*

Honohina; [Hina's harbor]; Hilo; *Hawaii;* elevation, 712 feet.

Honohina; (land section); Hilo; *Hawaii.*

Honoipu; [calabash harbor]; (land section); Kohala; *Hawaii.*

Honoipu; (village); North Kohala; *Hawaii.*

Honoipu Landing; North Kohala; *Hawaii.*

Honokaa; (village); Hamakua; *Hawaii.*

Honokahau; [harbor of the hau tree]; (land section); North Kona; *Hawaii.*

Honokahau; (stream); Kaanapali; *Maui.*

Honokahau; [harbor of the hau]; (land section); Kaanapali; *Maui.*

Honokahau; (village); North Kona; *Hawaii.*

Honokahau; (village); Kaanapali; *Maui.*

Honokahau Bay; Kaanapali; *Maui.*

Honokahua; (stream); Kaanapali; *Maui.*

Honokahua; [harbor of the fruit]; (land section); Kaanapali, *Maui.*

Honokaia; [fish harbor]; (land section); Hamakua; *Hawaii.*

Honokala; [harbor of the sun]; (land section); Hamakualoa; *Maui.*

Honokalani; [harbor of the chief]; (land section); Hana; *Maui.*

Honokane; [harbor of cane]; (land section); Kohala; *Hawaii.*

Honokane; (stream); Kohala; *Hawaii.*

Honokane Head; East Kohala; *Hawaii;* elevation, 4 698 feet.

Honokeana; [harbor of the cave]; (land section); Kaanapali; *Maui.*

Honokowai; (stream); Kaanapali; *Maui.*

Honokowai; [harbor of the water]; (land section); Kaanapali; *Maui.*

Honokowai; (village); Kaanapali; *Maui.*

Honokua; [harbor of the back country]; South Kona; *Hawaii.*

Honolii; (stream); Hilo; *Hawaii.*

Honolua; [two harbors]; (land section); Kaanapali; *Maui.*

Honolua; (stream); Kaanapali; *Maui.*

Honolua Bay; Kaanapali; *Maui.*

Honolulu; (town); Kona; *Oahu.*

Honolulu; [fair haven]; (land section); Koolau; *Maui.*

Honolulu; (land section); Kona; *Oahu.*

Honolulu; (land section); Puna; *Hawaii.*

Honolulu Harbor or Kou; Kona; *Oahu.*

Honomaele; (land section); Hana; *Maui.*

Honomainoa; (land section); Hilo; *Hawaii.*

Honomakau; [fish hook]; (land section); Kohala; *Hawaii.*

Honomakau; (village); North Kohala; *Hawaii.*

Honomalino; [calm harbor]; (land section); South Kona; *Hawaii.*

Honomanu; [bird harbor]; (land section); Koolau; *Maui.*

Honomanu; (stream); Koolau; *Maui.*

Honomú Landing; Hilo; *Hawaii.*

Honomú; (village); Hilo; *Hawaii.*

Honomú; [harbor of the mu]; (land section); Hilo; *Hawaii.*

Honomuni; (land section); Kona; *Molokai.*

Honopou; [post harbor]; (land section); Hamakualoa; *Maui.*
Honopou; (stream); Hamakualoa; *Maui.*
Honopu; [scorched]; (land section); Na Pali; *Kauai.*
Honopue; (land section); Hamakua; *Hawaii.*
Honopue; (stream); Hamakua; *Hawaii.*
Honopueo; [owl harbor]; (land section); Kohala; *Hawaii.*
Honouliuli; [blue harbor]; (land section); Ewa; *Oahu.*
Honouliuli; (village); Ewa; *Oahu.*
Honuaino; [evil land]; (land section); North Kona; *Hawaii.*
Honuápo; (village); Ka-u; *Hawaii.*
Honuapo; [dark land]; (land section); Kau; *Hawaii.*
Honuapo Landing; Ka-u; *Hawaii.*
Honuaula; [red land]; (land section); North Kona, *Hawaii.*
Honuaula; (district); *Maui.*
Hookapuna; (land section); Hana; *Maui.*
Hookena; (land section); South Kona; *Hawaii.*
Hookena; (village); South Kona; *Hawaii.*
Hoolehua; (land section); Kona; *Molokai.*
Hoomaha Puu; [hill of rest]; Ka-u; *Hawaii;* elevation, 6 636 feet.
Hoolawa; [to complete]; (land section); Hamakualoa, *Maui.*
Hoopuloa; (land section); South Kona; *Hawaii.*
Hopenui; [great end]; (land section); Koolau; *Maui.*
Hualalai; North Kona; *Hawaii;* elevation, 8 269 feet.
Hualele; [flying seed]; (land section); Kaupo; *Maui.*
Hualua; [two fruits]; (land section); Kohala; *Hawaii.*
Hue Puu; [hill of gourd]; North Kohala; *Hawaii;* elevation, 2 411 feet.
Huelo; [a tail]; (land section); Hamakualoa; *Maui.*
Huelo Landing; Hamakualoa; *Maui.*
Huelo; (village); Hamakualoa; *Maui.*
Huilua; [two companies]; (land section); Kaupo; *Maui.*
Hukiaa; (land section); Kohala; *Hawaii.*
Huleia; (subdistrict); Puna; *Kauai.*
Huleia; (stream); Puna; *Kauai.*
Hulihana; [seek for work]; (land section); Hana; *Maui.*
Huluhulu Puu; [hairy hill]; Hamakua; *Hawaii;* elevation, 6 637 feet.
Huluhulu Puu; Puna; *Hawaii;* elevation, 3 442 feet.
Hulumanai; (land section); Puna; *Hawaii.*
Humuula; [ax stone]; North Hilo; *Hawaii;* elevation, 1 086 feet.
Humuula; (land section); Hilo; *Hawaii.*
Iliililoa; [long pebbly beach]; (land section); Puna; *Hawaii.*
Ilikahi; (land section); South Kona; *Hawaii.*
Iliokaloa; [dog of Kanaloa]; (land section); Kau; *Hawaii.*
Imiola Church; [seek life]; South Kohala; *Hawaii;* elevation, 2 742 feet.
Io Puu; Hamakua; *Hawaii;* elevation, 4 062 feet.
Io Puu; [hawk hill]; Honuaula; *Maui;* elevation, 2 841 feet.
Iole; [rat]; (land section); Kohala; *Hawaii.*
Iole; (land section); Puna; *Hawaii.*
Iloli; [odoriferous]; (land section); Kona; *Molokai.*
Iwi o Pele; [Pele's bone]; Hana; *Maui;* elevation, 408 feet.
Ka; (land section); Kahikinui; *Maui.*
Kaa; [to roll]; (land section); Lanai; *Lanai.*
Kaaawa; (land section); Koolauloa; *Oahu.*
Kaaipu; [roll calabash]; (land section); Kona; *Oahu.*
Kaakaaniu; (land section); Koolau; *Kauai.*
Kaakaukukui; (land section); Kona; *Oahu.*
Kaakepa; (land section); Hilo; *Hawaii.*
Kaakopua; (land section); Kona; *Oahu.*
Kaala; Waianae Range, highest part; *Oahu;* elevation, 4 030 feet.
Kaala; South Kohala; *Hawaii;* elevation, 3 979 feet.
Kaalaa; (land section); Kona; *Oahu.*
Kaalaala; (land section); Ka-u; *Hawaii.*
Kaalaea; (land section); Koolaupoko; *Oahu.*
Kaalaea; [red ocher]; (land section); Hamakualoa; *Maui.*
Kaalaiki; [the small pebble]; (land section); Ka-u; *Hawaii.*
Kaalau; (land section); Hilo; *Hawaii.*
Kaala-waikini; (land section); Hamakua; *Hawaii.*
Kaalawai; [water way]; (land section); Kona; *Oahu,*
Kaaleo; (land section); Kona; *Oahu.*
Kaalualu Landing; [the rough, uneven]; Ka-u; *Hawaii.*
Kaamola; [turning round]; (land section); Kona; *Molokai.*
Kaanapali; (district); *Maui.*
Kaao; [legend]; Hamakua; *Hawaii;* elevation, 1 242 feet.
Kaao; [calm]; (land section); Hamakua; *Hawaii.*
Kaao; (land section); Koolau; *Maui.*
Kaapahu; (land section); Hamakua; *Hawaii.*
Kaapahu; (village); Hamakua; *Hawaii.*

Kaapahu; (land section); Kipahulu; *Maui.*
Kaapoko; [short Kaa]; (land section); Hilo; *Hawaii.*
Kaapahu; [cut square off]; Koolau; *Molokai;* elevation, 3 563 feet.
Kaapahu; (land section); Ka-u; *Hawaii.*
Kaapuna; (land section); South Kona; *Hawaii.*
Kaauhaloa; [long canoe shed]; (land section); Kona; *Oahu.*
Kaauhuhu; (village); Hamakua; *Hawaii.*
Kaauhuhu; [the fish poison plant]; (land section); Kohala; *Hawaii.*
Kaaumoa; (land section); Kona; *Oahu.*
Kaawalii; (stream); North Hilo; *Hawaii.*
Kaawaloa; [the long awa root]; (land section); South Kona; *Hawaii.*
Kaawaloa; (village); South Kona; *Hawaii.*
Kaawikiwiki; [roll quick]; (land section); Hamakua; *Hawaii.*
Kaehoeho; [stone pillar]; (land section); Kipahulu; *Maui.*
Kaelekú; [brittle]; (land section); Hana; *Maui.*
Kaelepulu; (land section); Koolaupoko; *Oahu.*
Kaelepulu; (pond); Kailua; *Oahu.*
Kaena; [room]; (land section); Koolauloa; *Oahu.*
Kaena; (point); Kaa; *Lanai.*
Kaena; (land section); Waialua; *Oahu.*
Kaena; (northwest point); Waialua; *Oahu.*
Kaeo; [winner]; (land section); Honuaula; *Maui.*
Kahaea; (land section); Ka-u; *Hawaii.*
Kahakuloa; [the long rock]; *Maui;* elevation, 635 feet.
Kahakuloa; (stream); Kaanapali; *Maui.*
Kahakuloa; (village); Kaanapali; *Maui.*
Kahakuloa Bay; Kaanapali; *Maui.*
Kahala; [the pandanus]; (cape); Puna; *Kauai.*
Kahalaia; (land section); Hamakuapoko; *Maui.*
Kahalauluahine; [old woman's shed]; (land section); Kona; *Oahu.*
Kahalii; (land section); Hilo; *Hawaii.*
Kahaluu; (land section); North Kona; *Hawaii.*
Kahaluu; (land section); Koolauloa; *Oahu.*
Kahana; (stream); Koolauloa; *Oahu.*
Kahana; [work]; (land section); Koolauloa; *Oahu.*
Kahana, (village); Koolauloa; *Oahu.*
Kahana Bay; Koolauloa; *Oahu.*
Kahanahaiki; [narrow Kahana]; (land section); Waianae; *Oahu.*
Kahananui; [great work]; (land section); Kona; *Molokai.*
Kahanui; [great mark], (land section); Kona; *Molokai.*
Kahapaakai; (land section); Kona; *Oahu.*
Kahaualea; (land section); Ka-u; *Hawaii.*
Kahaualea; (village); Puna; *Hawaii.*
Kahauloa; [the long hau tree]; (land section); South Kona; *Hawaii.*
Kahauiki [small hau tree]; (land section); Kona; *Oahu.*
Kahaumakaawe; (land section); Kona; *Oahu.*
Kahawaihapapa; [shallow aqueduct]; (land section); Kahikinui; *Maui.*
Kahawale; (land section); Kona; *Oahu.*
Kaheeka; (land section); Waialua; *Oahu.*
Kahehuna; (land section); Kona; *Oahu.*
Kahei; [girdle]; (land section); Kohala; *Hawaii.*
Kahikinui; [great Tahiti]; (district); *Maui.*
Kahili; Kona; *Kauai.*
Kahili; [fly brush]; (land section); Koolau; *Kauai.*
Kahilipali; (land section); Ka-u; *Hawaii.*
Kahinano; (land section); Hilo; *Hawaii.*
Kahoahuna; [the hidden friend]; (land section); Hilo; *Hawaii.*
Kahoiawa Bay, N. Kona, *Hawaii.*
Kahoiwai; (land section); Kona, *Oahu.*
Kaholo; Hamakua; *Hawaii;* elevation, 906 feet.
Kaholo; [the race, the running]; (land section); Hamakua; *Hawaii.*
Kahookane; (land section); Kona; *Oahu.*
Kahoolawe; (island).
Kahoolawe; (island); elevation, 1 472 feet.
Kahua; [foundation, site]; (land section); Kohala; *Hawaii.*
Kahua; (land section); Hilo; *Hawaii.*
Kahua-hookolo; (land section); Hilo; *Hawaii.*
Kahuai; [disinter, dig open], (land section); Kaupo; *Maui.*
Kahuai; (land section); Ka-u; *Hawaii.*
Kahue; [the gourd]; (land section); Ka-u; *Hawaii.*
Kahui; [junction]; (land section); Kona; *Oahu.*
Kahuku; (land section); Hilo; *Hawaii.*
Kahuku; (land section); Ka-u; *Hawaii.*
Kahuku; (land section); Niihau; *Niihau.*
Kahuku; [prominence]; (land section); Koolauloa; *Oahu.*
Kahuku; (northeast point); Koolauloa; *Oahu.*
Kahuku; (village); Koolauloa; *Oahu.*
Kahului; (land section); North Kona; *Hawaii.*
Kahului; (village); Wailuku; *Maui.*
Kahului Bay; Wailuku; *Maui.*
Kahuwa; (stream); Hilo; *Hawaii.*
Kaiaakea; (land section); Hilo; *Hawaii.*
Kaiaka Bay; Waialua; *Oahu.*
Kaieiewaho; (channel); between *Oahu* and *Kauai.*
Kaiholena; Ka-u; *Hawaii;* elevation, 3 824 feet.

Kaiholena; [banana]; (land section); Kohala; *Hawaii.*
Kaihooa; (land section); Kohala; *Hawaii.*
Kaihuiki; [the small nose]; (land section); Hilo; *Hawaii.*
Kaikahi; [one sea]; (land section); Kona; *Oahu.*
Kaili; (land section); Hana, *Maui.*
Kailio; [the dog]; Waianae Range; *Oahu;* elevation, 1 967 feet.
Kailiu; (cape); Na Pali; *Kauai.*
Kailiula; [the red bark]; (land section); Ka-u; *Hawaii.*
Kailiula; [red skin]; (land section); Kona; *Molokai.*
Kailua; (stream); Hamakualoa; *Maui.*
Kailua; [two seas]; (land section); North Kona, *Hawaii.*
Kailua; (stream); Koolaupoko, *Oahu.*
Kailua; (land section); Kula; *Maui.*
Kailua; (town); North Kona; *Hawaii.*
Kailua; (land section); Koolaupoko; *Oahu.*
Kailua; (village); Koolaupoko; *Oahu.*
Kailua Bay; North Kona; *Hawaii.*
Kaimú; (village); Puna; *Hawaii.*
Kaimú; [the oven]; (land section); Ka-u; *Hawaii.*
Kaímukí; [the oven for ti root]; (Telegraph Hill); Honolulu; elevation, 291 feet.
Kainalu [surf]; (land section); Kona; *Molokai.*
Kainehe [the murmuring sea]; (land section); Hamakua; *Hawaii.*
Kainehe; (land section); Lahaina; *Maui.*
Kai o Kalohi; [Sea of Kalohi]; (channel); between *Molokai* and *Lanai.*
Kaipapa; (land section); Kahikinui; *Maui.*
Kaipapau; [shallow sea]; (land section); Koolauloa; *Oahu.*
Kaipuhaa; (land section); Kohala; *Hawaii.*
Kaiwi (channel); between *Oahu* and *Molokai.*
Kaiwi; [the bone]; (point); North Kona; *Hawaii.*
Kaiwiki; [quick sea]; (land section); Hamakua; *Hawaii.*
Kaiwiki; (stream); Hilo; *Hawaii.*
Kaiwiki; (land section); Hilo; *Hawaii.*
Kaiwiki; (village); Hilo; *Hawaii.*
Kaiwilahilahi; [the thin bone]; (land section); Hilo; *Hawaii.*
Kaiwilahilahi; (stream); Hilo; *Hawaii.*
Kaiwiokaihu [bone of the nose]; (land section); Kona; *Oahu.*
Kakaalaea; [red ocher duck]; (land section); Hamakua; *Hawaii.*
Kakalahale; (land section); Kipahulu; *Maui.*
Kakanoni; [to split noni fruit]; (land section); Kipahulu; *Maui.*
Kakēa; [sugar loaf]; Honolulu; *Oahu;* elevation, 1 468 feet.
Kakio; [itch]; (land section); Kaupo; *Maui.*
Kakio; (land section); Hana; *Maui.*
Kakiweka; (land section); Hana; *Maui.*
Ka lae; [the cape]; (point); Ka-u; *Hawaii.*
Kalae; (village); Kona; *Molokai.*
Kalaehonu; [cape of the turtle]; (cape); Halelea; *Kauai.*
Ka-lae-loa; [the long cape]; (cape); Kona; *Molokai.*
Kalaeloá; [or Barbers Point]; (point); Ewa; *Oahu.*
Kalaeloa Landing; Kona; *Molokai.*
Ka-lae-milo; [cape of the milo tree]; (cape); Koolau; *Molokai.*
Kalaeoaihe; (land section); Kaupo; *Maui.*
Ka-lae-o-ka-hiu; [the cape of the fish's tail]; (cape); Koolau; *Molokai.*
Ka-lae-o-ka-ilio; [cape of the dog]; (cape); Kaluakoi; *Molokai.*
Ka-lae-o-ka-laau; [cape of the tree]; (cape); Kaluakoi; *Molokai.*
Ka-lae-o-ka-pahu; [cape of the drum]; (cape); Koolau; *Molokai.*
Kalaepohaku [rocky cape] (land section); Kona; *Oahu.*
Kalaheo; [proud day]; (land section); Kona; *Kauai.*
Kalaheo; (land section); Koolaupoko, *Oahu.*
Kalahiki; [the day of arrival]; (land section); South Kona; *Hawaii.*
Kalaieha; (latitude station); North Hilo; *Hawaii;* elevation, 6 738 feet.
Kalakalaula; (land section); Hamakua; *Hawaii.*
Kalala; [the limb]; (land section); Kohala; *Hawaii.*
Kalalau; (village); Na Pali; *Kauai.*
Kalalau; [the blunder]; (land section); Hilo; *Hawaii.*
Kalalau; [blunder]; (land section); Na Pali; *Kauai.*
Kalaloa; [long day]; (land section); Koolau; *Maui.*
Kalama; [the torch]; (land section); South Kona; *Hawaii.*
Kalamanamana; [branching sun]; (land section); Kona; *Oahu.*
Kalamaula; [red torch]; (land section); Kona; *Molokai.*
Kalanikaula, near Wend; [the prophet chief]; *Molokai;* elevation, 794 feet.
Kalaoa; (village); North Kona; *Hawaii.*
Kalaoa; (land section); North Kona; *Hawaii.*

