QB
296
U5
1913
c.2

75

G2612
Com

ANNUAL REPORT

OF THE

SUPERINTENDENT, UNITED STATES COAST AND GEODETIC SURVEY

TO THE

SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1913

64

LIBRARY
Recatalogued
JAN 29 1906
N.O.A.A.
U.S. DEPT. OF COMMERCE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1913

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

ERRATA NOTICE

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library, the Office of Coast Survey and the National Geodetic Survey. To view the original document please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or www.reference@nodc.noaa.gov.

LASON
Imaging Contractor
12200 Kiln Court
Beltsville, MD 20704-1387
March 22, 2005

Blank page retained for pagination

CONTENTS.

	Page.
General statements of progress:	
Hydrographic work	5
Geodetic, magnetic, and tidal work	6
International boundaries	8
Special surveys	10
Dangers to navigation	10
Office work	11
Office of Inspector of Hydrography and Topography	11
Office of Inspector of Geodetic Work	14
Office of Inspector of Magnetic Work	16
Appropriations and disbursements	18
Publications	18
Economy and efficiency	19
Special duty	20
Assistance rendered in saving life or property	20
Details of field operations:	
Atlantic coast	21
Interior States	40
Pacific coast	45
Alaska	48
Outlying territory—	
Philippine Islands	55
Porto Rico	65
Hawaiian Islands	65
Special duty	68
International boundaries	72
Details of office operations	91

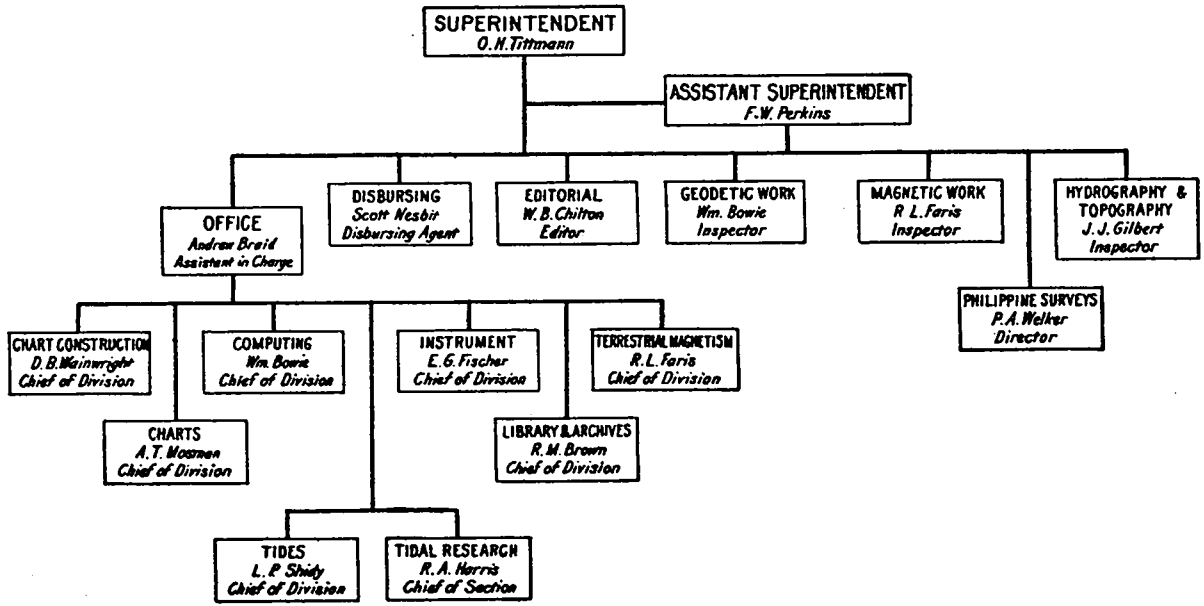
ILLUSTRATIONS.

	Chart showing organization of the Coast and Geodetic Survey, 1913	4
1.	Progress of reconnoissance and triangulation in the United States	48
2.	Progress of topography in the United States	48
3.	Progress of hydrography in the United States	48
4.	Distribution of the principal astronomic stations occupied to June 30, 1913.	48
5.	Positions of telegraphic longitude stations from 1846 to June 30, 1913	48
6.	Routes of geodetic spirit leveling and positions of gravity and tide stations to June 30, 1913	48
7.	Positions of magnetic stations occupied to June 30, 1913	48
8.	Positions of astronomic, gravity, and tide stations in Alaska to June 30, 1913.	54
9.	Progress of triangulation in Alaska to June 30, 1913	54
10.	Progress of topography in Alaska to June 30, 1913	54
11.	Progress of hydrography in Alaska to June 30, 1913	54
12.	Positions of magnetic stations in Alaska occupied to June 30, 1913	54
13.	General progress in Porto Rico to June 30, 1913	64
14.	General progress in the Hawaiian Islands to June 30, 1913	68
15.	General progress in the Philippine Islands to June 30, 1913	64

CHART SHOWING ORGANIZATION OF THE

COAST AND GEODETIC SURVEY

1913



REPORT

OF THE

SUPERINTENDENT, U. S. COAST AND GEODETIC SURVEY.

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, October 4, 1913.

SIR: I have the honor to submit the annual report of progress in the Coast and Geodetic Survey for the fiscal year ended June 30, 1913. It is accompanied by maps illustrating the general advance in the field work of the Survey up to that date.

GENERAL STATEMENTS OF PROGRESS.

During the fiscal year ended June 30, 1913, satisfactory progress was made in the survey of the coasts and in the interior of the United States and of territories under the jurisdiction of the United States, although in some localities, notably on the coast of Alaska, the weather conditions during the greater part of the working season were unfavorable for the rapid prosecution of field work.

HYDROGRAPHIC WORK.

On the Atlantic coast most of the hydrographic work done was in the nature of revision to show changes that have taken place in natural or artificial features, to investigate reported dangers, and to supplement former surveys found inadequate for the requirements of modern navigation. The examination with the wire drag of important harbors and channels has been continued, and this work has amply justified itself by the large number of previously uncharted rocks and shoals that have been discovered. Necessity for similar work on the Pacific coast has led to a supplemental estimate under the head of "Party expenses, Pacific coast" in order that funds may be provided for this important object.

The steamer *Bache* was employed on the coasts of Georgia, Florida, Delaware, Maryland, and South Carolina; the steamer *Endeavor* in Chesapeake Bay, on the coast of North Carolina and in Narragansett Bay; the steamer *Hydrographer* in coast pilot work between Key West, Fla., and Chesapeake Bay and on the coast of North Carolina; and the schooner *Matchless* on the survey of the Mattaponi, Pamunkey, and Elizabeth Rivers, Va.

Several parties were engaged in the revision of surveys on the Atlantic coast and an officer with headquarters at New York has acted as inspector of the section of coast between Rhode Island and New Jersey.

On the Pacific coast of the United States the steamer *Gedney* was employed during the winter months in revising the hydrography of Olympia Harbor, Bellingham Bay, and other harbors on the coast of Washington. An officer stationed at Seattle was engaged in inspecion duty on the coast of Washington and Oregon, and another with headquarters at San Francisco performed similar duty on the coast of California.

In Alaska surveys have been made in Tlevak Strait, Prince of Wales Island, Karta Bay, Kasook Inlet, Sukkwan Narrows, San Cristoval Channel, and Ulloa Channel; Turnagain Arm, Cook Inlet; Sumner Strait; approaches to Kuskokwim River; Aialik Bay and approaches and Nakat Harbor; between Naked Island and Port Wells, Prince William Sound; in Clarence Strait; Klawak Inlet; Knights Island Passage; Culross Island to Port Nelly Juan; Burnett Inlet and Davidson Inlet, Unimak Pass, including Shumagin Islands, and a search was made for Leonard and Anderson rocks. The steamers *Patterson*, *Gedney*, *McArthur*, *Explorer*, *Taku*, and *Yukon* were employed on surveys in Alaska during the season available for work. During the winter months the steamer *Patterson* was employed in hydrographic surveys on the coast of Maui, and off the west coast of Molokai, Hawaiian Islands.

An important work in Alaska was the survey of Tlevak Strait, Prince of Wales Island, which has made available a passage hitherto feared and avoided by navigators. By its use steamer routes may be considerably shortened.

In the Philippines the general survey of the islands has been continued by the Coast and Geodetic Survey steamer *Pathfinder* and by the steamers *Marinduque*, *Research*, *Romblon*, and *Fathomer*, supplied for the purpose by the insular government, the expenses of the work being divided between the United States and the insular government.

Surveys were made by the vessels named on the southeast coast of Mindanao and the southwest coast of Negros; on the Apo Reef and Busuanga Island, and between the Cuyos Islands and Palawan; in Ragay Gulf, southwestern Luzon, on the west coast of Mindanao and the west coast of Mindoro; in the area bounded by Luzon, Burias, Masbate, and Tablas Islands, in the vicinity of the Lubang Islands and the Calamianes group; and in the area bounded by Samar, Leyte, Biliran, and Masbate Islands.

GEODETIC, MAGNETIC, AND TIDAL WORK.

Two triangulation parties and a separate signal building party were employed on the primary triangulation along the one hundred and fourth meridian from the vicinity of Colorado Springs, Colo., to the Canadian boundary. This arc of triangulation, extending for a distance of 720 miles and involving the occupation of 100 primary stations, was completed in a single season.

A party was engaged in making a reconnoissance for the extension of the primary triangulation of the ninety-eighth meridian from

Alice, Tex., to the Mexican boundary, and another party was employed in the execution of this triangulation which will connect with that executed by the Mexican Government.

One party revised the triangulation on the coast of Louisiana in the vicinity of Cote Blanche and Atchafalaya Bay, and another the triangulation of Laguna Madre, Tex.

A secondary triangulation along the coast of Washington was begun.

Two parties were employed in running a line of precise levels between Crookston, Minn., and Butte, Mont., and one party was employed in running a line of precise levels between San Francisco, Cal., and Beowawe, Nev. Determinations of the difference of longitude were made by two cooperating observers at stations near the one hundred and fourth meridian in Nebraska, Colorado, Wyoming, and Montana.

Several parties were employed in determining the positions of aids to navigation and of wireless telegraph stations along the Atlantic and Pacific coasts, as requested by the Bureau of Navigation of the Department of Commerce.

The inspector of geodetic work inspected the operations of the triangulation parties engaged in the connection of the ninety-eighth meridian triangulation with that of the Mexican Government.

The usual absolute observations for magnetic declination, dip, and intensity were recorded during the year at the magnetic observatories maintained by the Survey at Cheltenham, Md.; Tucson, Ariz.; Vieques, P. R.; Sitka, Alaska, and Honolulu, Hawaii. Seismograph records were obtained at these observatories, and daily meteorological observations made in cooperation with the Weather Bureau. Special rapid-rate registration was maintained on certain term days in compliance with the plans adopted for international cooperation. Magnetic observations were made in the field at a large number of stations in the United States and in the Philippine Islands, and meridian lines were established where desired by local authorities. Vessels of the Survey are provided with instruments for making magnetic observations both at sea and on land and a large amount of valuable information is gathered in connection with the prosecution of surveys ashore and afloat.

The demand for magnetic data on the part of engineers, surveyors, and municipalities interested in local surveys or projects for improvements is a constant one. Much information of this kind is available in printed form, but much is furnished by transcripts from manuscript records.

Tide observations were made in connection with hydrographic surveys and at regular tide stations at Portland, Me.; Fort Hamilton, N. Y.; Atlantic City, N. J.; Philadelphia, Pa.; Baltimore, Md.; Fernandina, Fla.; Galveston, Tex.; San Diego and San Francisco, Cal.; Seattle, Wash.; and Juneau, Alaska. Tidal indicators were maintained at Fort Hamilton, N. Y.; at New York City; and at Reedy Island, Delaware River.

Through the cooperation of the Bureau of Lighthouses current observations were made at a number of light vessels along the Atlantic coast. Similar observations were made when practicable by the hydrographic parties of the Survey.

INTERNATIONAL BOUNDARIES.

UNITED STATES AND CANADA BOUNDARY.

On the boundary between the United States and Canada east of the summit of the Rocky Mountains from the Red River of the North to Lake of the Woods the party engaged in topography, vista cutting, leveling, and interpolation of monument sites advanced the topography for a distance of 95 miles along the boundary; and the vista cutting for a distance of 82 miles; 102 miles of boundary were located and 155.5 miles of levels run.

The party engaged in triangulation on this portion of the boundary occupied 24 triangulation stations and completed 550 square miles of triangulation, a distance along the boundary of 87 miles. The triangulation of Lake of the Woods was completed by June 20, 1913. A base line was measured near Fort Frances, Ontario, and a rapid reconnoissance was made with a view to the extension of the triangulation as far as the mouth of Rainy River. Seventy-five monuments were set on the boundary during the season of 1912. The north and south boundary to its intersection with the boundary running southeastward was located and marked in the spring of 1913 with reference monuments. The north and south line was measured twice with an invar tape. Eleven triangulation stations were occupied in May and June, 1913. A Canadian party, to which an American surveyor was attached, was at work during the season of 1912 from the northwest angle of Lake of the Woods to the southward. The triangulation was extended down the lake for a distance of about 25 miles; reference marks were established, and a hydrographic survey of the lake along the boundary was made by the American surveyor. Work in this locality was resumed May 27, 1913, at Bear Island, Ontario, and was in progress at the close of the fiscal year.

The party working between Pigeon River and Lake of the Woods during the season of 1912 carried the triangulation and topography from Round Lake to the western end of Knife Lake, a distance of about 35 miles. Twelve topographic sheets were complete.

Work was resumed in the spring of 1913, and by June 30, 50 square miles of triangulation and 78 square miles of topography had been completed, covering a distance along the boundary of 6½ miles.

The party at work on the survey and monumenting of the northeastern boundary between Maine and New Brunswick completed the measurement of 31.5 miles of boundary with invar tape, ran 37 miles of levels, and surveyed 42.39 square miles of topography, included on six topographic sheets. A lane 30 feet in width was cut through the dense forest along this portion of the boundary. The monuments set by the commission of 1842 were reset and additional monuments were interpolated where necessary.

The party engaged in the survey of the boundary in the valley of the St. Croix River completed 18 square miles of triangulation and 2 square miles of topography included on four topographic sheets. This work was done during the season of 1912. In the latter part of June, 1913, work was resumed and marks were placed, to which that portion of the boundary formed by Monument Stream was referred. A plane-table survey was commenced at the initial monument to show in detail the shore line of Monument Stream. Work was in progress at the close of the fiscal year.

ALASKA BOUNDARY.

During the season of 1912 the line tracing of the one hundred and forty-first meridian boundary was carried from latitude 69° 20′ to the shores of the Arctic Ocean in latitude 69° 39′, a distance of 22 miles.

In the same season the triangulation was completed from latitude 68° 54′ to the Arctic Ocean, 51 miles, and was extended eastward along the shore for 25 miles, to determine the relation of the terminal monument to the shore line.

Topography was carried northward along the meridian by one double topographic party from latitude 69° 04′ to latitude 69° 39′, a distance of 40½ miles, and was then expanded westward along the coast to longitude 141° 30′ and eastward to longitude 140° 48′. This topography takes in the natural features nearest the boundary, including Icy Reef, Beaufort Bay, and Demarcation Point to the west, and Clarence Bay to the east.

Vista cutting and stadia measurements were carried on from latitude 68° 50′ 40″ to the ocean coast, a distance of 58 miles. Another vista cutting and stadia party operated south of the Porcupine River for a distance of 33 miles, connecting with the work completed in 1911.

The final monumenting north of the Porcupine River was completed to the Arctic Ocean from latitude 68° 30′ where it terminated in 1911, a distance of 80 miles, and south of the Porcupine, over 78 miles. In all 56 monuments were placed in 1912.

The monuments were inspected and numbered from the Arctic coast to the Yukon River, the most northerly monument being No. 1. From the Arctic Ocean to the Yukon River there are 115 monuments in a distance of 344 miles, or an average of one monument to 3 miles.

The demarcation of the boundary line has therefore been completed north of the Yukon River. Between the Yukon and Mount Natazhat there remains only the inspection and numbering of the monuments, which it is expected will be completed during the present season.

In June, 1913, preparations were made for a joint inspection of the boundary monuments south of the Yukon River by an American and a Canadian surveyor, but owing to various delays work was not begun until June 27.