Kalapa; [the ridge]; South Kona; *Hawaii;* elevation, 1 271 feet.
Kalapaki; (land section); Puna, *Kauai.*
Kalapamoa; [the ridge of fowls]; Central Range; *Molokai;* elevation, 4 004 feet.
Kalapana; (village); Puna; *Hawaii.*
Kalapana; (land section); Ka-u; *Hawaii.*
Kalawahine; [woman's day]; (land section); Kona; *Oahu.*
Kalawao; (land section); Koolau; *Molokai.*
Kalauao; (land section); Ewa; *Oahu.*
Kalaupapa; [flat leaf of land]; (land section); Koolau; *Molokai.*
Kalaupapa; (village); Koolau; *Molokai.*
Kalaupapa Landing; Koolau; *Molokai.*
Kalawao; (village); Koolau; *Molokai.*
Kalawao Landing; Koolau; *Molokai.*
Kalehua; [metrosideros tree]; (land section); Kona; *Oahu.*
Kalehua-hakihaki; [the broken metrosideros tree]; Waimea; *Kauai.*
Kaleina-o-papio; [leaping place of papio]; (cape); Koolau; *Molokai.*
Kalena; [turmeric plant]; (land section); Kipahulu; *Maui.*
Kalena; Waiamae Range; *Oahu;* elevation, 3 504 feet.
Kalena; (land section); Waianae; *Oahu.*
Kalepa; [the flag]; Hamakua; *Hawaii;* elevation, 7 678 feet.
Kalepa; Puna; *Kauai.*
Kalepa; [flag]; (land section); Kaupo; *Maui.*
Kalepeamoa; [cock's comb]; Hamakua; *Hawaii;* elevation, 9 409 feet.
Kalia; (land section); Kona; *Oahu.*
Kaliae; (land section); Koolau; *Maui.*
Kalialinui; [great kaliali plant]; (land section); Kula, *Maui.*
Kalihi; [the border]; (land section); South Kona; *Hawaii.*
Kalihi; (land section); Hana; *Maui.*
Kalihi; [border, edge]; (land section); Honuaula; *Maui.*
Kalihi; (land section); Kahikinui; *Maui.*
Kalihi; (land section); Kaupo; *Maui.*
Kalihi; (stream); Halelea; *Kauai.*
Kalihi; (land section); Koolau; *Maui.*
Kalihi; (village); Halelea; *Kauai.*
Kalihi; [border]; (land section); Kona; *Oahu.*
Kalihi; (village); Kona; *Oahu.*
Kalihi Entrance; Kona; *Oahu.*
Kalihikai; [edge of the sea]; (land section); Halelea; *Kauai.*
Kalihiwai; [edge of the water]; (land section); Halelea; *Kauai.*
Kalimaohe; (land section); Lahaina; *Maui.*
Kaliu; Puna; *Hawaii;* elevation, 1 065 feet.
Kaliu; [bilge water]; (land section); Kona; *Oahu.*
Kaloaloa; (land section); Hilo; *Hawaii.*
Kaloaloa; North Hilo; *Hawaii;* elevation, 6 634 feet.
Kaloi; [taro patch]; (land section); Honuaula; *Maui.*
Kaloiiki; [small taro patch]; (land section); Kona; *Oahu.*
Kaloko; [the fish pond]; (land section); North Kona; *Hawaii.*
Kalokohonu; [deep fish pond]; (land section); Kona; *Oahu.*
Kalolo; (village); Hamakua; *Hawaii.*
Kalona; (land section); Ka-u; *Hawaii.*
Kalua; [the pit or crater]; (land section); Hamakua; *Hawaii.*
Kalua; (land section); Wailuku; *Maui.*
Kaluaaha; (land section); Kona; *Molokai.*
Kaluaaha; (village); Kona; *Molokai.*
Kaluaalaea; [red ocher pit]; (land section); Kona; *Oahu.*
Kaluahauoni; Central Range; *Molokai;* elevation, 3 282 feet.
Kaluahole; [pit for peeling vegetables]; (land section); Kona; *Oahu.*
Kaluahonu; [deep pit]; (land section); Niihau; *Niihau*
Kaluakailio; [the pit of the dog]; (land section); Hilo; *Hawaii.*
Kaluakoi; (district); *Molokai.*
Kaluakoi; [crater of axes]; (land section); *Molokai.*
Kaluaolohe; [naked pit]; (land section) Kona; *Oahu.*
Kaluamakani; [the windy crater]; Hamakua; *Hawaii;* elevation, 7 584 feet.
Kaluanui; [great pit]; (land section); Koolauloa; *Oahu.*
Kaluaokau; (land section); Kona; *Oahu.*
Kalua o Lapauila; South Kona, *Hawaii;* elevation, 120 feet.
Kalukalu; [a plant, sea grass]; (land section); South Kona; *Hawaii.*
Kalulu; [calm]; (land section); Lanai; *Lanai.*
Kamaee; (land section); Hilo; *Hawaii.*
Kamaili; (land section); Puna; *Hawaii.*
Kamaino; [abuse]; (land section); Koolau; *Maui.*
Kamakama; [prostitute]; (land section); Ka-u; *Hawaii.*
Kamákelá; (land section); Kona; *Oahu.*
Kamakou; central range; *Molokai;* elevation, 4 958 feet.

Kamaló; [dry]; (land section); Kona; *Molokai.*
Kamaló Landing; Kona; *Molokai.*
Kamaló; (village); Kona; *Molokai.*
Kamalomalo; (land section); Puna; *Kauai.*
Kamanawa; (point); Kaupo; *Maui.*
Kamani; [a kind of tree, calophyllum]; (land section); Lahaina; *Maui.*
Kamano; [the shark]; (land section); Kohala; *Hawaii.*
Kamanoni; (land section); Kona; *Molokai.*
Kamananui; [great power]; (land section); Waialua; *Oahu.*
Kamao; [wild cotton plant]; (land section); Lanai; *Lanai.*
Kamaoa; (land section); Ka-u; *Hawaii.*
Kamaoa; (village); Ka-u; *Hawaii.*
Kamaohanui; Waianae Range; *Oahu*; elevation 3 355 feet.
Kamaole; [childless]; (land section); Kula; *Maui.*
Kamaui; (land section); Hamakua; *Hawaii.*
Kamehame; (land section); Kula; *Maui.*
Kamilo; [milo tree]; (cape); Ka-u; *Hawaii.*
Kamiloloa; [long milo tree]; (land section); Kona; *Molokai.*
Kamoamoa; (land section); Puna; *Hawaii.*
Kamoawaa; [canoe fowl]; (land section); Kona; *Oahu.*
Kamokala; (land section); Hamakua; *Hawaii.*
Kamoku; (land section); Lanai; *Lanai.*
Kamoku; (land section); Kona, *Oahu.*
Kamooakua; [lizard god]; (land section); Kona; *Oahu.*
Kamooiki; [small lizard]; (land section); Kona; *Oahu.*
Kamoomuku; [strip cut short]; (land section); Kona; *Oahu.*
Kamouau; [the floating buoy]; (land section); Hamakua; *Hawaii.*
Kamuku; [cut short]; (land section); Kahikinui; *Maui.*
Kanahena; (land section); Honuaula; *Maui.*
Kanahonua; (land section); Hamakua; *Hawaii.*
Kanaio; [the bastard sandal wood]; (land section); Ka-u, *Hawaii.*
Kanaio; (land section); Honuaula; *Maui.*
Kanakau; (land section); South Kona; *Hawaii.*
Kanalaa; (land section); Kona; *Oahu.*
Kana; [name of a demigod]; (land section); Hamakua; *Hawaii.*
Kanane; (land section); Puna; *Hawaii.*
Kanapa; *Molokai;* elevation, 1 935 feet.
Kanaueue; [vibration, earthquake]; (land section); North Kona; *Hawaii.*
Kanehoa; Waianae Range; *Oahu;* elevation, 2 721 feet.
Kaneilio; (point); Waianae; *Oahu.*
Kanekiki; (land section); Puna; *Hawaii.*
Kaneloa; [long cane]; (land section); Kona; *Oahu.*
Kaneohe; [bamboo cane]; (land section); Koolaupoko; *Oahu.*
Kaneohe; (village); Koolaupoko; *Oahu.*
Kaneohe Bay; Koolaupoko; *Oahu.*
Kanepuu; (cane hill); *Lanai;* elevation, 1 800 feet.
Kanewai; [water cane]; (land section); Kona; *Oahu.*
Kaniaula; (land section); Kaupo; *Maui.*
Kaniukukahi; [cocoanut tree standing alone]; (land section); Kona; *Oahu.*
Kanoa Pepeekeo; Hilo; *Hawaii;* elevation, 910 feet.
Kaohaoha; [fond recollection]; (land section); Hilo; *Hawaii.*
Kaohe; [bamboo]; (land section); Hamakua; *Hawaii.*
Kaohe; (land section); Puna; *Hawaii.*
Kaohe; (land section); South Kona, *Hawaii.*
Kaohi; (land section); Lanai; *Lanai.*
Kaoma; (land section); Hilo; *Hawaii.*
Kaoma; [oven]; (land section); Kohala; *Hawaii.*
Kaonoulu; (land section); Kula; *Maui.*
Kaopala; [rubbish]; (land section); Kaupo; *Maui.*
Kaowahi; (cape); Halelea; *Kauai.*
Kapaa; [fast, firm]; (land section); Kohala; *Hawaii.*
Kapaa; (stream); Puna; *Kauai.*
Kapaa; (land section); Puna; *Kauai.*
Kapaa; (village); Puna; *Kauai.*
Kapaahu; (land section); Ka-u; *Hawaii.*
Kapaakea; [whitish rock]; (land section); Kona; *Molokai.*
Kapaakea; (land section); Kona; *Oahu.*
Kapaau; (land section); Kohala; *Hawaii.*
Kapahaha; (land section); Kona; *Oahu.*
Kapahulu; (land section); Kona; *Oahu.*
Kapaka; (land section); Koolauloa; *Oahu.*
Kapalaalaea; (land section); North Kona; *Hawaii.*
Kapalama; [fence of lama wood]; (land section); Kona; *Oahu.*
Kapalepo; [dirty inclosure]; (land section); Kona; *Oahu.*
Kapaloa; [long inclosure]; (land section); Kona; *Oahu.*
Kapano; [dark colored]; (land section); Koolauloa; *Oahu.*
Kapapala; [bird lime]; (land section); Ka-u; *Hawaii.*
Kapaula; [red inclosure]; (land section); Koolau; *Maui.*

Kapaula; (stream); Koolau; *Maui.*
Kapehu; [swelling]; (land section); Hilo; *Hawaii.*
Ka Pele, Puu; (hill of Pele); Ka-u; *Hawaii;* elevation, 5 768 feet.
Ka Pele, Puu; Waimea; *Kauai.*
Kapena; (land section); Hilo; *Hawaii.*
Kapewakua; (land section); Lahaina; *Maui.*
Kapiwai; [oozing water]; (land section); Kona; *Oahu.*
Kapóho; Puna; *Hawaii;* elevation, 437 feet.
Kapóho; [chalk]; (land section); Puna; *Hawaii.*
Kapoho; (village); Puna; *Hawaii.*
Kapolei, Puu; Honouliuli; Ewa; *Oahu;* elevation, 162 feet.
Kapoula; (land section); Hamakua; *Hawaii.*
Kapua; (land section); Kohala; *Hawaii.*
Kapua; [flower]; (land section); South Kona; *Hawaii.*
Kapuai, Puu; Hamakualoa; *Maui;* elevation, 1 150 feet.
Kapuai o Kamehameha; [foot of Kamehameha]; Hamakualoa; *Maui;* elevation, 1 149 feet.
Kapuaikini; [myriad footsteps]; (land section); Kipahulu; *Maui.*
Kapualei; [flower wreath]; (land section); Kona; *Molokai.*
Kapuaokoolau; [flower of Koolau]; (land section); Kona; *Molokai.*
Kapueokahi Harbor; [the owl place]; Hana; *Maui.*
Kapuhi; [the eel]; (cape); Halelea; *Kauai.*
Kapukaiki; [the small outlet]; North Kona; *Hawaii;* elevation, 1 404 feet.
Kapukaulua; (point); Hana; *Maui.*
Kapulena; [taboo turmeric]; (land section); Hamakua; *Hawaii.*
Kapulena; Kamakua; *Hawaii;* elevation, 904 feet.
Kapuna; [spring]; (land section); Kona; *Oahu.*
Kapuna; Ka-u; *Hawaii.*
Kapunakea; [whitish limestone]; (land section); Lahaina; *Maui.*
Kapunapuna; (land section); Kohala; *Hawaii.*
Ka-puu-poi; [the poi hill]; (cape); Kona; *Molokai.*
Ka-u; [the breast]; (district;) *Hawaii.*
Ka-u; (land section); Ka-u; *Hawaii.*
Ka-u; (land section); North Kona; *Hawaii.*
Kauaea; (land section); Puna; *Hawaii.*
Kauaea; (village); Puna; *Hawaii.*
Kauai; (island).
Kauamanu; [war of birds]; (land section); Hana; *Maui.*
Kauau; [U'an bird]; (land section); Kula; *Maui.*
Kauaula; [red war]; (land section); Lahaina; *Maui.*
Kauaula; (stream); Lahaina; *Maui.*
Kauaopu; Waianae Range; *Oahu;* elevation, 1 053 feet.
Kaueleau; (land section); Puna; *Hawaii.*
Kauhako; (land section); South Kona; *Hawaii.*
Kauhakó Bay; South Kona; *Hawaii.*
Kauhikio; (land section); Kona; *Oahu.*
Kauhiula; [red yarn]; (land section); Hilo; *Hawaii.*
Kauhola; (cape); Kohala; *Hawaii.*
Kauhuhuula; [red fish poison]; (land section); Ka-u; *Hawaii.*
Kauiki Head; (point); Hana; *Maui.*
Káukahokú; (land section); Kona; *Oahu.*
Kauhako; (land section); South Kona; *Hawaii.*
Kaukonahua; (stream); Waialua; *Oahu.*
Kauku; [the flea]; Hilo; *Hawaii;* elevation, 1 967 feet.
Kaukuhalahala; (land section); Hana; *Maui.*
Kaulahuki; [pull rope]; Central Range; *Molokai;* elevation, 3 749 feet.
Kaukulau; (land section); Puna; *Hawaii.*
Kaulana; [famous]; (land section); North Kona; *Hawaii.*
Kaulanamoa; (land section); Kaupo; *Maui.*
Kaulanamauna; [famous mountain]; (land section); South Kona; *Hawaii.*
Kaulei, Ili; (land section); Koolau; *Molokai.*
Kaulekohau; (land section); Hamakua; *Hawaii.*
Kauleoli; (land section); South Kona; *Hawaii.*
Kaulolo; (land section); Lahaina; *Maui.*
Kauluena; [hot bread fruit]; (land section); Koolau; *Maui.*
Kauluoa; (cape); South Kona; *Hawaii.*
Kauluwela; (land section); Kona; *Oahu.*
Kaumahalua; (land section); Kaupo; *Maui.*
Kaumakani; (land section); Kipahulu; *Maui.*
Kaumalumalu; [shady place]; (land section); North Kona; *Hawaii.*
Kaumana; (land section); Hilo; *Hawaii.*
Kauamanu; [war of birds]; (land section); Hana; *Maui.*
Kaumoali; (land section); Hamakua; *Hawaii.*
Kauna; (cape); Ka-u; *Hawaii.*
Kaunakakai; (land section); Kona; *Molokai.*
Kaunakakai; (village); Kona; *Molokai.*
Kaunakakai Harbor; Kona; *Molokai.*
Kaunala; (land section); Koolauloa; *Oahu.*
Kaunaloa; (land section); Puna; *Hawaii.*
Kaunamano; (land section); Hamakua; *Hawaii.*
Kaunamano; (land section); Ka-u; *Hawaii.*
Kauniho; (land section); Hilo; *Hawaii.*
Kaunolú; (land section); Lanai; *Lanai.*
Kaunuahane; (land section); Honuaula; *Maui.*