South of Mount Natazhat the boundary extends to the vicinity of Mount St. Elias, a distance of 84 miles in a very difficult mountainous region. A triangulation party and a topographic party were sent in 1912 to make surveys preliminary to defining the line in this region. Triangulation was carried from stations which had been established in Scolai Pass in 1909 down Scolai Creek, across country to the Chitina River, and up the Chitina River to within about 30 miles of the boundary, a distance altogether of about 90 miles. Plane-table topography was carried across the boundary from the mouth of the Canyon Creek on the Chitina, up the valley of the latter, taking in the top of the ridges on either side, and photographs were taken from which a considerable additional area can be plotted.

In May, 1913, a base line was measured, and arrangements were made for extending the triangulation up the Logan glacier. By June 1 the reconnoissance was completed to within 8 miles of the boundary, where progress was delayed by a heavy snow fall.

A topographic party took the field in the Mount Natazhat region in April, 1913. By June 30 about 100 square miles of topography had been surveyed.

The survey and monumenting of the water boundary on Portland Canal was conducted by a Canadian party to which an American surveyor was attached. A scheme of triangulation is being extended along Portland Canal and the topography of the adjacent shores is being mapped. Permanent reference monuments are placed on both sides of the canal and these are connected with the triangulation. During the season of 1912 the triangulation was extended for a distance of about 64 miles, and 31 reference monuments were placed. Field work was resumed at the end of May, 1913, and was in progress at the close of the fiscal year.

SPECIAL SURVEYS.

Requests were received for special surveys in the following localities: West Penobscot Bay, Me.; Rockland, Me.; Piscataqua River, N. H.; Weymouth Fore River, Mass.; Nantucket Shoals, Mass.; shores of Marthas Vineyard, Mass.; Point Judith Harbor of Refuge, R. I.; East River, N. Y.; Greater and Little Peconic Bays, Long Island, N. Y.; outer and inner harbors of Delaware Breakwater, Del.; survey of grounds of Hygienic Laboratory, Washington, D. C.; location of line of Florida Avenue, Washington, D. C.; special triangulation in District of Columbia; special hydrographic examination to determine extent of pollution of water in Potomac River, Md. and Va.; Hog Island Bay, Va.; channels at entrance to Chesapeake Bay, Va.; determination of position of objects on the north shore of Hampton Roads, Va.; Sheephead Rock, N. C.; determination of position of aids to navigation in St. Johns River, Fla.; Tampa Bay, Fla.; Mississippi Delta, Miss.; Angel Island, Cal.; Yaquina Bay, Oreg.; Halibut Bank, southwest of Newport, Oreg.; Culross and Perry Islands, Alaska; Chicagof and Lisianski Straits, Alaska; Shumagin Islands and Iniskin Bay, Alaska; and determination of position of wireless stations on the Atlantic and Pacific coasts.

DANGERS TO NAVIGATION.

Dangers to navigation were discovered, investigated, or reported as follows: Rocks near shore line in Narragansett Bay, R. I.; in channel near Plum Beach Light House; near Hope Island, and in entrance to Wickford Harbor, R. I.; shoal near Beaufort Inlet, N. C., and shoaling in channel between Beaufort Inlet and Core and Bogue Sounds; reported shoal near Cape Lookout, N. C.; channels near Hog Island shoal, Narragansett Bay; shoals on coast of North Carolina and Virginia; shoals and rocks in Block Island Sound; shoal near Point Judith on which U. S. S. *Nebraska* struck; rocks in Buzzards Bay, Mass.; shoals in Key West Harbor, Fla.; reported shoal near Winter Quarter Shoal Light Vessel; reported shoal northeastward from Cape Henry; wreck on Long Reef, Fla.; reported shoals off Jupiter Inlet and off St. Lucie Island, Fla.; wreck of the *Condor* off Carolina Shoal Beach; Weymouth Fore River, Mass.; reported shoal west of the Graves Light House; reported changes in Pollock Rip

Slue; shoal in Great Round Shoal Channel; reported shoaling in channel between Pollock Rip and Shovelful Light vessels; wreck of the *Luckenbach* in Chesapeake Bay; rock off Fish Egg Island, Alaska, on which the steamer *Curacao* grounded; rock in Tonawek Bay, Alaska, on which the *Curacao* was wrecked; rock at entrance to Coal Bay, Alaska; search for Leonard and Anderson rocks; shoals in approaches to Kuskokwim River; shoal in Port Wells, Alaska; rock near Perry Island Passage; reported rock nead Wedge Island, Clarence Strait, Alaska; reef southwest of Dall Head, Alaska; reefs near Cresto de Gallo Island, P. I.; rocks in channel running over Apo Reef, P. I.; shoals in region between Panay and Palawan, P. I.

OFFICE WORK.

The work of the Coast and Geodetic Survey office includes, besides administrative details, all operations necessary for the preparation and publication of charts, coast pilots, tide tables, notices to mariners, reports and special publications which give the results of triangulation, precise leveling, and magnetic work, except printing and binding, which is done at the Government Printing Office. These operations include the reduction and plotting of results obtained in the field, computing, drawing, engraving, lithographing, photographing, electrotyping, and chart printing. Instruments used by the field parties are repaired and in some cases constructed in the office, which has a complete equipment for mechanical work.

The proceeds of sales of charts and publications during the year amounted to $15,709.88, and miscellaneous receipts (work done for outside parties, sale of property, etc.) to $1,016.84, making a total of $16,726.72, which was duly covered into the Treasury.

OFFICE OF INSPECTOR OF HYDROGRAPHY AND TOPOGRAPHY.

The Inspector of Hydrography and Topography supervises the field work of parties on the surveying vessels and all other hydrographic and topographic work, including coast pilot work in field and office. He prepares plans for field work and instructions for the chiefs of parties and recommends the approval of estimates and changes in the personnel of vessels when necessary. He conducts the routine work relating to the shipment of seamen and makes an administrative examination of the accounts of the vessels. He reports monthly the progress of work under his direction and the status of the crews of vessels and of other employees not under civil-service classification. He also personally inspects the repairs of the surveying vessels on the Atlantic coast.

Work done in the office comprises compilation of the Coast Pilot, proof reading, correcting existing editions, and other miscellaneous details. The field work of the coast pilot party is referred to elsewhere in this report.

VESSELS AND PARTIES.

The party on the steamer *Bache* was engaged in inshore and offshore hydrography between Charleston and Savannah, including St. Andrews and Sapelo Sounds and Tybee and Port Royal entrances;

and offshore work between Delaware and Chesapeake Bays. The *Bache* was repaired at Boston between September 26 and October 27.

The steamer *Endeavor* was at work on the hydrography of Chesapeake Bay from Kedges Strait northward; in Narragansett Bay, R. I.; and between Cowpen Island, Core Inlet, and Morehead City, N. C. Repairs to this vessel were made at Baltimore, between November 20 and January 2, and at Jersey City between May 19 and 24 and June 24 and 30.

The steamer *Hydrographer* was employed on Coast Pilot revision between Chesapeake Bay and Key West; detached hydrographic surveys on the coast of Massachusetts and on the coast of North Carolina in the region between Cowpen Island, Core Inlet, and Morehead City. The *Hydrographer* was repaired at Baltimore between December 21 and January 20 and between June 19 and 30.

The party on the schooner *Matchless* completed a survey of the Pamunkey River, Va., to the head of navigation and began a survey of the southern and eastern branches of Elizabeth River. This survey was nearly completed by the end of the fiscal year. The *Matchless* was repaired at Baltimore between July 1 and 23 and between June 26 and 30.

Wire-drag work was done in the channel between Block Island, R. I., and Montauk Point, Long Island, N. Y.; in Buzzards Bay, Mass.; at Key West, Fla.; and on the coast of Maine in the vicinity of Matinicus Island.

A resurvey of the Delaware River from the House of Correction Wharf at Trenton was completed and a survey of Newark Bay and the Hackensack and Passaic Rivers was begun.

Chart-revision work was continued, including shore-line changes, improvements and additions in vicinity of New York City; on Long Island Sound eastward from Stamford, Conn.; on the coasts of Maine and Massachusetts; and a survey was made of the dredged channel between Great and Little Peconic Bays, Long Island, N. Y. Preparations were begun at the close of the fiscal year for making a series of current observations in the Potomac River.

An officer of the Survey continued to serve in cooperation with the Maryland Shell Fish Commission and was engaged throughout the year in the preparation for publication of maps, reports, and descriptive data relating to the surveys and delineation of the oyster grounds of the State. The same officer aided the Shell Fish Commission of the State of Delaware in the preparation of a report of their work.

Information was collected for the preparation of an inside route pilot from Cape Sable, Fla., to New Orleans, La.

A hydrographic survey was begun of Piscataqua River and Great Bay, N. H.

An officer of the Survey performed the duties of inspector for the region between Narragansett Bay and Delaware Bay during the year. Information was obtained by this officer for chart corrections and notices to mariners and data relating to charts, tides, and sailing directions has been supplied to navigators and others interested. A revision was made of the shore line of Hog Island and portions of Rhode Island and Bristol Island, and of the hydrography of the channel between Hog Island and Rhode Island and in the vicinity of Hog

Island Shoal Light. The construction of certain boats for the use of the Survey and of machinery and boilers for the same and the collection of data relating to depths in channels and harbors were among the varied duties performed by this officer whose headquarters are at the New York Custom House.

The steamer *Explorer* was employed in the survey of the entrance of the Kuskokwim River, Alaska. The *Explorer* was repaired at Seattle and at the Puget Sound Navy Yard between January 20 and the early part of April, and afterwards a radio apparatus was installed on the vessel.

The party on the steamer *Gedney* was engaged in surveys in Kasook Inlet, Sukwan Strait, Tlevak Strait, and San Christoval Channel, Alaska, and in revision work at Tacoma, Olympia, and Seattle, Wash. The vessel was repaired at Winslow, Wash., between February 24 and April 4.

The steamer *McArthur* made hydrographic surveys in Cook Inlet, of Aialik Bay, and offshore between Aialik and Resurrection Bays; at Nakat Harbor and Burnett Inlet and at Iniskin Bay, Alaska. The vessel was repaired between February 19 and April 15 at the Puget Sound Navy Yard.

The steamer *Patterson* was employed on the triangulation and topography of Clarence Strait, southeastern Alaska, and in the survey of the Shumagin Islands and Unimak Pass. During the winter the vessel was engaged in the hydrography around the island of Maui and off the west end of Molokai Island, Hawaiian Islands. Temperatures of sea water were obtained both in going to Hawaii and in returning. The *Patterson* was repaired at Seattle between July 1 and August 2 and in November and May. In the latter month a radio apparatus was installed on the vessel.

The steamer *Taku* operated in the northwestern part of Prince William Sound between Naked Island and Port Wells, and in the north arm of Simpson Bay, thence southward toward Knights Island Passage and westward from previous work to the mainland. The *Taku* was repaired at Cordova, Alaska, between April 2 and May 1.

The steamer *Yukon* was employed on the survey of Turnagain Arm, Cook Inlet, and in the approaches to the Kuskokwim River, Alaska. The *Yukon* was repaired at Seldovia between April 23 and May 10.

Revision work for the correction of charts was done at Blaine, Bellingham, Anacortes, Neah Bay, Port Angeles, Port Townsend, Richmond Beach, and Coupeville on Puget Sound.

The revision of the triangulation and topography of the island of Maui was completed and that of the island of Hawaii was begun. The work has been carried from Hilo around the northwest point of the island of Kawaihae.

An officer of the Survey continued in charge of the suboffice at San Francisco and as inspector for the coast of California. A resurvey was made under his direction of the United States immigration station on Angel Island, San Francisco Bay.

An officer acting as inspector for the coasts of Oregon, Washington, and Alaska and in charge of the office at Seattle in addition to other duties rendered valuable service in the preparation of specifications for repairs of vessels and of plans for a new launch for the

steamer *Pathfinder*, in planning work for vessels in Alaska, and in collecting and furnishing information useful to navigators and for corrections to the charts.

PHILIPPINE ISLANDS.

An officer of the Survey detailed to duty as Director of Coast Surveys, with headquarters at Manila, has direction of all field work in the Philippine Islands. The details of this work are mentioned elsewhere in this report.

The steamers *Pathfinder*, *Fathomer*, *Romblon*, *Marinduque*, and *Research*, have been engaged in that work. Of these vessels all except the *Pathfinder* are the property of the insular government, which provides the crews and keeps the vessels in repair. The salaries of the officers and the running expenses, including outfit, are paid by the United States.

Congress having made an appropriation for extraordinary repairs to the steamer *Pathfinder* she was taken to Hongkong, arriving December 24. Extensive repairs were made, which were completed on April 8, when the vessel returned to Manila.

The *Pathfinder* encountered several typhoons during the year, the most severe of which occurred on October 16, when she was lying at Cebu. Both of her launches were dragged from their moorings and swamped. One was recovered without serious damage; the other was lost.

On November 6 the steamer *Marinduque* during a typhoon was driven on shore of a small island east of Palawan and seriously damaged, necessitating extensive repairs.

OFFICE OF INSPECTOR OF GEODETIC WORK.

The duties of inspector, conducted at the office in Washington and in the field, consist in the supervision of the work of the parties of the Survey engaged in geodetic operations in the field, the discussion and preparation for publication of the results obtained, and the investigation of scientific problems based upon such results.

The inspector assisted the International Boundary Commission by inspecting the records and computations of triangulation and the reports of the field parties engaged in the survey of the boundaries.

As one of the delegates on the part of the United States he attended the meeting of the International Geodetic Association at Hamburg, Germany.

A field inspection was made of the work of the parties engaged in triangulation in Texas and Louisiana.

An important work completed during the year is the triangulation along the one hundred and fourth meridian from the transcontinental triangulation in the vicinity of Denver, Colo., northward to the Canadian boundary, and connecting at various points with State boundaries, with the triangulation of the United States Geological Survey at one point with the triangulation of the Missouri River Commission, and with bench marks established by the United States Geological Survey, by several railroads, and by the Coast and Geodetic Survey.

Two parties were engaged in this triangulation, which was begun May 10, 1912, and finished December 4, 1912. Two base lines, aggregating about 25 kilometers in length, were measured and 14 astronomical azimuths were observed. The scheme of this triangulation extends over 720 miles and covers an area of about 17,000 square miles. Eighty-two primary and 19 secondary stations were occupied and 133 geographic positions were determined. The reconnoissance and signal building for this work were completed in the summer of 1911.

Another event of great importance was the completion of the triangulation along the ninety-eighth meridian from Alice, Tex., to the Mexican boundary, a distance of 150 miles and covering an area of about 1,300 square miles. Thirty-four stations were occupied in the main scheme and 72 geographic positions were determined. In the month of April 15 primary stations were occupied. This is the greatest number ever occupied in one month by a single party in this country and has probably not been equaled elsewhere. The reconnoisance and signal building were conducted by a separate party.

This triangulation connects with the coast triangulation at Point Isabel, Tex., and it will finally be connected with the primary triangulation of Mexico, which extends across that country from the Pacific Ocean to the Rio Grande approximately along the ninety-eighth meridian. In connection with this work a determination was made of the difference of longitude between Austin and Donna, Tex.

A line of precise levels was completed from San Francisco, Cal., along the line of the Southern Pacific Railway to Brigham, Utah. The levels are connected with tidal bench marks at San Francisco and with precise level bench marks previously established at Brigham.

The fact that the Geodetic Commissions of Mexico and Canada have adopted the same datum and spheroid used in trigonometric surveys in the United States gives to this datum an international character. Its designation has accordingly been changed from United States standard datum to the North American datum.

Other work done during the year was the revision of triangulation and the determination of geographic positions of aids to navigation, the determination of the positions of wireless towers along the Atlantic and Pacific coasts, the telegraphic determination of difference of longitude between Omaha, Nebr., and five stations on the one hundred and fourth meridian, and the beginning of a secondary triangulation along the coast of Washington and of a line of levels between Crookston, Minn., and Butte, Mont., and the preparation for remeasurement of the El Paso base in Colorado.

Six new publications relating to geodetic work were issued during the year. These are listed under the head of "Publications" in another portion of this report. The manuscript of these publications was nearly all prepared before the beginning of the fiscal year, 1913.