Kaunuohua; Central Range; *Molokai;* elevation, 4 535 feet.
Kaupakulua; [two ridgepoles]; (land section); Hamakualoa; *Maui.*
Kaupalaoa; (land section); Kohala; *Hawaii.*
Kaupakuea; (stream); Hilo; *Hawaii.*
Kaupakuea; (land section); Hilo; *Hawaii.*
Kaupakuhale; (ridgepole); Hamakua; *Hawaii;* elevation, 9 990 feet.
Kaupakulua; (village); Hamakualoa; *Maui.*
Kaupulehu; North Kona; *Hawaii*; elevation, 6 143 feet.
Kaupulehu; [put in the oven to bake]; (land section); North Kona; *Hawaii.*
Kaupo; (district); *Maui.*
Kawahauwahi; [smoky mouth]; (land section); Ka-u; *Hawaii.*
Kawahoa; (point); *Niihau.*
Kawai; [the water]; (cape); Puna; *Kauai.*
Kawaihae; [wild stream]; (land section); Kohala; *Hawaii.*
Kawaihae; (village); South Kohala; *Hawaii.*
Kawaihae Landing; South Kohala; *Hawaii.*
Kawaihapai; (land section); Waialua; *Oahu.*
Kawaihoa, or Koko Head; (point); Kona; *Oahu.*
Kawaihoolana; [the buoyant water]; (stream); Puna; *Kauai.*
Kawaiiki; [little water]; (land section); Kona; *Oahu.*
Kawaikapu; [forbidden water]; (land section); Kona; *Molokai.*
Kawailoa; [long water]; (land section); Koolaupoko; *Oahu.*
Kawailoa; (land section); Waialua; *Oahu.*
Kawailoa; (stream); Waialua; *Oahu.*
Kawainui; [great water]; (land section); Hilo; *Hawaii.*
Kawaiolena; [yellow]; (land section); Kona; *Oahu.*
Kawaipapa; (land section); Hana; *Maui.*
Kawala; (land section); Ka-u; *Hawaii.*
Kawaloa; (land section); Hana; *Maui.*
Kawaluna; [upper space]; (land section); Koolau; *Molokai.*
Kawananakoa; [warrior's prophecy]; (land section); Kona; *Oahu.*
Kawanui; [great time]; (land section); North Kona; *Hawaii.*
Kawela; Hamakua; *Hawaii;* elevation, 938 feet.
Kawela; (land section); Hamakua; *Hawaii.*
Kawela; [heat, or hot]; (land section); Ka-u; *Hawaii.*
Kawela; (land section); Hana; *Maui.*
Kawela; (land section); Kona; *Molokai.*
Kawela; (land section); Koolauloa; *Oahu.*
Kawelikoa; (cape); Puna; *Kauai.*
Kawiwi; Waianae Range; *Oahu*; elevation, 2 985 feet.
Kea, Mauna; [white mountain]; Hamakua; *Hawaii*; elevation, 13 825 feet.
Kea, Puu; [white hill]; Hamakua; *Hawaii*; elevation, 5 722 feet.
Kea, Puu; Hamakua; *Hawaii*; elevation, 8 566 feet.
Keaa; [burning]; (land section); Hamakua; *Hawaii.*
Keaa; (land section); Ka-u; *Hawaii.*
Keaa; (land section); Koolau; *Maui.*
Keaa iki; [little Keaa]; (land section); Koolau; *Maui.*
Keaau; (land section); Ka-u; *Hawaii.*
Keaau; Waianae Range; *Oahu*; elevation, 2 270 feet.
Keaau iki; [small ripples]; (land section); Waianae; *Oahu.*
Keaau nui; [great ripples]; (land section); Waianae; *Oahu.*
Keaaula; [red Keaa]; (land section); Hamakualoa; *Maui.*
Keahakea; [ahakea tree]; (land section); Hamakua; *Hawaii.*
Keahaupono; [straight rising ground]; (land section); Kaupo; *Maui.*
Keahialaka; (village); Puna; *Hawaii.*
Keahialana; [fire of lana]; (land section); Puna; *Hawaii.*
Keahole; (cape); North Kona; *Hawaii.*
Keahua; [mound or hillock]; (land section); Hamakua; *Hawaii.*
Keahua; [mound, rising ground]; (land section); Kula; *Maui.*
Keahuloa; [long pile of stones]; (land section); Kaupo; *Maui.*
Keahuolú; [cairn of Lu]; (land section); North Kona; *Hawaii.*
Keaiwa; (land section); Ka-u; *Hawaii.*
Keakaamanu; [the bird's shadow]; Hana, *Maui;* elevation, 1 250 feet.
Kealahewa; [wrong way]; (land section); Kohala; *Hawaii.*
Kealahou; (village); Kula; *Maui.*
Kealahou; [new road]; (land section); Kula; *Maui.*
Kealaikahiki; [the way to Tahiti]; (cape); *Kohoolawe.*
Kealakaha; [marked way]; (land section); Hamakua; *Hawaii.*
Kealakehe; (land section); North Kona; *Hawaii.*
Kealakehe; (village); North Kona; *Hawaii.*

Kealakekua; [path of the gods]; (land section); South Kona; *Hawaii*.
Kealakekua; (land section); Hamakuapoko; *Maui*.
Kealakekua Bay; S. Kona; *Hawaii*.
Kealakomo; [entering way]; (land section); Puna; *Hawaii*.
Kealia; [salt pan]; (land section); South Kona; *Hawaii*.
Kealia; (land section); Puna; *Kauai*.
Kealia; (land section); Lanai; *Lanai*.
Kealia; (land section); Hamakuapoko, *Maui*.
Kealia; (land section); Waialua; *Oahu*.
Kealia; (village); Puna; *Kauai*.
Kealii iki; [little chief]; (land section); Hamakualoa; *Maui*.
Kealii nui; [great chief]; (land section); Hamakuapoko; *Maui*.
Keamuku; [the abrupt ledge]; S. Kohala; *Hawaii*; elevation, 3 078 feet.
Keana; [cave]; (land section); Koolauloa; *Oahu*.
Keanae; (point); Koolau; *Maui*.
Keanae; [mullet]; (land section); Koolau; *Maui*.
Keanae; (village); Koolau; *Maui*.
Keanae Landing; Koolau; *Maui*.
Keauhou; North Kona; *Hawaii*; elevation, 1 067 feet.
Keauhou; (land section); Ka-u; *Hawaii*.
Keauhou; [new time]; (land section); North Kona; *Hawaii*.
Keauhou; (land section); Honuaula; *Maui*.
Keauhou; (land section); Kona; *Oahu*.
Keauhou; (village); North Kona; *Hawaii*.
Keauhou Bay; North Kona; *Hawaii*.
Keauhou Landing; Puna; *Hawaii*.
Keauohana; (land section); Puna; *Hawaii*.
Keawanui; [great harbor]; (land section); Kona, *Molokai*.
Keawaula; [red harbor]; (land section); Waianae; *Oahu*.
Keawekaheka; (cape); South Kona; *Hawaii*.
Keehia; [fearful, awesome]; (land section); Hamakua; *Hawaii*.
Keei; (land section); South Kona; *Hawaii*.
Keekee; (land section); Puna; *Hawaii*.
Keekee; [crooked]; (land section); South Kona; *Hawaii*.
Keekeekai; (land section); Ka-u; *Hawaii*.
Kehena; (land section); Kohala; *Hawaii*.
Kehena; (land section); Puna; *Hawaii*.
Kehena; (village); Puna; *Hawaii*.
Keikipaula; *Hawaii*; elevation, 6 601 feet.
Keikiwaha; (cape); North Kona; *Hawaii*.
Kekaa; (point); Kaanapali; *Maui*.
Kekaha; (village); Waimea; *Kauai*.
Kekai; [sea]; (land section); Lahaina; *Maui*.
Kekio; [pool]; (land section); Kona; *Oahu*.
Kekualele; [meteor, shooting star]; (land section); Hamakua; *Hawaii*.
Kekuapaawela; [scorched back]; (land section); Koolau; *Maui*.
Ke Lae o ka Ilio; [cape of the dog]; (point); Kaupo; *Maui*.
Kemau; (land section); Hamakua; *Hawaii*.
Kemole; Hamakua; *Hawaii*; elevation, 8 000 feet.
Keokea; (land section); Puna; *Hawaii*.
Keokea; [white]; (land section); South Kona; *Hawaii*.
Keokea; (land section); Kula; *Maui*.
Keokea; (village); Kula; *Maui*.
Keokea Landing; North Kohala; *Hawaii*.
Keolewa; central north coast; *Molokai*; elevation, 2 100 feet.
Keolu; [pleasant]; (land section); Koolaupoko, *Oahu*.
Keonehehee; [the sliding sand]; Hamakua; *Hawaii*; elevation, 11 538 feet.
Keonekuino; (land section); Kona; *Molokai*.
Keonenelu; [the soft sand]; Honuaula; *Maui*; elevation, 3 942 feet.
Keoneoio; (land section); Honuaula; *Maui*.
Keoneula; [red sand]; (land section); Kona; *Oahu*.
Keonepoko; [short sand beach]; (land section); Puna; *Hawaii*.
Keopu; [belly]; (land section); North Kona; *Hawaii*.
Keopuka; (land section); South Kona; *Hawaii*.
Keopuka; (land section); Koolau; *Maui*.
Keopukaloa; [long belly]; (land section); Kona; *Molokai*.
Keopukauuku; [small belly]; (land section); Kona; *Molokai*.
Kepio; [captive]; (land section); Kaupo; *Maui*.
Kepuhi; [eel]; (land section); Kona; *Oahu*.
Kewalo; [outcry]; (land section); Kona; *Oahu*.
Ki, Puu; [hill of ti, cordyline terminalis]; Koolauloa; *Oahu*; elevation, 643 feet.
Ki; [plant, cordyline terminalis]; (land section); Puna; *Hawaii*.
Ki, Puu; Ka-u; *Hawaii*; elevation, 3 197 feet.
Kiao; (land section); Ka-u; *Hawaii*.
Kiapu; (land section); Hilo; *Hawaii*.
Kihalani; (land section); Hilo; *Hawaii*.
Kihapuhala; (land section); Hana; *Maui*.
Kihe; [sneeze]; Hamakua; *Hawaii*; elevation, 7 828 feet.
Kihei; (village); Kula; *Maui*.
Kiilae; (land section); South Kona; *Hawaii*.

Kiiokalani; [image of the chief]; (land section); Kohala; *Hawaii.*

Kikala; (land section); Hilo; *Hawaii.*

Kikala; [hips]; (land section); Puna; *Hawaii.*

Kiki; [to plaster the hair with lime]; (land section); Kona; *Oahu.*

Kikiaola; (land section); Kona; *Kauai.*

Kikipau; (land section); Koolau; *Molokai.*

Kikoo; [a bow]; (land section); Kipahulu; *Maui.*

Kilau; (land section); Hilo; *Hawaii.*

Kilauea; (land section); Koolau; *Kauai.*

Kilauea; (stream); Halelea; *Kauai.*

Kilauea; (village); Halelea; *Kauai.*

Kilauea Hotel; Puna; *Hawaii;* elevation (approximate) 4 000 feet.

Kilea, Oloalu; [a hillock]; Lahaina; *Maui;* elevation, 269 feet.

Kiloa; [long ki plant]; (land section); South Kona; *Hawaii.*

Kilohana; [surpassing]; Puna; *Kauai;* elevation, 1 100 feet.

Kilolani; [astrologer]; (land section); Lahaina; *Maui.*

Kiolakaa; (land section); Ka-u; *Hawaii.*

Kiolokú; (land section); Ka-u; *Hawaii.*

Kipahoehoe; South Kona; *Hawaii;* elevation, 943 feet.

Kipahoehoe; [smooth ki leaf]; (land section); South Kona; *Hawaii.*

Kipahulu; (district); *Maui.*

Kipapa; [pavement]; (land section); Kaupo; *Maui.*

Kipi; [rebel]; (land section); Kohala; *Hawaii.*

Kipu; [to back water with paddles]; (land section); Puna; *Kauai.*

Kipu; (land section); Koolau; *Molokai.*

Koa, Puu; [koa tree hill]; Makawao; *Maui;* elevation, 1 932 feet.

Koae; [tropic bird]; (land section); Ka-u; *Hawaii.*

Koae, Puu; [hill of the tropic bird]; *Maui;* elevation, 635 feet.

Koaeae; (land section); Kohala; *Hawaii.*

Koaie; [a species of koa tree]; (land section); Kohala; *Hawaii.*

Koaloa; [long koa]; (land section); Hilo; *Hawaii.*

Koanawai; [bladder]; (land section); Kipahulu; *Maui.*

Koea; (land section); Kohala; *Hawaii.*

Koele; (village); Northern Central; *Lanai.*

Kohala, North; (district); *Hawaii.*

Kohala, South; (district); *Hawaii.*

Kohala Mountains; North Kohala; *Hawaii;* elevation, 5 489 feet.

Kohanaike; [seen naked]; (land section); North Kona; *Hawaii.*

Koheo; (land section); Kula; *Maui.*

Kohoilo; (land section); Kula; *Maui.*

Koholalele; Hamakua; *Hawaii;* elevation, 1 428 feet.

Koholalele; [leaping whale]; (land section); Hamakua; *Hawaii.*

Koholalele; (village); Hamakua; *Hawaii.*

Koiuiu; [far away]; (land section); Kona; *Oahu.*

Kokio; [a species of hibiscus]; (land section); Kohala; *Hawaii.*

Koko Head; [blood]; (upper crater); *Oahu;* elevation, 1 205.

Koko Head; (lower crater); *Oahu;* elevation, 644 feet.

Kokoike; (land section); Kohala; *Hawaii.*

Kokole; (cape); Waimea; *Kauai.*

Kolanai; (land section); Kahikinui; *Maui.*

Kole; [red]; Hamakua; *Hawaii;* elevation, 9 632 feet.

Kolea; (stream); Koolau; *Maui.*

Kolea; [plover]; (land section); Koolau; *Maui.*

Kolekole; [red earth]; Koolau; *Molokai;* elevation, 3 951 feet.

Kolekole; (stream); Hilo; *Hawaii.*

Kolekole, Haleakala; *Maui;* elevation, 10 012 feet.

Kolekole Puu; [red hill]; Waianae; *Oahu;* elevation, 1 591 feet.

Kolo; [to creep]; (land section); South Kona; *Hawaii.*

Kolo Puu; [creeping hill]; Kona; *Kauai.*

Koloa; [duck]; (land section); Kona; *Kauai.*

Koloa; (stream); Kona; *Kauai.*

Koloa; [wild duck]; (land section); Koolau; *Maui.*

Koloa; (village); Kona; *Kauai.*

Koloa Bay; Kona; *Kauai.*

Koloaha; [a kind of potato]; (land section); Hamakua; *Hawaii.*

Kolowalu; (land section); Kona; *Oahu.*

Kona [leeward], South; (district); *Hawaii.*

Kona, North; (district); *Hawaii.*

Kona; (district); *Kauai;* south side.

Kona; (district); *Molokai;* on the south side.

Kona; (district); *Oahu.*

Kona; (point); *Niihau.*

Konahuanui; Koolau Range; *Oahu;* elevation, 3 105 feet.

Kooka; (land section); Lahaina; *Maui.*

Koolau; [windward side]; (district); *Kauai.*

Koolau; [windward]; (district); *Maui.*

Koolau; (district); *Molokai.*

Koolau Bay; Koolaupoko; *Oahu.*

Koolau Range above Wahiawá; *Oahu;* elevation, 2 381 feet.

Koolau Range above Waipio; *Oahu;* elevation, 2 700 feet.
Koolauloa; [long Koolau]; (district); *Oahu.*
Koolaupoko; [short Koolau]; (district); *Oahu.*
Koomano; (land section); Hilo; *Hawaii.*
Kopili; [white kapa]; (land section); Lahaina; *Maui.*
Kopu; (land section); Ka-u; *Hawaii.*
Kou; [tree, cordia subcordata]; (land section); Kohala; *Hawaii.*
Kou; (land section); Kaupo; *Maui.*
Kowali; [convolvulus]; (land section); Hana; *Maui.*
Kuaia; (land section); Hilo; *Hawaii.*
Kuaipaako; (land section); Kona; *Oahu.*
Kuaiula; (land section); Kona; *Oahu.*
Kualapa; [a ridge]; (land section); Honuaula; *Maui.*
Kualoa; [long ridge]; (land section); Koolaupoko; *Oahu.*
Kuamoo [path]; (land section); North Kona; *Hawaii.*
Kuhimana; (land section); Kona; *Oahu.*
Kuhiwa; (land section); Koolau; *Maui.*
Kuholilua; (land section); Lahaina; *Maui.*
Kuhua; [hard]; (land section); Hilo; *Hawaii.*
Kuhua; (land section); Lahaina; *Maui.*
Kuia; (land section); Lahaina; *Maui.*
Kuiaha; (land section); Hamakualoa; *Maui.*
Kuilei; [braid a wreath]; (land section); Hamakua; *Hawaii.*
Kuili; North Kona; *Hawaii;* elevation, 346 feet.
Kukai, Puu; [dung hill]; Koolau; *Maui;* elevation, 574 feet.
Kukaiau; (land section); Hamakua; *Hawaii.*
Kukanaka; (land section); Kona; *Oahu.*
Kukio; (land section); North Kona; *Hawaii.*
Kukoae; (land section); Kaupo; *Maui.*
Kukuau; (land section); Hilo; *Hawaii.*
Kukui; [candlenut tree, aleurites]; (land section); Ka-u; *Hawaii.*
Kukui; Koolau; *Maui.*
Kukui, Mountain; *Maui;* elevation, 5 790 feet.
Kukuiaeo; (land section); Kula; *Maui.*
Kukuihaeke; (land section); Hamakua; *Hawaii.*
Kukuihaele; (village); Hamakua; *Hawaii.*
Kukuihala; (land section); Puna; *Hawaii.*
Kukuikea; [white Kukui]; (land section); Hilo; *Hawaii.*
Kukuikapu; [forbidden Kukui]; (land section); Lahaina; *Maui.*
Kuilei; Hamakua; *Hawaii;* elevation, 1 429 feet.
Kukuio; (land section); Kona; *Oahu.*
Kukuioloa; (land section); Ka-u; *Hawaii.*
Kukuioolu; (land section); Kaupo; *Maui.*
Kukuiopae; (land section); South Kona; *Hawaii.*
Kukuipahu; (land section); Kohala; *Hawaii.*
Kukuiula; [red Kukui]; (land section); Kipahulu; *Maui.*
Kukuiwaluhia; (land section); Kohala; *Hawaii.*
Kukuluaeo; [stilt plover]; (land section); Kona; *Oahu.*
Kula; [dry upland]; (land section); Puna; *Hawaii.*
Kula; (district); *Maui.*
Kulaikahonu; (land section); Hilo; *Hawaii.*
Kulaimáno; (land section); Hilo; *Hawaii.*
Kulanakii; (stream); Hilo; *Hawaii.*
Kulanakii; [place of idols]; (land section); Hilo; *Hawaii.*
Kulani Hill; [heavenly stand]; Hilo; *Hawaii;* elevation, 5 574 feet.
Kuliamano; (stream); Hilo; *Hawaii.*
Kulihai; (land section); Hamakua; *Hawaii.*
Kuliouou; (land section); Kona; *Oahu.*
Kuloli; Hamakualoa; *Maui;* elevation, 855 feet.
Kumakalii; Waianæ Range; *Oahu;* elevation, 2 908 feet.
Kumimi; [rattoons]; (land section); Kona; *Molokai.*
Kumu; [foundation]; (land section); Ka-u; *Hawaii.*
Kumueli; (land section); Kona; *Molokai.*
Kumukahi; (cape); Puna; *Hawaii.*
Kumukahi; (channel); between *Kauai* and *Niihau.*
Kumukumu; [short stumps]; (land section); Puna; *Kauai.*
Kumunui; [great foundation]; (land section); Kaupo; *Maui.*
Kumuula; [red stump]; (land section); Kona; *Oahu.*
Kunawai; (land section); Kona; *Oahu.*
Kuokalá; (land section); Waialua; *Oahu.*
Kupahu; (land section); Puna; *Hawaii.*
Kuwale; [stand alone]; Waianae; *Oahu;* elevation, 582 feet.
Kuwili; (land section); Kona; *Oahu.*
Laalaau, Puu; [bushes]; North Kona; *Hawaii;* elevation, 7 451 feet.
Laaloa; (land section); North Kona; *Hawaii.*
Laaukahi; [one tree]; Kona; *Kauai.*
Laaumama; [light tree]; (land section); Kohala; *Hawaii.*
Laeapuki; [cape of Puki]; (land section); Puna; *Hawaii.*
Lae Loa; [long cape]; (cape); South Kona; *Hawaii.*
Lae Mano; [shark cape]; (cape); North Kona; *Hawaii.*

Lae-o-ka-Oio; (point ; Koolauloa; *Oahu.*
Laepaoo; [cape of Paoo fish]; (land section); Puna; *Hawaii.*
Lahaina; (district); *Maui.*
Lahaina; (town); Lahaina; *Maui.*
Lahaina Roadstead; Lahaina; *Maui.*
Lahikiola; [day of safety]; North Kohala; *Hawaii;* elevation, 3 259 feet.
Lahilahi; [thin]; (point); Waianae; *Oahu;* elevation, 228 feet.
Lahokea; (land section); Puna; *Hawaii.*
Lahuipuaa; [multitude of hogs]; (land section); Kohala; *Hawaii.*
Laie; (point); Koolauloa; *Oahu.*
Laie; [leaf of Ie, freycinetia]; (land section); Koolauloa; *Oahu.*
Laie; (village); Koolauloa; *Oahu.*
Laimi; [day of seeking]; (land section); Hilo; *Hawaii.*
Laimi; (land section); Kona; *Oahu.*
Laina, Puu; Lahaina; *Maui;* elevation, 648 feet.
Laina; N. W. coast, *Molokai;* elevation, 658 feet.
Lamaloloa; [long torch]; (land section); Kohala; *Hawaii.*
Lamanui; [great torch]; (land section); Kaupo; *Maui.*
Lanai; (island).
Lanihau; [snow chief]; (land section); North Kona; *Hawaii.*
Lanihuli, Koolau Range; *Oahu;* elevation, 2 781 feet.
Lanipo; (land section); Kahikinui; *Maui.*
Lapa Hapuu; [ridge of pulu ferns]; Hilo; *Hawaii;* elevation, 4 099 feet.
Lapakahi; (land section); Kohala; *Hawaii.*
Lapakea; [white ridge]; (land section); Lahaina; *Maui.*
Lapalapaiki; [little boiling]; (land section); Hana; *Maui.*
La Perouse Bay; Honuaula; *Maui.*
Lauhulu; [banana leaf]; (land section); Hilo; *Hawaii.*
Lauka; (land section); Hamakua; *Hawaii.*
Laukaha; (land section); Kona; *Oahu.*
Laumaia; [banana leaf]; North Hilo; *Hawaii;* elevation, 5 145 feet.
Launiupoko; Lahaina; *Maui;* elevation, 808 feet.
Launiupoko; [short cocoanut leaf]; (land section); Lahaina; *Maui.*
Laupahoehoe; (cape); North Hilo; *Hawaii.*
Laupahoehoe; [smooth lava plant]; (land section); Hamakua; *Hawaii.*
Laupahoehoe; (stream); North Hilo; *Hawaii.*
Laupahoehoe; (land section); Hilo; *Hawaii.*
Laupahoehoe; (village); Hilo; *Hawaii.*
Laupahoehoe Landing; North Hilo; *Hawaii*
Lawai; (land section); Kona; *Kauai.*
Lawai; (stream); Kona; *Kauai.*
Lawai Bay; Kona; *Kauai.*
Leahi (Diamond Head); (point); Kona; *Oahu;* elevation, 761 feet.
Lehu, Puu; [ash hill]; Waimea; *Kauai.*
Leehuula; [red ashes]; (land section); North Kona; *Hawaii.*
Leleiwi; (cape); Hilo; *Hawaii.*
Lepeuli; (land section); Koolau; *Kauai.*
Lepoloa; [very dirty]; (land section); Hilo; *Hawaii.*
Lihue; (village); Puna; *Kauai.*
Lilinoe, M. Kea; [mist, fine rain]; Hamakua; *Hawaii;* elevation, 12 996 feet.
Liolio, Puu; Hamakua; *Hawaii;* elevation, 1 889 feet.
Lipoa; (point); Kaanapali; *Maui.*
Loa, Puu; [long hill]; Kohala; *Hawaii;* elevation, 4 124 feet.
Loiloa; [long taro patch]; (land section); Koolau; *Maui.*
Lole; [cloth]; (land section); Kaupo; *Maui.*
Lolipali; (land section); Ka-u; *Hawaii.*
Louluape; [fan palm]; (land section); Kahikinui; *Maui.*
Luahine, Puu; [old woman's hill]; west central *Molokai;* elevation, 1 208 feet.
Luakalo; (land section); Kona; *Oahu.*
Lualailua; Kipahulu; *Maui;* elevation, 1 960 feet.
Lualailua; (land section); Kahikinui; *Maui.*
Lumahai; (land section); Halelea; *Kauai.*
Lumahai; (stream); Halelea; *Kauai.*
Lupehu; (land section); Kona; *Molokai.*
Maalaea Bay; Wailuku; *Maui.*
Maalo; [to pass by]; (land section); Kaupo; *Maui.*
Maelieli, Heeia; Koolaupoko; *Oahu;* elevation, 715 feet.
Magnetic Peak, Haleakala; *Maui;* elevation, 10 009 feet.
Mahaiula; (land section); Ka-u; *Hawaii.*
Mahakahanaloa; (land section); Hilo; *Hawaii.*
Mahana; [warm]; (land section); Lanai; *Lanai.*
Mahaulepu; (land section); Puna; *Kauai.*
Mahinahina; (land section); Kaanapali; *Maui.*
Mahoe, Puu; [twin hills]; Honuaula; *Maui;* elevation, 2 685 feet.
Mahukona; [leeward stream or smoke]; (land section); Kohala; *Hawaii.*
Mahukona Harbor; North Kohala; *Hawaii.*
Mahukuolo; (land section); Hamakua; *Hawaii.*
Mahulile; (land section); Koolau; *Molokai.*
Mahulua; (land section); Hana; *Maui.*

Maihi; [stripped, peeled]; (land section); North Kona; *Hawaii.*

Mailepai; (land section); Kaanapali; *Maui.*

Maili; North Waianae; *Oahu;* elevation, 1 505 feet.

Mailiilii; Waianae; *Oahu;* elevation, 729 feet.

Maipalaha; (land section); Kaupo; *Maui.*

Makaaikuloa; (point); Kipahulu; *Maui.*

Makaakini; (point); Kaupo; *Maui.*

Makaalae; (land section); Hana; *Maui.*

Makaeha; [sore eye]; (land section); Kula; *Maui.*

Makaha; [robbery]; (land section); Waianae; *Oahu.*

Makaha; (village); Waianae; *Oahu.*

Makahahana; Hana; *Maui;* elevation, 1 287 feet.

Makahakupea; (land section); Kona; *Molokai.*

Makahiupá; (land section); Hilo; *Hawaii.*

Makahuena; (cape); Kona; *Kauai.*

Makaiwa; (land section); Koolau; *Maui.*

Makaka; (land section); Ka-u; *Hawaii.*

Makakaha; (land section); Lahaina; *Maui.*

Makakilo; Honouliuli; Ewa; *Oahu;* elevation, 970 feet.

Makakupaia; Koolau; *Molokai;* elevation, 2 610 feet.

Makakupu, (land section); Ka-u; *Hawaii.*

Makalawena; (village); North Kona; *Hawaii.*

Makalawena; (land section); North Kona; *Hawaii.*

Makaliihanau; [birth of the Pleiades]; Hana; *Maui;* elevation, 607 feet,

Makaluapuna; (point); Kaanapali; *Maui.*

Makamoku; (land section); Kahikinui; *Maui.*

Makanalua; [two presents]; (land section); Koolau; *Molokai.*

Makanikahio; (land section); Kohala; *Hawaii.*

Makao; (land section); Koolauloa; *Oahu.*

Makapala; (land section); Kohala; *Hawaii.*

Makapala; [ripe]; (land section); Koolau; *Maui.*

Makapala; (village); North Kohala; *Hawaii.*

Makapihi; (land section); Koolau; *Maui.*

Makapuu; [on the hill]; (land section); Hana; *Maui.*

Makapuu; (point); Kona; *Oahu,* elevation, 665 feet.

Makaua; (land section); Koolauloa; *Oahu.*

Makaula; [prophet]; (land section); North Kona; *Hawaii.*

Makawao; (village); Hamakuapoko; *Maui.*

Makawao; [on the upland]; (land section); Hamakuapoko; *Maui.*

Makaweli; (stream); Kona; *Kauai.*

Makaweli; [fearful eye]; (land section); Kona; *Kauai.*

Makaweli; (village); Kona; *Oahu.*

Makea (land section); Hilo; *Hawaii.*

Makeanehu; (land section); Kohala; *Hawaii.*

Makena; [mourning for the dead]; (land section); Puna; *Hawaii.*

Makena; (village); Honuaula; *Maui.*

Makena anchorage; Honuaula; *Maui.*

Makiki Valley; (land section); Kona; *Oahu.*

Makila; (land section); Lahaina; *Maui.*

Makiloa; (land section); Kohala; *Hawaii.*

Makole; [sore eye]; (land section); Kona; *Molokai.*

Makolelau; (land section); Kona; *Molokai.*

Makoloaka; (point); Koolau; *Maui.*

Makua; (village); Waianae; *Oahu.*

Makua; [parent]; (land section); Waianae; *Oahu.*

Mahukona; (village); North Kohala; *Hawaii.*

Makuu; (land section); South Kona; *Hawaii.*

Makuu; (land section); Puna; *Hawaii.*

Makuu; (village); Puna; *Hawaii.*

Malaekahana; (land section); Koolauloa; *Oahu.*

Malama; [month]; (land section); Puna; *Hawaii.*

Malamalamaiki; [little light]; (land section); Hilo; *Hawaii.*

Malamalamaiki; (stream); Hilo; *Hawaii.*

Malanahae; (land section); Hamakua; *Hawaii.*

Maliko; (stream); Hamakualoa; *Maui.*

Maluaka; (land section); Honuaula; *Maui.*

Mamaloa; (cape); Kona; *Kauai.*

Mamalu; [shade, screen]; (land section); Kaupo; *Maui.*

Mana; [crumb of food]; Hamakua; *Hawaii;* elevation, 3 505 feet.

Manaá; (village); Waimea; *Kauai.*

Mana, Puu; [crumb]; Hamakua; *Hawaii;* elevation, 1 633 feet.

Manai; [needle]; (land section); Hamakua; *Hawaii.*

Mahaiula; (land section); North Kona; *Hawaii.*

Manana iki; [little manana]; (land section); Ewa; *Oahu.*

Manana nui; [great manana]; (land section); Ewa; *Oahu.*

Manawahua, Waianae Range; *Oahu;* elevation, 2 432 feet.

Manawai; (branch stream); (land section); Kona; *Molokai.*

Manawainui; [great time]; (land section); Kaupo; *Maui.*

Manele Harbor; [a litter or sedan]; *Lanai.*

Manienie; [bermuda grass]; (land section); Hamakua; *Hawaii.*

Manienie; (land section); Ka-u; *Hawaii.*

Maniniowali; (land section); North Kona; *Hawaii.*
Manoa; (stream); Kona; *Oahu.*
Manoa; (village); Kona; *Oahu.*
Manoa Valley; [thick, deep]; (land section); Kona; *Oahu.*
Manoloa; [long shark]; (land section); Hilo; *Hawaii.*
Manowaialee; (land section); Hamakua; *Hawaii.*
Manono; [a kind of tree, gouldia]; (land section); Ka-u; *Hawaii.*
Manowaiopae; (land section); Hilo; *Hawaii.*
Manowaikohau; (land section); Hamakua; *Hawaii.*
Manu, Puu; [bird hill]; *Lanai;* elevation, 2 070 feet.
Manuká; (land section); Ka-u; *Hawaii.*
Maonakomalie; (land section); Hamakua; *Hawaii.*
Mapulehu; (land section); Kona; *Molokai.*
Maui; [name of a demigod]; (island).
Maulekikepa; (land section); Kona; *Oahu.*
Maulili; (land section); Hilo; *Hawaii.*
Maulili; (land section); Kohala; *Hawaii.*
Maulili; (land section); Kipahulu; *Maui.*
Maulua; [hard, difficult]; (land section); Hilo; *Hawaii.*
Maulua; (stream); Hilo; *Hawaii.*
Maulua Bay; Hilo; *Hawaii.*
Maumau; [firm, perpetual]; (land section); Hilo; *Hawaii.*
Mauna Kapu; [tabu mountain]; *Oahu;* elevation 2 742 feet.
Mauna Kea; Hamakua; *Hawaii;* elevation, 3 825 feet.
Maunalua; [two mountains]; (land section); Kona; *Oahu.*
Maunalei; (village); *Lanai.*
Mauna Loa; [long mountain]; South Kona; *Hawaii;* elevation, 13 675 feet.
Mauna Loa; Kaluakoi; *Molokai;* elevation, 1 382 feet.
Maunalei; [mountain of wreaths]; (land section); Lanai; *Lanai.*
Maunaoni; [moving mountain]; (land section); South Kona; *Hawaii.*
Maunauna; [waste]; Waianae Range; *Oahu;* elevation, 1 768 feet.
Mehamenui; (land section); Kahikinui; *Maui.*
Miana; (land section); Kaupo; *Maui.*
Miananai; (land section); Ka-u; *Hawaii.*
Middle Hill or Kapena Hulu; *Molokai;* elevation, 1 018 feet.
Mikimiki; [brisk, quick]; (land section); Kaupo; *Maui.*
Milolii; [little milo tree]; South Kona; *Hawaii;* elevation, 932 feet.
Milolii; (land section); South Kona; *Hawaii.*
Milolii; (village); South Kona; *Hawaii.*
Milolii Landing; South Kona; *Hawaii.*
Moakea; [white fowl]; (land section); Kona; *Molokai.*
Moalii; (land section); Lahaina; *Maui.*
Moanalua; (stream); Kona; *Oahu.*
Moanalua; [two oceans]; (land section); Kona; *Oahu.*
Moanalua; (village); Kona; *Oahu.*
Moanalua Bay; Kona; *Oahu.*
Moanalulu: [smooth ocean]; (land section); Hilo; *Hawaii.*
Moano; Hamakua; *Hawaii*; elevation, 6 879 feet.
Moanui; [great fowl]; (land section); Kona; *Molokai.*
Moaula; [red fowl]; (land section); Ka-u; *Hawaii.*
Moeauoa; (land section); North Kona; *Hawaii.*
Mohokea; [white moho]; (land section); Ka-u, *Hawaii.*
Mohowae; (land section); Ka-u; *Hawaii.*
Moiliili; (village); Kona; *Oahu.*
Mokae; [a plant]; (land section); Hana; *Maui.*
Mokae Landing; Hana; *Maui.*
Mokapu, east of Kaneohe Bay; Koolau; *Oahu*; elevation, 681 feet.
Mokapu; (point); Koolaupopo; *Oahu.*
Mokuhonua; [district of level land]; (land section); Hilo; *Hawaii.*
Mokuhooniki; (islet); west end near *Molokai;* elevation, 198 feet.
Mokuia; [cut, divided]; (land section); Kaupo; *Maui.*
Mokulau; (village); Kaupo; *Maui.*
Mokulau Landing; Kaupo; *Maui.*
Mokuleia; [a kind of fish]; (land section); Waialua; *Oahu.*
Mokuleia; (village); Waialua; *Oahu.*
Mokuola, Island; [island of safety, life]; (land section); Hilo; *Hawaii.*
Mokuoniki; (land section); Hilo; *Hawaii.*
Mokupapa; [level district]; (land section); Hamakualoa; *Maui.*
Moloaa; (land section); Koolau; *Kauai.*
Moloaa; (stream); Halelea; *Kauai.*
Molokai; (island).
Molokini; (island); elevation, 160 feet.
Molokini; (island).
Mooiki; [small moo, strip of land]; (land section); Hilo; *Hawaii.*
Mooiki; [little strip]; (land section); Honuaula, *Maui.*
Mooiki; (land section); Kaupo, *Maui.*