The manuscript of a report on the triangulation of the west coast of Florida was sent to the printer before the close of the year. A publication on the precise level net in the United States and a report on the triangulation of the coast of Texas were nearly completed.

OFFICE OF INSPECTOR OF MAGNETIC WORK.

The duties of this officer are to plan magnetic work to be carried out in the United States and outlying territory under the jurisdiction of the United States, to inspect magnetic work in the field, and at magnetic observatories; to recommend changes in the personnel and salaries of magnetic observers; to recommend the purchase or construction of new magnetic instruments or alterations of old ones when required, or the designing of new ones; to recommend changes in the design of instruments or methods of observing to secure better results or save time; and to supervise the planning and construction of buildings for magnetic observations.

In October the Cheltenham Observatory was inspected and in March the Porto Rico Observatory was visited and inspected under instructions from the Superintendent. All other inspection work during the year was performed at the office by the current examinations of the records and reports from chiefs of magnetic parties and others engaged in magnetic work. Detailed instructions were prepared for the guidance of magnetic observers in the execution of the field and observatory work and computations.

The magnetic observatories at Cheltenham, Md.; Tucson, Ariz.; Honolulu, Hawaii; Sitka, Alaska; and Vieques, P. R., were in operation throughout the year. Seismographs were kept in operation and meteorological observations were made at all of the observatories.

Special rapid-rate registration was carried out on specified-term days, each month in conformity with requests for international cooperation in connection with the Australasian Antarctic expedition engaged in magnetic observational work in the Antarctic regions. At the request of the Batavia, Java, magnetic observatory special rapid-rate registration was carried out at specified-term hours during the month of October for the purpose of securing additional data for the study of the rate of propagation of magnetic disturbances.

All of the instruments used in field magnetic work during the year were standardized at the Cheltenham Observatory and special observations and comparisons were made for determining the constants of various instruments.

Further instruction was given at the Cheltenham Observatory to an observer preparing to go with the Crocker land expedition and to a newly appointed magnetic observer of the Coast and Geodetic Survey.

Necessary repairs and alterations were made to the observatory buildings where required.

MAGNETIC WORK ON LAND.

The magnetic elements (declination, dip, and horizontal intensity) were determined at 245 stations. The stations were distributed, in accordance with most urgent needs, over 28 States and Territories and outlying territory under the jurisdiction of the United States, and one foreign country, as shown in the table following. Forty-eight "repeat" stations were occupied during the year for the purpose of obtaining observational data for maintaining adequate information of the secular change of the magnetic elements, especially of the magnetic declination. The magnetic work in the Philippines, mentioned in my last report, was concluded in January, 1913.

SUMMARY OF RESULTS ON LAND.

States.	Localities.	Stations.	Old localities reoccupied.	Declination results.	Dip results.	Intensity results.
Alabama	4	4	1	4	4	4
Alaska	17	17	1	17	2	2
Arizona	1	1	1	2	2	2
Arkansas	18	18	1	18	18	18
Colorado	3	3	1	3	3	3
Delaware	5	5	1	5	5	5
Georgia	2	2	0	2	2	2
Iowa	10	10	3	10	10	10
Kansas	1	1	1	1	1	1
Kentucky	21	22	3	22	22	22
Maryland	1	1	1	7	5	5
Massachusetts	4	4	1	4	4	4
Michigan	2	2	0	2	2	2
Mississippi	6	6	0	6	6	6
Missouri	16	16	1	16	16	16
Nebraska	5	5	2	5	5	5
New Jersey	7	7	0	7	7	7
North Carolina	6	6	1	6	6	6
Ohio	3	3	1	3	3	3
Oklahoma	14	14	3	14	14	14
Pennsylvania	8	10	3	10	10	10
Philippine Islands	20	23	14	23	23	23
South Dakota	3	3	1	3	3	3
Tennessee	9	9	0	9	9	9
Texas	30	31	2	31	31	31
Virginia	18	18	2	18	14	14
Washington	1	1	1	1	1	1
West Virginia	1	1	0	1	1	1
British Columbia	1	1	1	1	2	2
Yukon Territory	1	1	1	1	0	0
Total	238	245	48	252	231	231

The magnetic work done at sea by the vessels of the Survey was, as in past years, incidental to the regular surveying duties upon which they were engaged, and the magnetic observations were made when the vessels were en route to or from their working grounds, or where opportunity offered on the working grounds. The sea results are not so numerous as in past years, due largely to the fact that the ships have recently covered little new territory. The following table shows (approximately) the amount of magnetic work carried out on board ship during the year, several of the vessels under instructions for magnetic work not having yet reported the work done during the first half of this calendar year:

SUMMARY OF RESULTS AT SEA.

Vessels.	General region.	Results from swings.			Declination results from course observations.
		Declination.	Dip.	Intensity.	
Hydrographer	Atlantic coast	5	0	0	0
Patterson	Pacific coast	1	1	1	0
Gedney	do		1	0	0
McArthur	do	1	0	0	0
Explorer	do	1	1	1	0
Taku	do	2	0	0	0
Total					

All of the vessels of the service that are suitable for it are instructed during each season to make such magnetic observations, espe-

cially the magnetic declination, as there is opportunity for doing, either at sea or on land, where the weather conditions and the requirements of their regular duties permit. The *Patterson* and *Explorer* on the Pacific coast are supplied with sea-dip circles for determination of dip and intensity at sea, and they are also equipped with magnetometers for magnetic work on land. The *Bache* has not had a dip circle during the year. One of the needles of the *Bache's* dip circle was broken over a year ago and since that time this office has been experimenting in the construction of dip needles for this instrument, with the intention of ultimately being able to make suitable dip needles here and thus avoid the necessity of having to send to Europe for them with the consequent long delays in getting them.

APPROPRIATIONS AND DISBURSEMENTS.

The total appropriation made by Congress in the sundry civil act for the fiscal year ending June 30, 1913, for the Coast and Geodetic Survey was $1,022,720, divided as follows:

Field expenses	$314,400
Repairs and maintenance of vessels	40,000
Extraordinary repairs of steamer *Pathfinder*	20,000
Officers and men, vessels	245,000
Pay of field officers	160,200
Pay of office force	193,120
Office expenses	50,000
Total	1,022,720

The deficiency act for 1913 contained two items for the Coast and Geodetic Survey, namely:

Repairs and maintenance of vessels:	
For installation of wireless apparatus on three vessels	$9,000
For rewiring the Coast and Geodetic Survey buildings	4,300
Total	13,300

The statement of disbursements required by law to be made annually to Congress and published as a separate document gives an account of the names and number of employees of different classes employed on the work, the amount of their salary or compensation, the length of time employed, to whom payments were made under the different items of appropriation and on what account, and the balances left of the amounts appropriated for the fiscal year.

PUBLICATIONS.

The following publications of the Coast and Geodetic Survey were received from the printer during the fiscal year 1913:

Results of observations made at the Coast and Geodetic Survey magnetic observatory at Vieques, P. R., 1909–10; by Daniel L. Hazard, 1912. 10 charts. 94 pp. 4to.

Same: Sitka, Alaska, 1909–10; by Daniel L. Hazard. 21 charts. 96 pp. 4to.

Same: Tucson, Ariz., 1909–10; by Daniel L. Hazard. 5 charts. 2 text fig. 59 pp. 4to.

Catalogue of charts, coast pilots, and tide tables, 1912. 86 text fig. 228 pp. 4to.

Effect of topography and isostatic compensation upon intensity of gravity, 2d paper; by William Bowie, 1912. (Special publication No. 12.) 5 maps in pocket. 28 pp. 4to.

Geodetic operations in the United States, 1909–12, report to 17th conference of International Geodetic Association (Hamburg, Germany, Sept., 1912, with list of geodetic publications by Coast and Geodetic Survey since Jan. 1, 1909); by O. H. Tittmann, 1912. 3 pl. 18 pp. 4to.

Texas-California arc of primary triangulation; by William Bowie, 1912. (Special publication No. 11.) 2 pl. 6 pp. of pl. 141 pp. 4to.

Survey of oyster bars, description of boundaries and landmarks, and report of work of Coast and Geodetic Survey in cooperation with Bureau of Fisheries and Maryland Shell Fish Commission; by C. C. Yates, 1912 [each large 8vo., with large map]:

Talbot County, Md. 250 pp.