Mookahi; (land section); Kona, *Oahu.*
Mooloa; [long strip]; (land section); Honuaula, *Maui.*
Mooloa; (land section); Koolau; *Maui.*
Moomuku; [cut short]; (land section); Honuaula; *Maui.*
Muolea; (land section); Hana; *Maui.*
Muolea; (village); Hana; *Maui.*
Nahaha, Puu; [broken hill]; South Kona; *Hawaii;* elevation, 767 feet.
Nahanawale; (land section); Hana; *Maui.*
Nahiku; (stream); Koolau; *Maui.*
Nahiku; [seven lands]; (land section); Koolau; *Maui.*
Nahiku; (village); Koolau; *Maui.*
Naholokú; [the garments]; (land section); Kaupo; *Maui.*
Nahuakamalii; [the children's fruits]; (land section); Hana; *Maui.*
Nailiilipoko; [short pebbles]; (land section); Kipahulu; *Maui.*
Naiwa; (land section); Kona; *Molokai.*
Nakaaha; (land section); Kahikinui; *Maui.*
Nakalii; (land section); Koolau; *Maui.*
Nakaohu; (land section); Kahikinui; *Maui.*
Nakapauku; (land section); Kaupo; *Maui.*
Nakapehu; (land section); Koolau; *Maui.*
Nakooko; (land section); Hamakua; *Hawaii.*
Nakukuikea; [white Kukui]; (land section); Kahikinui; *Maui.*
Nakula; [uplands]; (land section); Kaupo; *Maui.*
Nalua; [pits]; (land section); Ka-u; *Hawaii.*
Namahana; Halelea; *Kauai.*
Namahana; (land section); Koolau; *Kauai.*
Namolokama; Halelea; *Kauai;* elevation, 4 200 feet.
Nanawale; [only look]; (land section); Puna; *Hawaii.*
Naniumalu; [shady cocoanut trees]; (land section); Kaupo; *Maui.*
Nanue; (stream); Hilo; *Hawaii.*
Nanue; [to shake, tremble]; (land section); Hilo; *Hawaii.*
Na Pali; [the precipices]; (district); *Kauai.*
Napahoa; [daggers]; (land section); Koolau; *Maui.*
Napili; (land section); Kaanapali; *Maui.*
Napili Bay; Kaanapali; *Maui.*
Napoopoo; (village); South Kona; *Hawaii.*
Napuukulua; [two hills standing together]; Hamakua; *Hawaii*; elevation, 5 757 feet.
Napuhaehae; (land section); Koolau; *Maui.*
Nawiliwili; [wiliwili tree, Erythrina]; (land section); Puna; *Kauai.*
Nawiliwili Bay; Puna; *Kauai.*

Nene; [goose]; (land section); Hilo; *Hawaii.*
Nene, Puu; [goose hill]; Wailuku; *Maui;* elevation, 186 feet.
Nianiau, Puu; [straight hill]; *Maui;* elevation, 6 850 feet.
Nienie; [smooth, calm]; (land section); Hamakua; *Hawaii.*
Nihoa; (land section); Koolau; *Molokai.*
Niihau; (island).
Nini; (land section); Kona; *Oahu.*
Niniao; [pour, clouds]; (land section); Kaupo; *Maui.*
Ninole; (land section); Hilo; *Hawaii.*
Ninole; (land section); Ka-u; *Hawaii.*
Niolopá; (land section); Kona; *Oahu.*
Niu; (village); Kona; *Oahu.*
Niuhelewai; (stream); Kona; *Oahu.*
Niulii, [small cocoanut tree]; (land section); Kohala, *Hawaii.*
Niulii; (village); North Kohala; *Hawaii.*
Niulii; (stream); Kohola; *Hawaii.*
Niumalu; [shady cocoanut tree]; (land section); Puna; *Kauai.*
Niumalu;' (land section); Hana; *Maui.*
Niupaipai; (land section); Kona; *Oahu.*
Niupea; (land section); Hamakua; *Hawaii.*
Niupuka; [cocoanut tree with a hole through it]; (land section); Hamakua; *Hawaii.*
Nohoiki; [little seat]; (land section); Ka-u; *Hawaii.*
Nohonaohae; [dwelling of Hae]; South Kohala; *Hawaii;* elevation, 3 253 feet.
Nono; (pond); Puna; *Kauai.*
Nuaailua; (stream); Koolau; *Maui.*
Nukakaia; (land section); Ka-u; *Hawaii.*
Nukunukuaula; [frame of a fishing net]; (land section); Kona; *Oahu.*
Nunulu; [bird song]; North Kohala; *Hawaii;* elevation, 1 589 feet.
Nuu; [terrace]; (land section); Kaupo; *Maui.*
Nuu; (land section); Kona; *Oahu.*
Nuu (village); Kaupo; *Maui.*
Nuu Landing; Kaupo; *Maui.*
Nuuanu; (stream); Kona; *Oahu.*
Nuuanu Valley; [cool terraces]; (land section); Kona; *Oahu.*
Nuuanu Pali Pass; [cool terraces]; Koolau Range; *Oahu;* elevation, 1 209 feet.
Oahu; (island).
Ohai, Puu; [cassia gaudichaudii]; North Hilo; *Hawaii;* elevation, 737 feet.
Ohau, Puu; [hill of dew]; South Kona; *Hawaii;* elevation, 231 feet.
Ohia; [Eugenia malaccensis]; (land section); Hana; *Maui.*

Ohia; [fruit tree, Eugenia malaccensis]; (land section); Kona; *Molokai.*

Ohia, Puu; [hill of the Ohia, metrosideros; tantalus]; *Oahu;* elevation, 2 013 feet.

Ohiki; (land section); North Kona; *Hawaii.*

Ohikilolo; (land section); Waianae; *Oahu.*

Ohohia, Puu; South Kona; *Hawaii;* elevation, 5 522 feet.

Ohulehule, Puu; [bald hill]; Koolau Range; *Oahu;* elevation, 2 263 feet.

o Hulu, Puu; Waianae; *Oahu;* elevation, 856 feet.

Oio; [procession of ghosts]; (land section); Koolauloa; *Oahu.*

o Ka Haula, Puu; Hana; *Maui;* elevation, 540 feet.

o Kali, Puu; [hill of waiting]; Kula; *Maui;* elevation, 1 479 feet.

o Kanaloa, Puu; [Kanaloa's hill]; Honuaula; *Maui;* elevation, 213 feet.

o Keokeo, Puu; [white hill]; Ka-u; *Hawaii;* elevation, 6 870 feet.

Okoe; (land section); South Kona; *Hawaii.*

Okoe Landing; South Kona; *Hawaii.*

o Koha, Puu; [Koha's hill]; Kula; *Maui;* elevation, 1 051 feet.

Okóholá, Puu; [whale hill]; Koolau; *Maui;* elevation, 844 feet.

Oku; (point); *Niihau.*

Olaa; (trig. sta.); Puna; *Hawaii;* elevation, 662 feet.

Olaa; (village); Puna; *Hawaii.*

Olaa; (land section); Puna; *Hawaii.*

Olai, Puu; [earthquake hill]; Honuaula; *Maui;* elevation, 356 feet.

Olinda; Makawao; *Maui;* elevation, 4 043 feet.

Olelomoana; [voice from the ocean]; (land section); South Kona; *Hawaii.*

Oloewa; (land section); Hana; *Maui.*

Olohena; (land section); Puna; *Kauai.*

Olokú; (land section); Kona; *Oahu.*

Olokui; North Central Range; *Molokai;* elevation, 4 600 feet.

Olomana; (land section); Kona; *Oahu.*

Olomana; (land section); Koolaupoko; *Oahu.*

Olomana Peak; Koolaupoko; *Oahu;* elevation, 1 645 feet.

Olopawa; Hana; *Maui;* elevation, 1 843 feet.

Olowalu; (land section); Lahaina; *Maui.*

Olualu; (stream); Lahaina; *Maui.*

Olualu; (village); Lahaina; *Maui.*

Omokaa; (land section); South Kona; *Hawaii.*

Omaokoili; Hamakua; *Hawaii;* elevation, 7 087 feet.

Omaopio; (land section); Kula; *Maui.*

o Nale; Puu; North Kohala; *Hawaii;* elevation, 1 797 feet.

Onau; (land section); Honuaula; *Maui.*

Oneloa; [long sand beach]; (land section); Puna; *Hawaii.*

Onomea; Hilo; *Hawaii;* elevation, 465 feet.

Onomea; (land section); Hilo; *Hawaii.*

Onomea; (village); Hilo; *Hawaii.*

Onomea Bay; Hilo; *Hawaii.*

Onouli; North Kona; *Hawaii;* elevation, 1 574 feet.

Onouli; (land section); South Kohala; *Hawaii.*

Onouli; (land section); Hana; *Maui.*

Onoulimaloo; [dry onouli]; (land section); Kona; *Molokai.*

Onouliwai; [watered onouli]; (land section); Kona; *Molokai.*

Oo, Puu; [bird with yellow feathers]; Hilo; *Hawaii;* elevation, 6 934 feet.

Ookala; (stream); North Hilo; *Hawaii.*

Ookala; (land section); Hilo; *Hawaii.*

Ookala; (village); Hilo; *Hawaii.*

Ookala Landing; Hilo; *Hawaii.*

Ooma; [a spout, a gouge]; (land section); North Kona; *Hawaii.*

o Pae, Puu; [hill of Pae]; Waimea; *Kauai.*

Opaeula; [red shrimp]; (land section); Lahaina; *Maui.*

Opaeula; (stream); Waialua; *Oahu.*

Opana; (land section); Hamakualoa; *Maui.*

Opana; (land section); Koolauloa; *Oahu.*

Opea; [a cross]; (land section); Hilo; *Hawaii.*

Opea; (stream); Hilo; *Hawaii.*

Opihihali; (land section); South Kona; *Hawaii.*

Opihikao; (land section); Puna; *Hawaii.*

Opihikao; (village); *Hawaii.*

Opihilala; (land section); Hamakua; *Hawaii.*

Opihipau; [limpets all gone]; (land section); Kohala; *Hawaii.*

Opikoula; (land section); Koolau; *Maui.*

Opuola; (stream); Koolau; *Maui.*

Ouli, Puu; [hill of omens]; Honuaula; *Maui;* elevation, 4 354 feet.

o Umi, Puu; [Umi's hill]; Hamakualoa; *Maui;* elevation, 629 feet.

o Uo, Puu; [hill of Uo]; South Kona; *Hawaii;* elevation, 8 226 feet.

Pa, Puu; [fort hill]; South Kohala; *Hawaii;* elevation, 2 671 feet.

Paa; [fast, secure]; (land section); Kona; *Kauai.*

Paakai; [salt]; (point); *Lanai.*

Paakea; (stream); Koolau; *Maui.*

Paako; (land section); Hamakua; *Hawaii.*

Paalaa; (land section); Waialua; *Oahu.*

Paalaea; [red ocher inclosure]; (land section); Hamakua; *Hawaii.*
Paana; (land section); Hilo; *Hawaii.*
Paanau; [bathing inclosure]; (land section); Ka-u; *Hawaii.*
Paauhau; [tax yard]; Hamakua; *Hawaii;* elevation, 1 345 feet.
Paauhau; (land section); Hamakua; *Hawaii.*
Paauhau; (land section); Kaupo; *Maui.*
Paauilo; (land section); Hamakua; *Hawaii.*
Paauilo; (village); Hamakua; *Hawaii.*
Paeahu; (land section); Honuaula; *Maui.*
Paehala; (land section); Hana; *Maui.*
Paeohe; (land section); Hilo; *Hawaii.*
Paeohi; (land section); Lahaina; *Maui.*
Pahala; (village); Ka-u; *Hawaii.*
Pahau; (point); *Niihau.*
Paheehee; [slippery]; Waianae; *Oahu;* elevation 652 feet.
Pahinahina; (land section); Kohala, *Hawaii.*
Pahipahialua; (land section); Koolauloa; *Oahu.*
Pahoa; [dagger]; (land section); Kohala; *Hawaii.*
Pahoa; [dagger]; (land section); Lahaina; *Maui.*
Pahoa; [dagger]; (land section); Waianae, *Oahu.*
Pahoa; (village); Puna; *Hawaii.*
Pahoehoe; [smooth lava]; South Kona; *Hawaii;* elevation 736 feet.
Pahoehoe; (stream); Hilo; *Hawaii.*
Pahoehoe; (land section); Hilo; *Hawaii.*
Pahoehoe; (land section); North Kona; *Hawii.*
Pahoehoe A; (land section); South Kona; *Hawaii.*
Pahoehoe B; (land section); South Kona; *Hawaii.*
Pahukii; [idol drum]; (land section); Hamakua; *Hawaii.*
Páhuoloná; [flax drum]; Hana; *Maui*; elevation, 837 feet.
Pahupahuapuaa; (land section); Kona; *Oahu.*
Paia; [fish yard]; (land section); Hamakuapoko; *Maui.*
Paia; (village); Hamakuapoko; *Maui.*
Paihaaloa; (land section); Hilo; *Hawaii.*
Pailolo; (channel); between *Maui* and *Molokai.*
Paina; [eating]; (land section); Kaupo; *Maui.*
Paka, Puu; Halelea; *Kauai.*
Pakakia; (land section); Hana; *Maui.*
Pakaoao, Haleakalá; *Maui;* elevation, 9 370 feet.
Pakea; [whitish rock]; (land section); Koolau; *Maui.*
Pakihi, E side of Haleakalá; *Maui;* elevation, 8 108 feet.
Pakiloa; (land section); Hamakua; *Hawaii.*
Pakini; (land section); Ka-u; *Hawaii.*
Palaau; [wooden fence]; (land section); Kona; *Molokai.*
Palailai; Honouliuli; Ewa; *Oahu;* elevation, 490 feet.
Palauea; (land section); Honuaula; *Maui.*
Palauhulu; (stream); Koolau; *Maui.*
Palauhulu; (land section); Ka-u; *Hawaii.*
Palawai; (village); *Lanai.*
Palawai; [a kind of sea moss]; (land section); Lanai; *Lanai.*
Palemano; [keep off sharks]; (cape); South Kona; *Hawaii.*
Palemo; [sunk]; (land section); Hana; *Maui.*
Palikea; [white precipice]; Na Pali; *Kauai.*
Palikea; Waianae Range; *Oahu;* elevation, 3 111 feet.
Palikea; [whitish precipice]; (land section); Kona; *Oahu.*
Palima; (land section); Ka-u; *Hawaii.*
Palolo; (stream); Kona; *Oahu.*
Palolo; (village); Kona; *Oahu.*
Palolo Valley; [clay]; (land section); Kona; *Oahu.*
Pamoa; [hen yard]; (land section); Kona; *Oahu.*
Panaewa; (land section); Lahaina; *Maui.*
Panaiau; (land section); Hamakuapoko; *Maui.*
Panau iki; (land section); Puna; *Hawaii.*
Pane, Puu; Kahikinui; *Maui;* elevation, 3 988 feet.
Pane, Puu; [answer hill]; Kula; *Maui;* elevation, 2 568 feet.
Pane, Puu; Waianae; *Oahu;* elevation, 2 441 feet.
Paomai; (land section); Lanai; *Lanai.*
Paoo; (land section); Kohala; *Hawaii.*
Paopao; [beating, strife]; (land section); Kohala; *Hawaii.*
Papa; [flat, level]; (land section); South Kona; *Hawaii.*
Papa; (village); South Kona; *Hawaii.*
Papaa; [tight, secure]; (land section); Hilo; *Hawaii.*
Papaa; (land section); Kohala; *Hawaii.*
Papaa A; (land section); Koolau; *Kauai.*
Papaa B; (land section); Koolau; *Kauai.*
Papaaea [turtle Papaa]; (land section); Hamakualoa; *Maui.*
Papaahawahawa; [filthy Papaa]; (land section); Hana; *Maui.*
Papaakoko; (land section); Koolauloa; *Oahu.*
Papaaloa; [dried up]; Hilo; *Hawaii;* elevation, 918 feet.
Papaaloa; [long, tight]; (land section); Hilo; *Hawaii.*

Papaanui; [great tight]; (land section); Hamakua; *Hawaii.*
Papaanui; [great Papaa]; (land section); Honuaula; *Maui.*
Papaauhau; [tax Papaa]; (land section); Hana; *Maui.*
Papaikou; Hilo; *Hawaii;* elevation, 304 feet.
Papaikou; (land section); Hilo; *Hawaii.*
Papaikou; (stream); Hilo; *Hawaii.*
Papaikou; (land section); Ka-u; *Hawaii.*
Papaikou; (village); Hilo; *Hawaii.*
Papaikou Landing; Hilo; *Hawaii.*
Papaka; (land section); Honuaula; *Maui.*
Papaka; (point); Honuaula; *Maui.*
Papaki; (land section); Hamakua; *Hawaii.*
Papalawa; (land section); Koolau; *Molokai.*
Papalekoki; [helmet]; Hamakua; *Hawaii;* elevation, 11 249 feet.
Papalele; (land section); Hamakua; *Hawaii.*
Papauluana; (land section); Kipahulu; *Maui.*
Papohaku; [stone wall]; (land section); Ka-u; *Hawaii.*
Pau; [done, finished]; (land section); Kona; *Oahu.*
Paukaa; (land section); Hilo; *Hawaii.*
Paukoa; (land section); Kona; *Oahu.*
Pauku iki; [small piece]; (land section); Ka-u; *Hawaii.*
Pauku nui; [great piece]; (land section); Ka-u; *Hawaii.*
Paumalu; (land section); Koolauloa; *Oahu.*
Paunau; (land section); Lahaina; *Maui.*
Pauoa; (stream); Kona; *Oahu.*
Pauoa Valley; (land section); Kona; *Oahu.*
Paupau; (Mount Ball); Lahaina; *Maui;* elevation, 2 254 feet.
Pauwalu; (point); Koolau; *Maui.*
Pauwela; [burned up]; (land section); Hamakualoa; *Maui.*
Pauwela; (stream); Hamakualoa; *Maui.*
Pauwela; (village); Hamakualoa; *Maui.*
Pawaa; [wild]; (land section); Kona; *Oahu.*
Peahi; [beckon]; (land section); Hamakualoa; *Maui.*
Pearl City; (village); Ewa; *Oahu.*
Pearl Lochs; Ewa; *Oahu.*
Peleau; (land section); Hilo; *Hawaii.*
Pelekunu; [strong-smelling]; (land section); Koolau; *Molokai.*
Pelekunu; (village); Koolau; *Molokai.*
Pelekunu Bay; Koolau; *Molokai.*
Pepeekeo; (land section); Hilo; *Hawaii.*
Pepeekeo; (village); Hilo; *Hawaii.*
Piapia; [sore eye]; (land section); Hana; *Maui.*
Pihá; (land section); Hilo; *Hawaii.*
Piiholo; *Maui;* elevation, 2 255 feet.
Piihonua; [ascend land]; (land section); Hilo; *Hawaii.*
Pilaa; (land section); Koolau; *Kauai.*
Pili, Puu; North Kohala; *Hawaii;* elevation, 4 678 feet.
Piliamoo; (land section); Kona; *Oahu.*
Pimoe; Honuaula; *Maui;* elevation, 1 766 feet.
Poe; [round]; (land section); Kaupo; *Maui.*
Poeaki; (land section); Kona; *Oahu.*
Pohakanele; (land section); Hana; *Maui.*
Pohakea; [white rock]; Waianae Range; *Oahu;* elevation, 3 106 feet.
Pohaku Palaha, Haleakala; [broad rock]; *Maui;* elevation, 8 101 feet.
Pohaku Eaea; [spray rock]; (point); Kahikinui; *Maui.*
Pohakuao; (land section); Na Pali; *Kauai.*
Pohakuau; [swimming rock]; Na Pali; *Kauai.*
Pohakuawaawa; [bitter rock]; Na Pali; *Kauai.*
Pohakuhaku; [rocky]; (land section); Hamakua; *Hawaii.*
Pohakuloa; (land section); Ka-u; *Hawaii.*
Pohakuloa; [long rock]; (land section); Kohala; *Hawaii.*
Pohakuloa; (land section); Koolau; *Molokai.*
Pohakupili; Puna; *Kauai.*
Pohakupili; (land section); Kona; *Molokai.*
Pohakupuka; (stream); Hilo; *Hawaii.*
Pohakupuka; (village); Hilo; *Hawaii.*
Pohoiki A; (land section); Puna; *Hawaii.*
Pohoiki B; (land section); Puna; *Hawaii.*
Poho iki Landing; [small poho]; Puna; *Hawaii.*
Pohoula; *Lanai;* elevation, 2 026 feet.
Pohoula; [red chalk]; (land section); Kaupo; *Maui.*
Pohue; [gourd]; (land section); Hana; *Maui.*
Pohueloa; [long vine]; (land section); Niihau; *Niihau.*
Polaiki; [small Pola, platform of double canoe]; (land section); Lahaina; *Maui.*
Pokakupuka; [pierced rock]; (land section); Hilo; *Hawaii.*
Polala; [sun Pola]; (land section); Kahikinui; *Maui.*
Polanui; [great Pola]; (land section); Lahaina; *Maui.*
Polapola; [flowing robe]; (land section); Lahaina; *Maui.*
Polapola; (land section); Koolau; *Molokai.*
Poliahu, M. Kea; [snow goddess]; Hamakua; *Hawaii;* elevation, 13 646 feet.
Polipoli; [soft porous rock]; Kula; *Maui;* elevation, 1 051 feet.
Polipoli; (land section); Wailuku; *Maui.*

Poloke; [fresh poi]; (land section); Kona; *Oahu*.
Poloai; [to summon]; (land section); Kahikinui; *Maui*.
Pololu; [stream]; Kohala; *Hawaii*.
Pololú; [spear]; (land section); Kohala; *Hawaii*.
Pololú; (village); North Kohala; *Hawaii*.
Polua; [dizziness]; (land section); Kaanapali; *Maui*.
Ponahale; (land section); Ka-u; *Hawaii*.
Ponahawai; (land section); Hilo; *Hawaii*.
Poohina; [gray head]; (land section); Ka-u; *Hawaii*.
Poopao; (land section); Hana; *Maui*.
Poopoo; (stream); Hilo; *Hawaii*.
Poopuaa; [hog's head]; Hamakua; *Hawaii;* elevation, 6 012 feet.
Popoiwi; [corner]; (land section); Kaupo; *Maui*.
Popoki; (land section); Puna; *Hawaii*.
Popoloa; [long bundle]; (land section); Kipahulu; *Maui*.
Poponui; [great bundle]; (land section); Kipahulu; *Maui*.
Popouwela; (land section); Ka-u; *Hawaii*.
Pouhuluhulu; (land section); Kona; *Oahu*.
Poupou; [short]; (land section); Puna; *Hawaii*.
Puaa; [hog]; (land section); Lahaina; *Maui*.
Puaa; (land section); North Kona; *Hawaii*.
Puaahala; (land section); Kona; *Molokai*.
Puaahaunui; [hog with big bristles]; (land section); Koolau; *Molokai*.
Puaakuloa; (land section); Hilo; *Hawaii*.
Puaaloa; [long pig]; (land section); Lahaina; *Maui*.
Puahia; (land section); Kona; *Oahu*.
Puahoowali; [flower ground up]; (land section); Lahaina; *Maui*.
Puahùla; [dance flower]; (land section); Niihau; *Niihau*.
Puaiki; [little flower]; (land section); Kohala; *Hawaii*.
Puakea; [pale]; (land section); Kohala; *Hawaii*.
Puakea; [pale, whitish]; (land section); Koolau; *Maui*.
Puakó; [sugar-cane blossom]; (land section); South Kohala; *Hawaii*.
Puakó; [sugar-cane flower]; (land section); Lahaina; *Maui*.
Puakó; (village); South Kohala; *Hawaii*.
Puakó Bay, South Kohala; *Hawaii*.
Pualaa; [sacred flower]; (land section); Puna; *Hawaii*.
Pualaea; [red ocher hill]; (land section); Hilo; *Hawaii*.
Pualaea; (land section); Kaupo; *Maui*.
Pualoalo; [hibiscus Kokio]; (land section); Kona; *Oahu*.
Puanui; [great flower]; (land section); Hamakua; *Hawaii*.
Puanui; (land section); South Kohala; *Hawaii*.
Puapuaa; [collected as fagots]; (land section); North Kona; *Hawaii*.
Puehu; (point); Hamakualoa; *Maui*,
Puehuehu; [scattered]; (land section); South Kohala; *Hawaii*.
Puehuehu; (land section); Lahaina; *Maui*.
Puehuehuiki; (land section); Lahaina; *Maui*.
Pueke; (land section); South Kohala; *Hawaii*.
Puelelu; (land section); Kona; *Molokai*.
Pueokahi; [place of owls]; (land section); Hana; *Maui*.
Pueopaku; (land section); Hilo; *Hawaii*.
Puhalanui; [great Pandanus tree]. (land section); Ka-u; *Hawaii*.
Puheemiki; (land section); Koolauloa; *Oahu*.
Puiwa; [fright]; (land section); Kona; *Oahu*.
Pukaauhuhu; [fish poison outlet]; (land section); Kaupo; *Maui*.
Pukalani; [heavenly door]; (land section); Kula; *Maui*.
Pukele; (land section); Kona; *Oahu*.
Pukoo; (land section); Kona; *Molokai*.
Pukoo; (village); Kona; *Molokai*.
Pukoo Landing; Kona; *Molokai*.
Pukuilua; (land section); Hana; *Maui*.
Pulama; [torch]; (land section); Puna; *Hawaii*.
Pulama; (land section); Kaupo; *Maui*.
Pulehu iki; [little roasting]; (land section); Kula; *Maui*.
Pulehu nui; [great roasting]; (land section); Kula; *Maui*.
Puna; [coral, lime]; (district); *Hawaii*.
Puna; (district); *Kauai*.
Punaánaaná; [sorcerer's spring]; (land section); Kona; *Oahu*.
Punahelu; [mouldy]; (land section); Hilo; *Hawaii*.
Punahoa; (land section); Hilo; *Hawaii*.
Punalau; [leaf coral]; (land section); Kona; *Molokai*.
Punaluu; [coral dived for]; (land section); Ka-u; *Hawaii*.
Punaluu; (land section); Koolau; *Maui*.
Punaluu; (land section); Koolauloa; *Oahu*.
Punaluu; (village); Ka-u; *Hawaii*.
Punaluu; (village); Koolauloa; *Oahu*.
Punaluu Landing; Ka-u; *Hawaii*.
Punaula; [red coral]; (land section); Kona; *Molokai*.

Punohu; [smoke]; Hamakua; *Hawaii*; elevation, 4 325 feet.
Puohai; [hill of the Ohai shrub]; (land section); Hilo; *Hawaii*.
Puohai A; (land section); Hilo; *Hawaii*.
Puohai B; (land section); Hilo; *Hawaii*.
Puolua; (land section); Hamakualoa; *Maui*.
Puopaha; (land section); Hamakua; *Hawaii*.
Puou; (land section); Lahaina; *Maui*.
Puowaina; [hill of sacrifice]; Kona; *Oahu*; elevation, 498 feet.
Pupukea; [white shell]; (land section); Koolauloa, *Oahu*.
Puua; [rain hill]; (land section); Puna; *Hawaii*.
Puuanahulu; [hill of Anahulu]; (land section); North Kona; *Hawaii*.
Puueo; [owl]; (land section); Hilo; *Hawaii*.
Puueo; (land section); Ka-u; *Hawaii*.
Puuepa; [hill of deceit]; (land section); Kohala; *Hawaii*.
Puuhaoa; [hot hill]; (land section); Hana; *Maui*.
Puuhue; (village); North Kohala; *Hawaii*.
Puuhune; [hill of poverty]; (land section); Hilo; *Hawaii*.
Puuiki; [small hill]; (land section); Hana; *Maui*.
Puuiki; (land section); Lahaina; *Maui*.
Puuiki; (village); Hana; *Maui*.
Puukala; [rough hill]; (land section); North Kona; *Hawaii*.
Puukalaiipu; [hill where calabashes are cut out]; (land section); Koolau; *Maui*.
Puukoa; [koa tree hill]; (land section); Ka-u; *Hawaii*.
Puu Koae; [tropic bird hill]; (point); Kaanapali; *Maui*.
Puukóholá; [whale hill]; (land section); Hana; *Maui*.
Puukole; [red or bare hill]; (land section); Kohala; *Hawaii*.
Puula; (village); Puna; *Hawaii*.
Puulakua; (land section); Kaupo; *Maui*.
Puulani; [heavenly hill]; (land section); Kaupo; *Maui*.
Puulena; [cool breeze]; (land section); Kona; *Oahu*.
Puuloa; [long hill]; (land section); Ewa; *Oahu*.
Puulonalona; (land section); Koolau; *Maui*.
Puumahoe; (stream); Koolau; *Maui*.
Puumaile; [hill of maile, Alyxia olivae formis]; (land section); Koolau; *Maui*.
Puumakaa; (land section); Ka-u; *Hawaii*.
Puu Makawana; (point); Kaanapali; *Maui*.
Puumaneoneo; [hill of sea grass]; (land section); Kaupo; *Maui*.
Puumoi; [royal hill]; (land section); Hilo; *Hawaii*.
Puumoi: (stream); Hilo; *Hawaii*.
Puunau; [hill of nau]; (land section); Lahaina; *Maui*.
Puunene; (village); Wailuku; *Maui*.
Puunoa; [hill free from kapu]; (land section); Lahaina; *Maui*.
Puunoa; (point); Lahaina; *Maui*.
Puunui; [big hill]; (land section); Kona; *Oahu*.
Puuoehu; [hill of Ehu]; (land section); Ka-u; *Hawaii*.
Puuohua; [hill of hua]; (land section); Hilo; *Hawaii*.
Puuokumau; [hill of standing firm]; (land section); South Kohala; *Hawaii*.
Puu Olai; [earthquake hill]; (point); Honuaula; *Maui*.
Puuomahuka; [run away hill]; (land section); Hana; *Maui*.
Puuomaiai; (land section); Kaupo; *Maui*.
Puuomaile; [hill of maile vine]; (land section); Hamakualoa; *Maui*.
Puupapaia; [forbidden hill]; (land section); Koolau; *Maui*.
Puu Poa; (cape); Halelea; *Kauai*.
Puuwaawaa; [hill furrowed with gulches]; (land section); North Kona; *Hawaii*.
Puuwai; (point); *Niihau*.
Salt Lake Crater, Leilono [Lono's wreath]; *Oahu*; elevation, 486 feet.
Salt Lake; (pond); *Oahu*.
Spreckelsville; (village); Wailuku; *Maui*.
Summit; *Lanai*; elevation, 3 400.
Summit, west *Maui*; elevation, 5 790 feet.
Tantalus, Puu Ohia; Kona; *Oahu*; elevation, 2 013 feet.
Ualakaa; [rolling potato]; Kona; *Oahu*; elevation, 1 049 feet.
Ualapue; [potatoes hilled]; (land section); Kona; *Molokai*.
Uaoa; (land section); Hamakualoa; *Maui*.
Uau, Aiea; [a sea bird]; Ewa; *Oahu*; elevation, 1 700 feet.
Uhao; (land section); Lahaina; *Maui*.
Ukula; (cape); Kona, *Kauai*.
Ukumehame; (land section); Lahaina; *Maui*.
Ukumehame; (village); Lahaina; *Maui*.
Ukumehame; (stream); Lahaina; *Maui*.
Ulaino; (land section); Koolau; *Maui*.
Ulalena; [yellow, red]; Hamakualoa; *Maui*; elevation, 2 163 feet.
Ulaula, Puu; [red hill]; Ka-u; *Hawaii*; elevation, 10 092 feet.