Dorchester County, Md. 180 pp.

Statement of expenditures in Coast and Geodetic Survey, fiscal year 1912. Jan. 16, 1913. (H. Doc. 1271.) 14 pp. 8vo.

Inside route pilot, New York to Key West, 1912 [by Herbert C. Graves and W. E. Parker]. 8 maps in pocket. 62 pp. large 8vo.

Annual report of Superintendent, fiscal year 1912. Portfolio of 9 maps. 1 diag. 106 pp. 8vo.

Same (H. Doc. 966).

Inland waterway, Atlantic coast. 2 pp. 8vo.

Regulations and instructions for government of Coast and Geodetic Survey, 1913. 83 pp. 8vo.

California-Washington arc of primary triangulation; by A. L. Baldwin, 1913. (Special publication No. 13.) 7 text fig. 78 pp. 4to.

Determination of time, longitude, latitude, and azimuth; by William Bowie. 5th edition, 1913. (Special publication No. 14.) 8 pl. 18 pp. of pl. 177 pp. 4to.

United States coast pilot, Atlantic coast: pts. 1, 2, St. Croix River to Cape Ann [supplement to 3d edition]. May 27, 1913. 5 l. large 8vo.

Same: pt. 3, Cape Ann to Point Judith [supplement to 3d edition]. May 20, 1913. 4 l. large 8vo.

Same: pt. 4, Point Judith to New York [supplement to 5th edition]. Apr. 22, 1913. 8 l. large 8vo.

Same: pt. 5, New York to Chesapeake Bay entrance [supplement to 4th edition]. May 12, 1913. 7 l. large 8vo.

Same: pt. 6, Chesapeake Bay and tributaries [compiled by Edwin H. Tillman and John Ross]. 4th edition [revised by Herbert C. Graves]. 1913. 2 maps. 5 text fig. 162 pp. large 8vo.

Same: pt. 8, Gulf of Mexico from Key West to Rio Grande [supplement to 3d edition]. May 12, 1913. 9 l. large 8vo.

United States coast pilot, Pacific coast: California, Oregon, and Washington [supplement to 2d edition]. May 12, 1913. 8 l. large 8vo.

Same: Alaska, pt. 1, Dixon Entrance to Yakutat Bay, with inland passage from Juan de Fuca Strait to Dixon Entrance. 5th edition. 9 pl. 4 text fig. [Reprint.] large 8vo.

Same, supplement. May 20, 1913. 12 l. large 8vo.

A number of other publications were in press or in course of preparation for publication at the close of the year.

The total cost of printing and binding for the Coast and Geodetic Survey, including blank forms and miscellaneous job printing for the year, payable from the appropriation for printing and binding for the Department of Commerce, was $26,526.52.

ECONOMY AND EFFICIENCY.

A large amount of the time of officers and employees of the Coast and Geodetic Survey was devoted during the year to the preparation of statistical and other information called for by the President's Commission on Economy and Efficiency. An analysis was made of the expenditures of the Survey and special estimates were prepared in a form requested by the commission. An itemized statement was made of the expenditures for transportation and a number of special reports were prepared.

SPECIAL DUTY.

International Geodetic Association.—The Superintendent continued to supervise the operations of the observatories maintained by the International Geodetic Association at Gaithersburg, Md., and Ukiah, Cal.; and the Superintendent and the inspector of geodetic work, as delegates on the part of the United States, attended the meeting of the association at Hamburg, Germany, in October, 1912.

Board on life-saving appliances.—The Superintendent is chairman of the board appointed by the Secretary of the Treasury to examine and report upon life-saving appliances.

Mississippi River Commission.—An officer of the Survey, in addition to other duties, has continued to serve as a member of the Mississippi River Commission.

Maryland Shell Fish Commission.—An officer detailed for duty with the Maryland Shell Fish Commission continued on duty in charge of office work and the preparation of maps, reports, and publications. Assistance was rendered by the same officer to the Oyster Survey Commission of the State of Delaware without expense to the Federal Government.

Two officers of the Survey were detailed to represent the Department of Commerce at the conference of port authorities. Both of these officers were in attendance at the meeting in New York and one of them also attended the meetings of the conference at Boston, Philadelphia, and Baltimore.

ASSISTANCE RENDERED IN SAVING LIFE OR PROPERTY.

On October 7 the steamer *Hydrographer*, on her way from Pollock Rip to Boston, sighted a stranded four-masted schooner just south of the Marconi Towers, Cape Cod, and went to her assistance. She was loaded to 21 feet with coal. The *Hydrographer* at first alone and then with the assistance of the U. S. S. *Cyrus W. Field* managed to move her a little, but was unable to dislodge her. Through the *Field's* wireless apparatus the revenue cutter *Gresham* was notified, and with two life-saving crews standing by the schooner the *Hydrographer* proceeded on her way to Boston. The *Gresham* was expected in time for the high water of that evening.

The *Hydrographer* also rendered assistance to the schooner *Sallie Purnell Beswick*, which went aground in North Landing River, N. C.

The Pacific Coast Steamship Co.'s steamer *Curacao*, which ran aground on a bowlder spit near Fish Egg Island, Alaska, was assisted in getting afloat by the Coast and Geodetic Survey steamer *Gedney* and launch *Cosmos*. Afterwards when the *Curacao* was wrecked in Tonawek Bay the *Gedney* took off the passengers and crew and conveyed them to Ketchikan, 140 miles distant, the nearest port of call for steamships.

A very severe typhoon passed over the southern part of Samar, Leyte, Cebu, and the northern part of Negros on October 15 and 16. Hundreds of lives were lost and shipping and property were destroyed in its path. The steamer *Pathfinder* rode out the storm in safety in Cebu Harbor, but 17 smaller merchant steamers foundered or were beached. Two of the *Pathfinder's* launches, although anchored in a protected part of the harbor, were swamped. One of

these was afterwards recovered. Great praise was expressed by the public for the heroic services rendered by a volunteer boat's crew from the *Pathfinder* in going to the rescue of shipwrecked sailors during the height of the storm, although they knew they could not return to their own vessel but would have to remain on shore until the storm abated. Assistance was also rendered the steamer *Lizarraga* which was sighted in distress and she was towed to a protected anchorage.

The officers of the steamer *Research* aided in extinguishing what might have been a serious fire on a new tugboat in the dock on Engineers Island, Manila Bay. For this service the officers of the *Research* were thanked by the Director of Navigation of the Philippine government.

DETAILS OF FIELD OPERATIONS.

Atlantic Coast.

MAINE.

[E. B. Latham.]

Summary of results.—Triangulation: 185 square miles of area covered, 22 signal poles erected, 13 old stations recovered, 7 stations searched for but not found, 23 spires, lighthouses, etc., identified, 23 stations in main scheme and 19 in supplemental scheme occupied for horizontal measures, 88 geographic positions determined. Topography: 94 square miles of area revised and changes noted but work incomplete, 6 topographic sheets partly revised.

On July 1 chart revision work was being done between Ipswich, Mass., and York, Me. Revision work between Hampton Beach, N. H., and York, Me., was continued until September 30, when work between York and Portland Head was begun. The work of inspecting and noting changes in the topography and search for old triangulation stations was first attended to, leaving the collection of plans, local surveys, and data relating to new roads and railroads until the time when the weather would be unfavorable for outside operations. In December the compilation and plotting of the revised sheets south of York were completed.

The triangulation station Mount Independence north of Portland was recovered and marked.

During the calendar year 1912 the revision of the topography was completed from York, Me., to the road just north of and parallel with Saco River, excepting the towns of Kennebunkport, Cape Porpoise, Biddeford, and Saco.

Chart revision between York and Portland Head Light was continued until April 9, by which time the work needed was nearly completed.

MAINE, MASSACHUSETTS, CONNECTICUT, RHODE ISLAND, NEW YORK, AND FLORIDA.

[N. H. Heck.]

Summary of results.—Triangulation: 444.5 square miles of area covered, 13 signal poles erected, 30 stations occupied for horizontal measures, 52 geographic positions determined. Leveling: 17 elevations determined by leveling, 3 miles of levels run. Hydrography: 169 square miles of area dragged, 416.8 miles run with wire drag, 18,621 angles measured, 561 soundings, 5 tide stations established, 5 hydrographic sheets finished.