Ulukanu; [planted bread fruit tree]; (land section); Hilo; *Hawaii.*
Ulumalu; [shady bread fruit trees]; (land section); Hamakualoa; *Maui.*
Ulumawao, Kailua; Koolaupoko; *Oahu;* elevation, 992 feet.
Ulupalakua; (village); Honuaula; *Maui.*
Ulupehupehu; [swollen breadfruit]; (land section); Koolauloa; *Oahu.*
Umauma; (stream); Hilo; *Hawaii.*
Umauma [breast]; (land section); Hilo; *Hawaii.*
Upolu; [a Samoan island name]; (land section); Kohala; *Hawaii.*
Upolu; (cape); Kohala; *Hawaii.*
Uwau; [a sea bird, Procellaria alba); (land section); Koolaupoko, *Oahu.*
Uwekahuna, west side Kilauea; Ka-u; *Hawaii;* elevation, 4 089.
Waawaa, Puu; [gullied hill]; North Kona; *Hawaii;* elevation, 3 824 feet.
Waawaa; [gullied, furrowed]; (land section); Puna; *Hawaii.*
Wahiawa; [place of awa]; (land section); Kona; *Kauai.*
Wahiawa; (stream); Kona; *Kauai.*
Wáhiawá; (land section); Waialua; *Oahu.*
Wahiawa; (village); Waialua; *Oahu.*
Wahiawa Bay; Kona; *Kauai.*
Wahie [firewood]; (point); Paomai; *Lanai.*
Wahikuli; [deaf place]; (land section); Lahaina; *Maui.*
Wahinepee; (stream); Koolau; *Maui.*
Waiaha; (land section); North Kona; *Hawaii.*
Waiahole; (land section); Kaupo; *Maui.*
Waiahole; (land section); Koolau; *Maui.*
Waiahole; (land section); Koolaupoko; *Oahu.*
Waiahole; (village); Koolaupoko; *Oahu.*
Waiaka; [laughing water]; (land section); Kona; *Oahu.*
Waiakahiula; (land section); Puna; *Hawaii.*
Waiakalua; [water of the crater]; (land section; Koolau; *Kauai.*
Waiakea; [open water]; (land section); Hilo; *Hawaii.*
Waiakea; (village); Hilo; *Hawaii.*
Waiakoa; (land section); Kula; *Maui.*
Waialae; (village); Kona; *Oahu.*
Waialae; [water of the mud hen]; (land section); Kona; *Oahu.*
Waialae Bay; Kona; *Oahu.*
Waialeale; [rippling water]; (land section); Hamakua; *Hawaii.*
Waialeale, Mt.; *Kauai.*
Waialee; (land section); Koolauloa; *Oahu.*
Waialua; (district); *Oahu.*
Waialua; (village); Kona; *Molokai.*
Waialua; [two waters]; (land section); Kona, *Molokai.*
Waialua; (village); Waialua; *Oahu.*
Waialua Bay; Waialua; *Oahu.*
Waianae; (district); *Oahu.*
Waianae; (village); Waianae; *Oahu.*
Waianae Range; *Oahu.*
Waianu; [cold water]; (land section); Koolau, *Maui.*
Wai Anapanapa; (pond on Haleakala), *Maui.*
Waiapuka; [deceitful water]; (land section); Kohala, *Hawaii.*
Waiau; [water to swim in]; (land section); Ewa; *Oahu.*
Waiau; (pond on Mauna Kea); *Hawaii.*
Waiau Lake; [swimming water]; Hamakua; *Hawaii;* elevation, 1 600 feet.
Waiawa; [bitter water]; (land section); Ewa; *Oahu.*
Waiawa; (stream); Ewa; *Oaku.*
Waiawa; (village); Ewa; *Oahu.*
Waiea; [water of the turtle]; (land section); South Kona; *Hawaii.*
Waiehu; (land section); Wailuku; *Maui.*
Waieli; [water dug for]; (land section); Hana; *Maui.*
Waihee; [water of flight]; (land section); Wailuku; *Maui.*
Waihee; (land section); Koolaupoko; *Oahu.*
Waihee; (stream); Wailuku; *Maui.*
Waihee; (village); Wailuku; *Maui.*
Waihi; [waterfall]; (land section); Kona; *Oahu.*
Waihonu; [deep water]; (land section); Hana; *Maui.*
Waika; (land section); South Kohala; *Hawaii.*
Waikaalulu; [quick water]; (land section); Hamakua; *Hawaii.*
Waikahalulu; [roaring water]; (land section); Kona; *Oahu.*
Waikahekahe; [flowing water]; (land section); Puna; *Hawaii.*
Waikakuu; (land section); South Kona; *Hawaii.*
Waikamoi; (stream); Koolau; *Maui.*
Waikane; [water of cane]; (land section); Koolaupoko; *Oahu.*
Waikane; (stream); Koolaupoko; *Oahu.*
Waikane; (village); Koolaupoko; *Oahu.*
Waikapu; [forbidden water];(land section); Hamakua; *Hawaii.*
Waikapu; (land section); Wailuku; *Maui.*
Waikapu; (stream); Wailuku; *Maui.*
Waikapu; (village); Wailuku; *Maui.*
Waikaumalo; (land section); Hilo; *Hawaii.*
Waikaumalo; (stream); Hilo; *Hawaii.*

Waikele; [muddy water]; (land section); Ewa; *Oahu.*
Waikele; (stream); Ewa; *Oahu.*
Waikiki; [spurting water]; (subdistrict); Kona; *Oahu.*
Waikiki; (village); Kona; *Oahu.*
Waikoko; [bloody water]; (land section); Halelea; *Kauai.*
Waikoekoe; [chilly water]; (land section); Hamakua; *Hawaii.*
Waikoloa; (land section); Hamakua; *Hawaii.*
Waikoloa; [wild duck water]; (land section); South Kohala; *Hawaii.*
Waikolu; [three waters]; (land section); Koolau; *Molokai.*
Wailamoa; (land section); Kipahulu; *Maui.*
Wailau; [four hundred streams]; *Molokai;* elevation, 4 547 feet.
Wailau; (land section); Ka-u; *Hawaii.*
Wailau; (village); Koolau; *Molokai.*
Wailau; [many waters]; (land section); Koolau; *Molokai.*
Wailaulau; (land section); Kahikinui; *Maui.*
Wailaulau; (land section); Koolau; *Maui.*
Wailea; [water of pleasure]; (land section); Hilo; *Hawaii.*
Wailele; [waterfall]; (land section); Kona; *Oahu.*
Wailoa; [long water]; (land section); Ka-u; *Hawaii.*
Wailua; [two waters]; (stream); Puna; *Kauai.*
Wailua; (land section); Hilo; *Hawaii.*
Wailua; (stream); Koolau; *Maui.*
Wailua; (land section); Puna; *Kauai.*
Wailua; (stream); Hana; *Maui.*
Wailua; (land section); Hana; *Maui.*
Wailua; (village); Puna; *Kauai.*
Wailua; (village); Koolau; *Maui.*
Wailuaiki; [little two waters]; (land section); Koolau; *Maui.*
Wailua nui; [great two waters]; (land section); Koolau; *Maui.*
Wailuku; [water of slaughter]; (district); *Maui.*
Wailuku; (stream); Hilo; *Hawaii.*
Wailuku; (land section); Wailuku; *Maui.*
Wailuku; (stream); Wailuku, *Maui.*
Wailuku; (town); Wailuku; *Maui.*
Wailupe; (land section); Kona; *Oahu.*
Wailupe; (village); Kona; *Oahu.*
Waimalu; [shaded water]; (land section); Ewa; *Oahu.*
Waimalu; (stream); Ewa; *Oahu.*
Waimanalo; [brackish water]; (land section); Koolaupoko; *Oahu.*
Waimanalo; (stream); Koolaupoko; *Oahu.*
Waimanalo; (village); Koolaupoko; *Oahu.*
Waimano; [many waters]; (land section); Ewa; *Oahu.*
Waimanu; (village); Hamakua; *Hawaii.*
Waimanu; (stream); Hamakua; *Hawaii.*
Waimanu; [bird water]; (land section); Hamakua; *Hawaii.*
Waimea; (district); *Kauai.*
Waimea; [a kind of tree]; (land section); South Kohala; *Hawaii.*
Waimea; (stream); Waimea; *Kauai.*
Waimea; (stream); Koolauloa; *Oahu.*
Waimea; (land section); Kona; *Kauai.*
Waimea; (village); South Kohala; *Hawaii.*
Waimea; (village); Waimea; *Kauai.*
Waimea; (land section); Koolauloa; *Oahu.*
Waimea; (village); Koolauloa; *Oahu.*
Waimea Bay; Waimea; *Kauai.*
Waimea Bay; [lonely water]; Koolauloa; *Oahu.*
Waimea Court-House; South Kohala; *Hawaii;* elevation, 2 669 feet.
Waimuku; [water cut short]; (land section); Ka-u; *Hawaii.*
Wainaku; [water of rushes]; (land section); Hilo; *Hawaii.*
Wainaku; (stream); Hilo; *Hawaii.*
Wainee; (land section); Lahaina; *Maui.*
Wainiha; [rude, wild water]; (land section); Halelea; *Kauai.*
Wainiha; (stream); Halelea; *Kauai.*
Waiohinu; [water of slime]; (land section); Ka-u; *Hawaii.*
Waiohinu; (village); Ka-u; *Hawaii.*
Waiohue; (land section); Koolau; *Maui.*
Waiohuli; (land section); Kula; *Maui.*
Waiokama; [water of Kama]; (land section); Lahaina; *Maui.*
Wai o Kamilo; (stream); Koolau; *Maui.*
Waiokila; [water of Kila]; (land section); Kaanapali; *Maui.*
Wailolama; (stream); Hilo; *Hawaii.*
Waioli; [singing water]; (land section); Halelea; *Kauai.*
Waioli; (village); Halelea; *Kauai.*
Waioli; (stream); Halelea; *Kauai.*
Waiomao; [green water]; (land section); Ka-u; *Hawaii.*
Waiomao; (land section); Kona; *Oahu.*
Waioni; [moving water]; (land section); Koolau; *Maui.*
Waiono; [sweet water]; (land section); Koolauloa; *Oahu.*

Waiopai; (land section); Kahikinui; *Maui.*
Waiopua; [water of flowers]; (land section); Ka-u; *Hawaii.*
Waipá; (land section); Halelea; *Kauai.*
Waipahihi; (land section); Koolau; *Maui.*
Waipahu; (village); Ewa; *Oahu.*
Waipake; (land section); Koolau; *Kauai.*
Waipaké; (stream); Halelea; *Kauai.*
Waipao; [water obtained by digging]; (land section); Honuaula; *Maui.*
Waipio; (stream); Hamakua; *Hawaii.*
Waipio; [curving water]; (land section); Hamakua; *Hawaii.*
Waipio; (village); Hamakua; *Hawaii.*
Waipio; [curved, winding]; (land section); Ewa; *Oahu.*
Waipio Landing; Hamakua; *Hawaii.*
Waipio Pali; [waipio precipice]; Hamakua; *Hawaii;* elevation, 1 394 feet.
Waipouli; [dark water]; (land section); Puna, *Kauai.*
Waipouli; [water of darkness]; (land section); Kaupo; *Maui.*
Waipunalei; [spring of wreaths]; (land section); Hilo; *Hawaii.*
Waipunaula; [red spring of water]; (land section); South Kona; *Hawaii.*
Wakiu; (land section); Hana; *Maui.*
Wananalua; [two prophecies]; (land section); Hana; *Maui.*
Wawaie; (land section); Kona; *Molokai.*
Wawapuhi; (land section); Na Pali; *Kauai.*
Weha; (land section); Hamakua; *Hawaii.*
Weliweli; [terrible]; (land section); Kona; *Kauai.*
Weliwelinui; [great terror]; (land section); Ka-u; *Hawaii.*
Weloká; (land section); Hilo; *Hawaii.*

APPENDIX No. 8.

REPORT 1902.

A BIBLIOGRAPHY OF GEODESY.

SECOND EDITION.

By JAMES HOWARD GORE, B. S., Ph. D.,

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PREFACE.

The immediate occasion for the publication of the second edition of this work, the first having appeared as Appendix 16 to the Report of the United States Coast and Geodetic Survey for 1887, was the formal vote passed by the International Geodetic Association on October 6, 1900. The resolution here adopted was a request to prepare a revised edition of the Bibliography.

Since the issue of the earlier edition supplementary material has been constantly secured, but in complying with the wish of the association another inspection was made of the libraries of this country and of Europe, and in order to procure titles of such recent works of living authors as might escape notice, owing to delay in obtaining a place in the library catalogues, a circular letter was sent to every mathematician whose address could be obtained. Each circular had appended to it the titles of all the known works of the recipient, with a request that omissions be supplied. This alone was the labor of several months, but was fully repaid in the gratifying assurances from many that nothing could be added, as well as the few additional titles which tend toward making this work complete.

Special effort has been made to examine carefully catalogues of libraries, however small, bibliographies of the exact sciences, biographies of mathematicians, and trade lists of antiquarian books, in addition to such well-known sources as the Royal Society Catalogue of Scientific Papers, Repertorium of Reuss, etc.

A most opportune assistance was furnished by Col. John Herschel, R. E., who, through the courtesy of the Royal Society, and with the consent of the India Office, sent a manuscript supplement to his contribution to pendulum bibliography, which was published in Operations of the Great Trigonometrical Survey of India, Vol. V. From this veritable treasure seventy-two new titles were found, each in the body of this work followed by (H). Most cordial thanks are due Colonel Herschel for his aid, as well as the confidence displayed in unreservedly placing such valuable material in the hands of another.

The title "Bibliography" may appear as high sounding or inappropriate to a work in which all the refinements of bibliographic science are not observed. The entire collation is not always given, since a *large* proportion of the books have appeared in but one edition. The only well-defined purpose has been to give as much of the title as will enable one desiring the book to obtain it from any library possessing it, with the minimum effort to himself and the librarian. This object was also in view in preparing the abbreviations for the serial publications, which, it is hoped, may be amplified without looking for their equivalents in their alphabetical place.

The scope of the work will easily make itself evident to the user. The intention was to include only such works as treated directly of the figure of the earth or described operations which could be used in determining that figure. The only digression from this plan will be seen in the case of the pendulum, where the theoretical side is also included. This was done because of the belief that the pendulum will soon become a more important geodetic instrument, when it may be necessary to reconsider some of its theoretical features. Geographic position will be found in the work, but the purpose was to include discussions of the formulas by which latitude, longitude, and azimuth are computed, but not the methods of determining these elements by observations. A few treatises on surveying, bearing the word "geodesy" or its equivalent in the title, have been inserted with a remark indicating the character of the contents. As a rule, remarks are used simply to correct erroneous impressions which the title alone might make.

The omission of papers on the variation of latitude will perhaps be the most marked. The reason for this is that the subject was too problematical at the time of the publication of the first edition to be included, and since that time the work has been so close to the astronomic side that it was deemed best to leave this subject to the compilers of bibliographies of astronomy.

The plan adopted is to use only *one* alphabet, in which will be found authors, abbreviations, and subjects. Full names of the authors have been given as far as possible, but in any subsequent repetition only the initials of their Christian names are given. The title will be found repeated under the name of each co-writer or each person named in the title. A dash (—) in a title refers to the *first* name given, as the one who wrote the review or about whom the article was written. This method gives, so far as entry is concerned, equal prominence to all persons named. An asterisk (*) after a title signifies that the work has not been seen by the compiler.

Under the authors their works are arranged chronologically; in the case of serials, according to the date as given to the entire volume. This will be found advantageous when it is desired to find the full title from the abbreviated form as given under a subject. It is also believed that the insertion of an abbreviated title in the subject classification will be found helpful, as it will enable one to see at a glance if an author whose name appears under the desired subject has written upon the special theme sought for, without turning to the author catalogue.

After each book title, and after the full title of each serial publication, there appears in parentheses the name of the owner of the work from which the title as given was taken. Of course it does not intimate that the work in question can be found *only* there. When a book was once found it was not again looked for. As a rule, those accredited to European libraries could not, at the time of trial, be found in any library in America.

While it is impossible to mention all who have assisted in the compilation of this work, it is only right to thus publicly express the thanks of the author to Mr. Cyrus H. McCormick, whose generosity made it possible to personally inspect the great libraries of the world, and to Mr. O. H. Tittmann, Superintendent United States Coast and Geodetic Survey, for his prompt response to the wishes of the International Geodetic Association in making this work a part of his annual report.

JAMES HOWARD GORE.

COLUMBIAN UNIVERSITY, *October, 1902.*

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In deducing the figure of the earth from the observed length of the pendulum, I have always thought it necessary to leave out a few of the experiments that were inconsistent with the rest. The inconsistency is proved by comparing the pendulum on the same parallel, or nearly on the same, when a correction must be applied. If they are excessively irregular, I always rejected such as were irreconcilable with the rest.

—— A letter to the editors, relating to the ellipticity of the earth as deduced from experiments with the pendulum.

Phil. Mag. (Taylor), III, 1828, 241-243.

It is also stated that it is useless to involve terms of the second order.

—— On the figure of the earth, as deduced from measurements of different portions of the meridian.

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From the Peru, India, France, and England arcs an ellipticity of $\frac{1}{305}$ was found.

—— On the latitudes and differences of longitude of Beachy Head and Dunnose, in the Isle of Wight, as laid down in the trigonometrical survey of England; and the length of a degree perpendicular to the meridian at the latitude of Beachy Head.

Phil. Mag. (Taylor), IV, 1828, 6-11.

Criticises the formula used by the trigonometric survey for finding difference of longitude. Segments of the above arc showed a decrease in the length of a degree in going north. Ivory found an error of 18″ in the amplitude, which, when applied, gave increasing degrees toward the north.

—— On measurements on the earth's surface perpendicular to the meridian.

Phil. Mag. (Taylor), IV, 1828, 189-194.

States that the measurements in England and India belong to the same spheroid, but disagree with the French, while a measured arc perpendicular to the meridian in France agrees with the trigonometric degree, which tends to throw doubt upon the English methods of computing difference of longitude.

—— On the method employed in the trigonometrical survey for finding the length of a degree perpendicular to the meridian.

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Stating that the azimuth between two points on a spheroid is not the same as on a sphere

Ivory (James)—Continued.

when the latitude and difference of longitude are the same; hence the error in the formula used by the trigonometric survey for computing difference of longitude.

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—— On the method in the trigonometrical survey for finding the difference of longitude of two stations very little different in latitude.

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Phil. Soc. London, Trans., 1831, 109; Phil. Mag., II, 1827, 161, 241, 321.

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—— Letter relating to the figure of the earth.

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Struve (Otto)—Continued.

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ALPHABETICAL INDEX.

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Report of the Superintendent of the Coast and geodetic survey showing the progress of the work from July 1, 1901, to June 30, 1902. Washington: Government printing office. 1903.

799 pp. 13 views, 76 maps and sketches (4 progress sketches in pocket), 5 diag. [U. S. Treasury dept.]
O. H. Tittmann, superintendent.
Also published as Senate ex. doc. 223, 57th Cong., 2d sess. In v. 20. Appendices 3, 5, 6, 7, and 8 also issued separately.

CONTENTS OF APPENDICES.