At the beginning of the fiscal year the wire-drag party was engaged in work in Block Island Sound. Owing to lack of shelter from the wind, strong tidal currents, the necessity of using distant signals, frequent haze, and the large number of lobster pots which had to be removed before the drag could be used, the conditions here were found unfavorable for rapid progress.

The area dragged in Block Island Sound consisted of a ridge with comparatively shoal water connecting Block Island and Long Island, surrounded by deeper water on both sides. The general width of the area in a north and south direction between the 10-fathom curves is from 4 to 7 miles. An area of 46 square miles was dragged between July 2 and September 24. A considerable number of uncharted bowlders and sand ridges were located. The location of the deepest channel was determined, and a dangerous rock was located.

Under instructions of August 10 a survey was made of an uncharted shoal in Block Island Sound to the westward of Point Judith, R. I., on which the battleship *Nebraska* had struck on August 8.

A careful examination was made with the wire drag of the locality mentioned, and a least depth of 21 feet was found on detached bowlders. An extensive bowlder-strewn area was developed.

This shoal lies 1⅛ miles from the north shore of Block Island Sound and 4½ miles west from Point Judith.

Tides were observed at two stations on Block Island. Soundings were made in Trims Pond, Block Island, which has been connected with Great Salt Pond since the original survey.

Changes in certain topographic features on Block Island were determined by the party.

Triangulation was executed over an area of 84 square miles to determine the position of additional objects to be used as signals in Block Island Sound and of other objects useful as aids to navigation.

Between September 13 and November 20 the party was engaged in the northern end of Buzzards Bay, with headquarters at Marion, Mass.

An especial effort was made to determine the safest channel leading to the Cape Cod Canal. An area of 28 square miles was covered. The number of soundings taken, a large per cent of which represent uncharted depths on bowlders or ledges, indicates the necessity for this work.

A ridge of bowlders, with depths from 24 to 27 feet, was found to the southeastward of Cormorant Ledge extending for about 2 miles at right angles to the general direction of the bay. In the eastern part of the bay extensive bowlder-strewn areas were developed with depths from 14 to 20 feet.

Six stations were occupied and 11 objects determined by triangulation for use as signals, 3 of which are prominent water towers. The triangulation covered an area of 45 square miles.

Five old tidal stations were visited, at 3 of which the old bench marks were recovered. Eight new bench marks were established.

Between January 4 and April 20 a wire-drag survey was made of the channels at the entrance of the harbor of Key West, Fla.

The object of this work was to cover the areas not previously dragged to a depth of 30 feet, to find the greatest safe depth that can

be taken through each of the seven possible channels to Key West, not including the main ship channel or the west channel, and to find the safe depths that can be taken over the inner reefs at various points. A long drag, averaging 2,700 feet, was used throughout the season, and a large number of shoals were found and dragged over.

The weather during the season was unfavorable for rapid progress. Thirty-one square miles of area were covered, however, and 316 soundings were obtained, about 80 per cent of which were made on uncharted shoals or shoals on which a less depth was found than had been indicated on the charts. A new triangulation was executed, many of the old stations having been destroyed by hurricanes. All of the beacons, including the range beacons for entering the main ship channel, were determined, as well as many prominent objects of a permanent nature at Key West. The stations were all carefully marked. Some verification work was done to ascertain the correctness of topographic details on the chart.

Considerable improvement has been made in the methods of work and equipment used in the drag work as the result of practical experience, and a complete description embodying these improvements is in course of preparation for publication.

On June 10 wire-drag work was begun near Matinicus, on the coast of Maine, and was in progress at the close of the fiscal year.

MASSACHUSETTS.

[EARL F. CHURCH.]

In November the necessary observations were made for connecting the triangulation of the Coast and Geodetic Survey with that of the Corps of Engineers, United States Army, at Newburyport, Mass.

Preliminary to this work copies of triangulation data were obtained from the office of the United States Engineers at Boston and from the Harbor and Land Commission of Massachusetts concerning certain triangulation stations at Newburyport.

Four points of the United States Engineers' survey of 1911 were joined with three stations of the Coast and Geodetic Survey.

The location was determined by triangulation of Plum Island Lighthouse and of Black Rock (Butler's Toothpick) Beacon.

The Salisbury Beach wharf and range lights are located by the Engineers' survey with which the Coast and Geodetic Survey triangulation was connected, but sextant angles were taken to give approximate determination of Salisbury Beach range lights and of the point on Salisbury Beach wharf, where the tide staff is located. The jetties at the mouth of the river are well determined by the Engineers' survey.

In formation was gathered in regard to changes in topographic details at the northwestern point of Plum Island and of the shore line and adjacent buildings along Salisbury Beach.

A tide staff was erected at Salisbury Beach, levels were run between the tide staff and several bench marks, and tide observations were begun by observers hired for the purpose.

MASSACHUSETTS, VIRGINIA, AND NORTH CAROLINA.

[PAUL C. WHITNEY, Commanding Steamer *Hydrographer*.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme, 48 miles. Base lines: 1,541.3 meters in length. Triangulation: 163 square miles of area covered, 84 signal poles erected, 3 observing tripods and scaffolds built (average height 30 feet), 63 stations in main scheme occupied for horizontal measures. 130 geographic positions determined. Topography: 27 square miles of area surveyed, 103.3 miles of general coast line surveyed, 6 miles of roads, 4 topographic sheets finished. Hydrography: 77 square miles of area covered, 662 miles run while sounding, 4,860 positions determined, 28,794 soundings made, 13 tide stations established, 13 hydrographic sheets finished.

Between September 24 and December 2 the steamer *Hydrographer* was engaged in chart revision work on the coast of Massachusetts. The work done includes a survey of the channel around Peddocks Island, into the mouth of Weymouth Fore River, Boston Harbor; search for reported shoal west of the Graves Lighthouse; hydrography of Cape Cod Bay, between Minot Ledge and Sandwich, Mass., survey of changes in Barnstable Harbor; resurvey of entrance to Wellfleet Harbor; survey of reported changes in Pollock Rip Slue; resurvey of channel between Handkerchief and Shovelful Shoals, and search for a reported shoal in Great Round Shoal Channel.

On October 7 the *Hydrographer* rendered assistance to a stranded schooner south of the Marconi Towers, Cape Cod.

September 5, 1912, the commanding officer of the *Hydrographer* was directed to make a hydrographic survey of the channel from Weymouth Fore River, around Pig Rock and westward of Peddocks Island to Nantucket Sound; make a thorough examination of the vicinity of the 5-fathom spot shown on chart 357, reported in November, 1911, by Capt. Giles of the steamship *Everett* in the following position, "Graves gas and bell buoy bears SE. by E. ½ E., Graves Lighthouse bears about S. by W."; examine 5-fathom spot about 2 miles off North Scituate Beach; examine the 8½ and 9 fathom spots 2½ miles east of Scituate Harbor and the 7-fathom spot about 1 mile south-southwest; also the 3¾-fathom sounding 1 mile off New Inlet and the 7-fathom sounding off South River; examine the limits of 6-fathom curve north of Howland Ledge off Manomet Point and from Center Hill Point to Sagamore Beach; fill in soundings between North Scituate to Sagamore Beach; make hydrographic survey of entrance to Wellfleet Harbor; and survey entrance to Barnstable Harbor.

On September 24, 1912, the Hydrographic Office of the Navy Department transmitted to the Coast and Geodetic Survey copy of a letter from Mr. W. E. I. Stiles of the Branch Hydrographic Office, Norfolk, Va., stating that he had received reports from masters of vessels of shoaling on the southern side of Pollock Rip Channel midway between Pollock Rip and Shovelful light vessels.

Under instructions of September 26, 1912, the *Hydrographer* made a careful examination of this channel, but found no indication of an 18-foot shoal spot in the position reported. An examination of an 18-foot sounding shown on the chart just to the southwestward developed a least depth of 14 feet, and it appears probable that this is the shoal that the *Kershaw* struck and not some new shoal to the

northward. Many vessels were observed passing dangerously close to this shoal, the position of which was determined under date of September 24, 1912. The lighthouse inspector at Boston had reported that Shovelful Shoal was extending to the southward and Handkerchief Shoal to the eastward and that the passage between the shoals was so nearly closed as to be unsafe without local knowledge, and he recommended that the channel be closed to navigation. Subsequently the Bureau of Lighthouses ordered the removal of the buoys marking this channel.