1. Details of field operations. 2. Details of office operations. 3. Triangulation in Kansas. By J. F. Hayford. 4. The hypsograph. By Fremont Morse. 5. Magnetic observatories of the U. S. Coast and geodetic survey. By L. A. Bauer and J. A. Fleming. 6. Magnetic dip and intensity observations. By D. L. Hazard. 7. Hawaiian geographic names. By W. D. Alexander. 8. Bibliography of geodesy. Second edition. By J. H. Gore.

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Report of the Superintendent of the Coast and geodetic survey showing the progress of the work from July 1, 1901, to June 30, 1902. Washington: Government printing office. 1903.

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6. Magnetic dip and intensity observations January, 1897, to June 30, 1902. By Daniel L. Hazard, computer, division of terrestrial magnetism. With preface by L. A. Bauer, inspector of magnetic work and chief of division of terrestrial magnetism, assistant, Coast and geodetic survey. pp. 333–366.

3 views.
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7. Hawaiian geographic names. Compiled by W. D. Alexander, assistant, Coast and geodetic survey. pp. 367–425.

CONTENTS: Islands; districts; channels; bays and harbors; capes and points; rivers and streams; ponds; elevations; list of lands; towns, villages, and hamlets; meaning of names; glossary; index.

8. A bibliography of geodesy. Second edition. By James Howard Gore, B. S., Ph. D., professor of mathematics, Columbian university; sometimes acting assistant, U. S. Coast and geodetic survey; author of Elements of geodesy and History of geodesy. pp. 427–787.

Note: ". . . one alphabet, in which will be found authors, abbreviations, and subjects."—Preface.

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(and Fleming, J. A.). Magnetic observatories of the U. S. Coast and geodetic survey. Rept. 1902, app. 5, pp. 301–331.

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UNITED STATES
COAST AND GEODETIC SURVEY
SKETCH OF GENERAL PROGRESS
JUNE 30 1902.
Eastern Sheet
Scale 1/5000000
Statute Miles
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
INDIAN TER.
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MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
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INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
ATLANTIC OCEAN
Axis of the Gulf Stream Warmest Band
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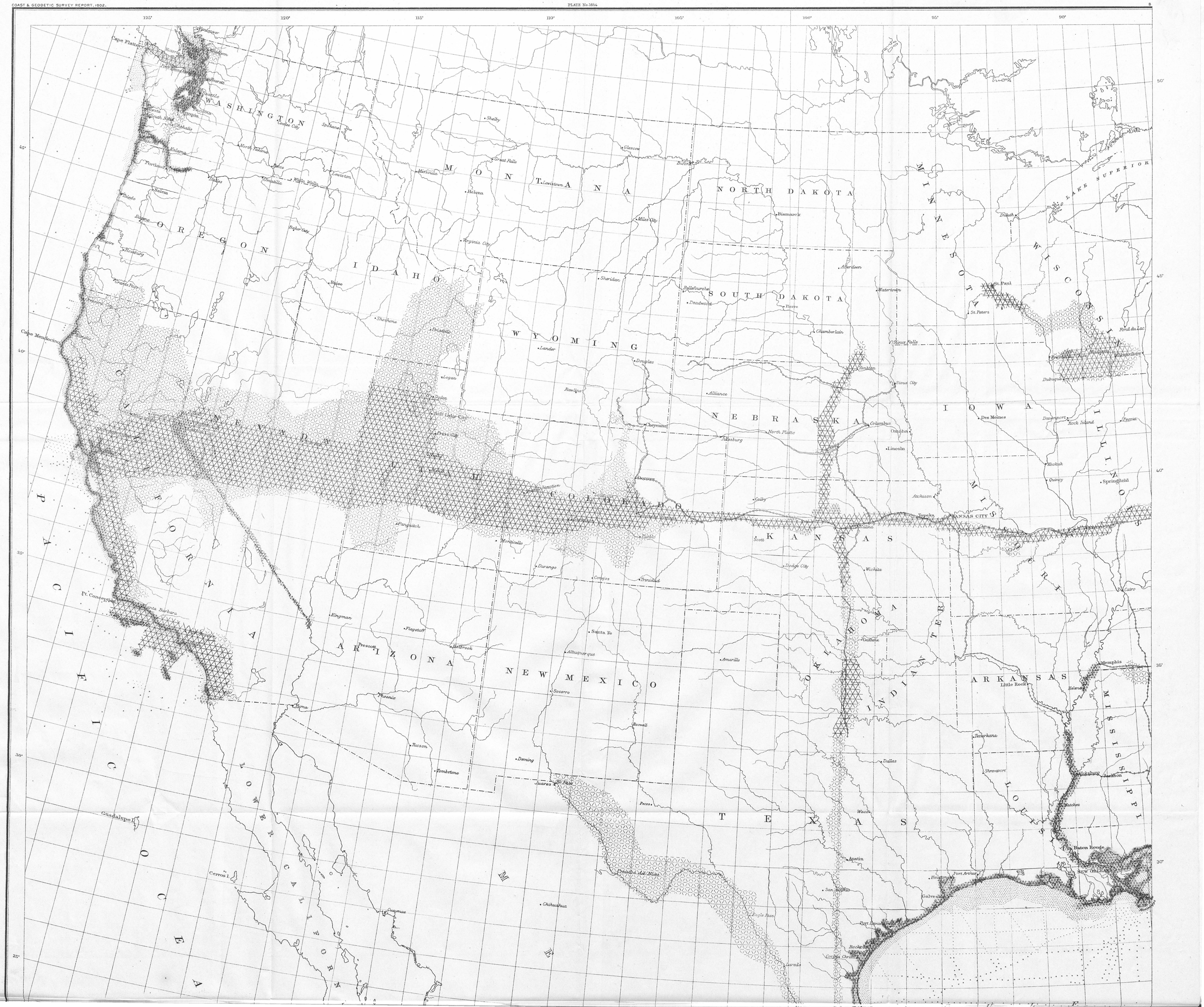
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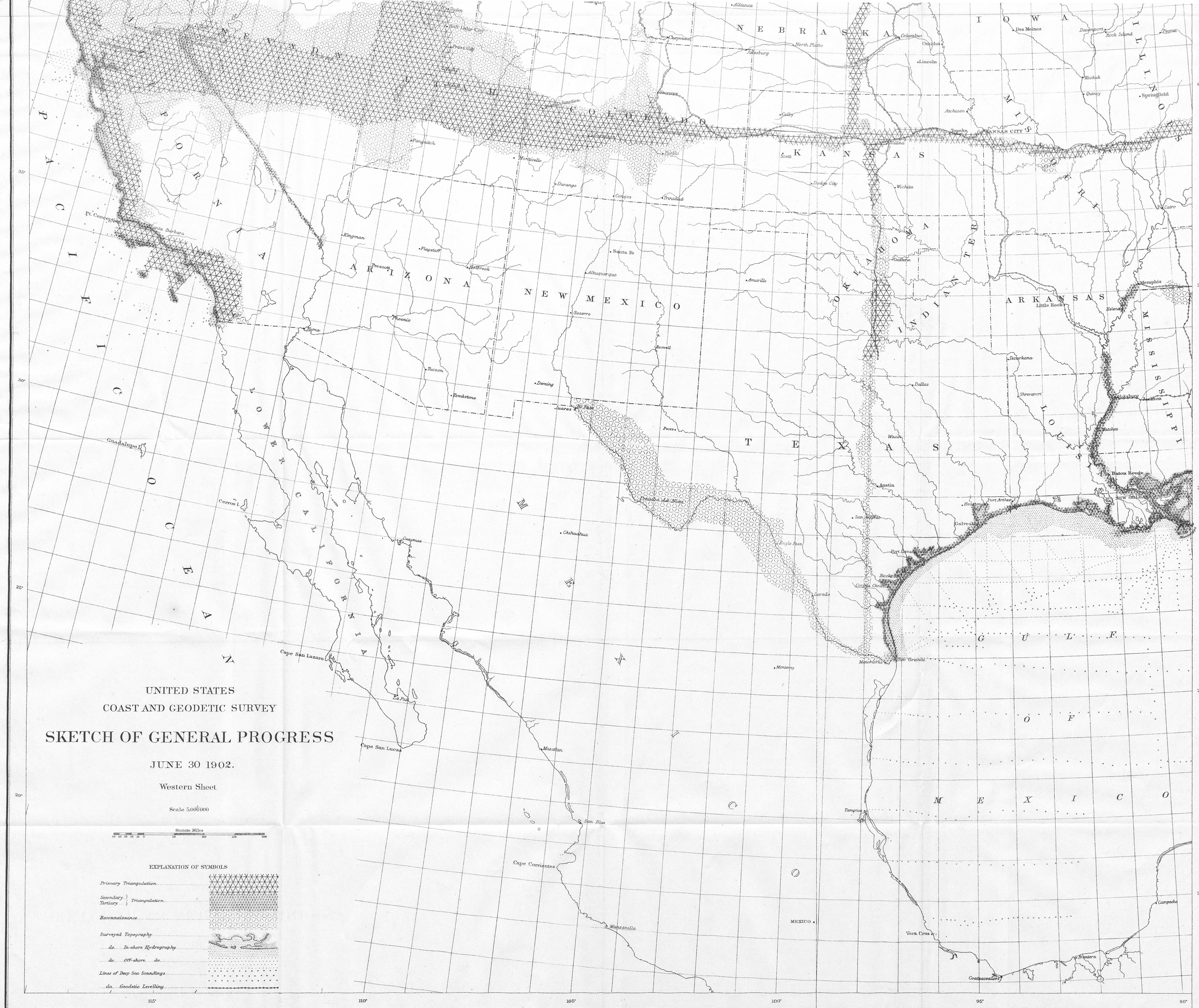

UNITED STATES
COAST AND GEODETIC SURVEY

SKETCH OF GENERAL PROGRESS

JUNE 30 1902.

Western Sheet

Scale 5,000,000

Statute Miles

EXPLANATION OF SYMBOLS

- Primary Triangulation
- Secondary / Tertiary Triangulation
- Reconnaissance
- Surveyed Topography
- do. In-shore Hydrography
- do. Off-shore do.
- Lines of Deep Sea Soundings
- do. Geodetic Levelling

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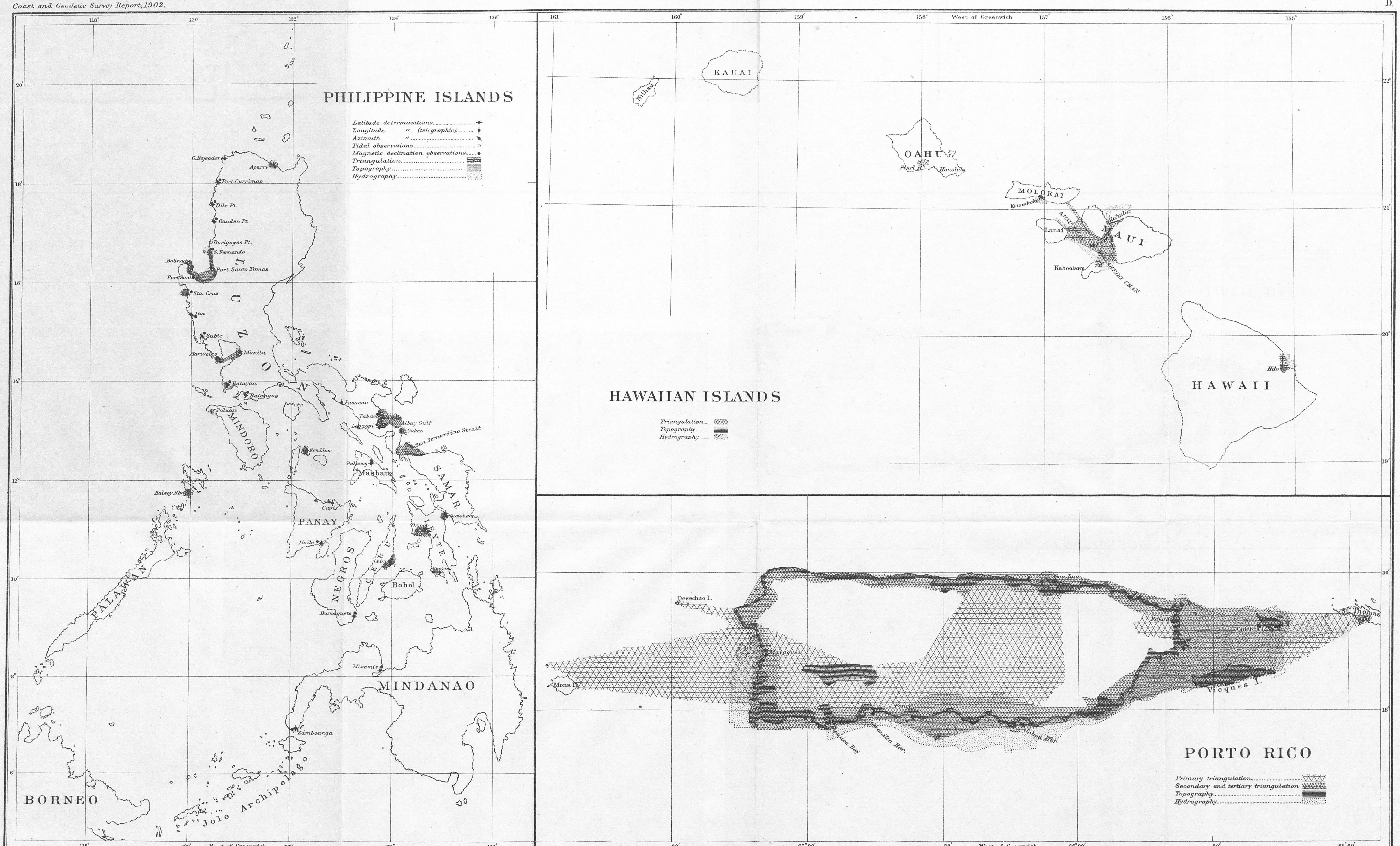
GENERAL PROGRESS SKETCH



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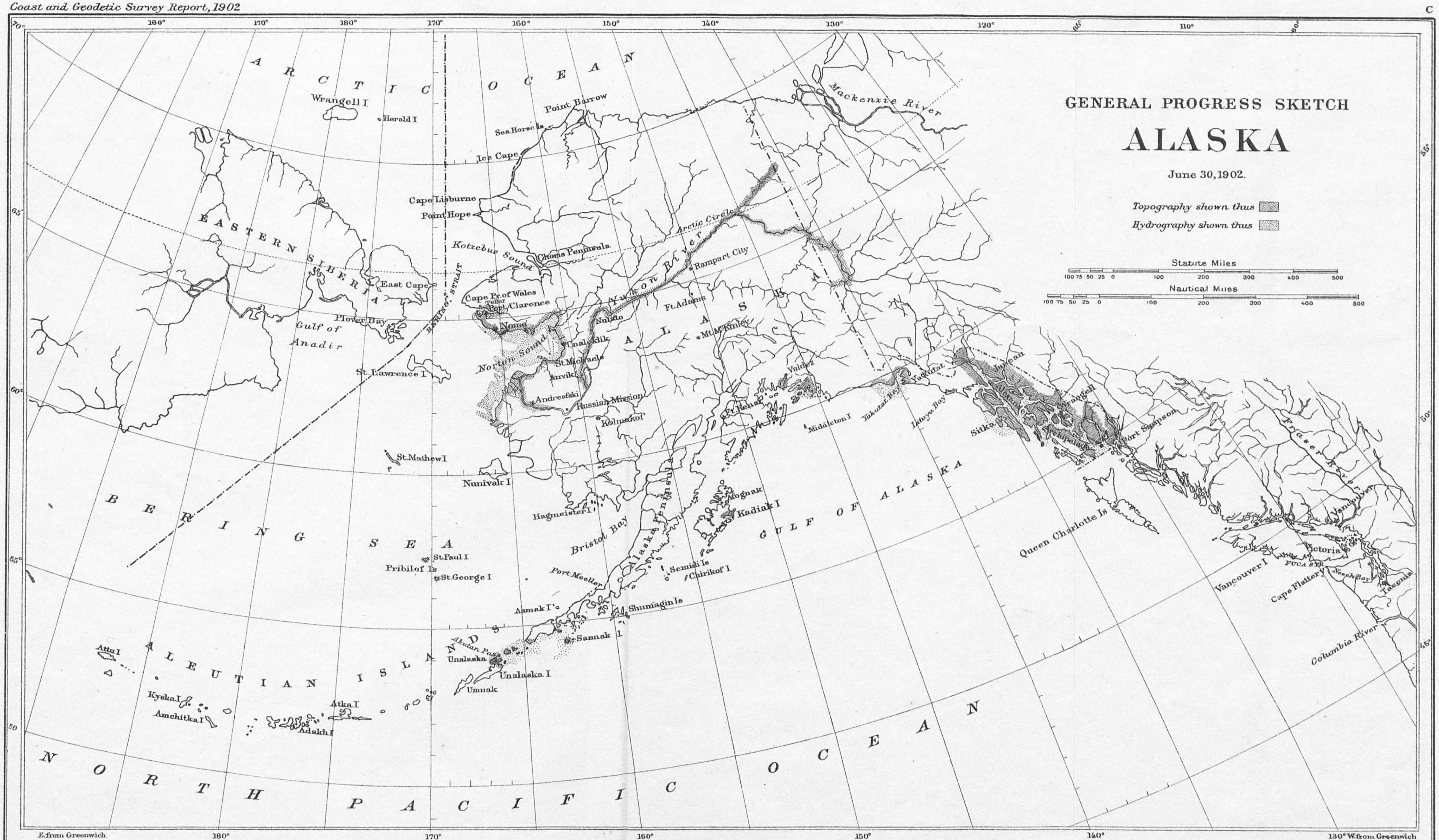

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