The alleged shoaling in the channel to the Pollock Rip gas and whistling buoy reported by the master of the *Juniata* was investigated, but no evidence of such shoaling was discovered. A least depth of 24 feet, reduced, was found close to the buoy and one of 21 feet just inside the buoy.

A course laid 300 feet off the outer buoy will not put a vessel in anything like 18 feet of water. The master of the *Juniata* stated that when the vessel struck the buoys were to the eastward of their subsequent position, and it is probable that she touched the extreme western end of the broken part of Pollock Rip instead of an obstruction in the channel.

In January, while on her way to the coast of North Carolina, the *Hydrographer* determined the position of the wreck *Julia Luckenbach* in Chesapeake Bay, and in North Landing River assistance was given to the schooner *Sallie Purnell Beswick*, which had run aground. The new channel from Pamlico Sound to Core Sound, past Harbor Island Bar Light was sounded out.

Hydrography executed in conjunction with the steamer *Endeavor* included a resurvey of the land and water areas lying between meridian 76° 35′ and a line from Bells Point and the ocean beach passing through Cowpen Island, except the southern extremity of Cape Lookout and part of Back Sound. A scheme of tertiary triangulation was executed, forming a loop around Harkers Island and extending to Cowpen Island and Bells Point as a base for future operations to the eastward in Core Sound. The topography and hydrography of Core Creek were also included in the work of this season.

In cooperation with the steamer *Endeavor* search was made for a reported shoal 18 miles southwest of Cape Lookout. It was found that no shoal exists in the locality indicated.

In the vicinity of Neuse River hydrographic work was done to determine the present location of shoals, spits, and bars, and the positions of all aids to navigation were determined from Wilkinsons Point down, including Adams Creek and Bay River to Bayboro. A new tertiary triangulation was executed joining the work by Assistant Ritter in 1911 and running down the Neuse River to its mouth and connecting in Bay River with the triangulation of 1909 by the Corps of Engineers, United States Army. From the western end of this a traverse line was run to Bayboro locating the day marks in the dredged channel. At Oriental a survey was made to show the bulkhead and the depths behind it. The triangulation of the United States Engineers in Adams Creek was connected with that by this party and a check base was measured for the purpose of verification. A topographic survey of Vandemere, N. C., a new town on Bay River, was made.

This work was completed on June 14.

MASSACHUSETTS, RHODE ISLAND, SOUTH CAROLINA, AND GEORGIA.

[ISAAC WINSTON.]

SUMMARY OF RESULTS.—Triangulation: 176 square miles of area covered, 8 beacons built (heights 25 and 40 feet), 41 stations in supplemental scheme occupied for horizontal measures, 24 geographic positions determined.

Between August 26 and November 1 a revision was made of the triangulation of Narragansett Bay, R. I.

Nearly all of the old stations along the western passage in Narragansett Bay, between Narragansett Pier and Wickford, were readily recovered so as to be available for use by the hydrographic party on the Coast and Geodetic Survey steamer *Endeavor* upon arrival on September 10.

Valuable information in regard to surveys and dredging in progress in Narraganset Bay and vicinity was obtained from the United States Engineers office at Newport.

The stations of the triangulation by the United States Engineers were visited in company with a United States assistant engineer, and notes were made showing their condition. Preliminary arrangements were made with a view to permanently marking those stations at which only temporary marks had been placed.

A blue print showing a hydrographic survey of Wickford Harbor and approaches including a dredged channel in the harbor was furnished by the United States Engineers.

The search for old triangulation stations was extended over Narragansett Bay, Providence River, Hope Bay, and Sakonnet River; new wharves were located, and the positions of prominent objects useful as hydrographic signals or aids to navigation were determined. Several tidal bench marks were recovered and additional bench marks were established.

During the season one chart agency at Providence and two at Newport were inspected. Thirty-four Coast and Geodetic Survey triangulation stations and 42 triangulation stations established by the United States Engineers were recovered, and supplementary marks were established and supplementary descriptions in the case of the Coast and Geodetic Survey stations were prepared. Two new Coast and Geodetic Survey triangulation stations were established, and 26 were found to have been destroyed. Ten stations of the triangulation by the United States Engineers were found to have been destroyed. The locations of 26 lighthouses and 1 beacon were reported unchanged. One lighthouse and 3 beacons were found to have been destroyed. The positions of 2 lighthouses and 4 beacons were determined. Nine prominent objects, previously determined, were recovered. Ten such objects were found to have been destroyed. Twenty-nine such objects were determined in position.

The office of the United States Engineers at Boston was visited and useful information was obtained in regard to surveys by the United States Engineers in the vicinity of Newburyport, Mass.

Work was closed for the season on November 16.

The chart agencies at Providence and Newport, R. I., were inspected during the progress of field work in the localities mentioned.

The determination of the positions of buoys and beacons and of prominent objects useful as aids to navigation in the vicinity of

Savannah, Ga., which had been begun by Mr. R. R. Lukens was continued after March 26 by Mr. Isaac Winston.

Information in regard to beacons and buoys was obtained from the lighthouse inspector at Charleston, and in regard to the triangulation in the vicinity data were obtained from the office of the United States Engineers at Savannah. Three old triangulation stations of the Coast and Geodetic Survey, viz, Fort Jackson 3, South Base, and Proctor were recovered, and from these a scheme of triangulation was extended sufficient to determine the points required. The geographic positions of 10 prominent objects were determined in addition to completing the scheme of triangulation begun by Mr. Lukens. Four of the triangulation stations used by the United States Engineers were recovered and marked. Blue prints showing the condition of the wharves at Savannah were obtained and other data collected for use in the correction of the charts.

In April the chart agency of the Coast and Geodetic Survey at Savannah, Ga., was inspected, the number of Charts, Tide Tables, and Coast Pilots checked, and out of date or damaged publications returned to the office at Washington.

Between April 13 and June 12 the triangulation of Port Royal Sound and North Edisto River was revised. A number of beacons were erected and their positions determined for the use of the Lighthouse Service in locating aids to navigation.

A beacon 40 feet in height was erected on Hilton Head south of the entrance to Port Royal Sound, and one on Capers Island north of the entrance. The beacon on Hilton Head was erected over the triangulation station Hilton established in 1900. The triangulation station on Capers Island established in 1900 has been destroyed. The beacon was erected on the southwest end of the island as it exists at present, and its geographic position was determined from three old stations. This determination places the beacon about 1 mile outside the shore line shown on the charts, corresponding to a similar change in the position of the channel over the bar since the survey was made. In connection with this work five of the old triangulation stations were recovered, two found to have been destroyed, and one new station was established. In the vicinity of Helena Sound two beacons 40 feet high were erected, one on the south shore of Tripp Inlet south of the entrance and one on the south end of Edisto Island north of the entrance. One beacon 25 feet in height was erected on Marsh Island in Coosaw River. The old triangulation station on Tripp Inlet has been destroyed and the beacon is built over a new station, Tripp 2. On Edisto Island the beacon was built over station Point, established in 1902. The beacon on Marsh Island was built over a new station, Marsh.

In this work four old triangulation stations were established and three stations were found to have been destroyed.

In the vicinity of North Edisto River three beacons 25 feet in height were constructed. No triangulation stations were available near two of these points, and their geographic positions remain to be determined.

Much information was obtained concerning the condition of other triangulation stations in this region.

MASSACHUSETTS AND NEW YORK.

[T. L. WARNER.]

SUMMARY OF RESULTS.—Triangulation: 12 signal poles erected, 25 stations occupied for horizontal measures in supplemental scheme, 26 geographic positions determined.

In January and February the positions of two wireless telegraph towers in Boston, Mass., one at 131 State Street and the other at the corner of Washington and Sumner Streets, were determined, and also that of a small wireless telegraph pole at 126 State Street. At Nantucket, Mass., the location of the wireless masts at Siasconset was determined.

At Coney Island, N. Y., the position of the Marconi wireless mast was located, and a similar determination was made of the wireless tower at Sayville and of the wireless mast at Sagaponack, both on Long Island.

A number of aids to navigation in the vicinity of Great Peconic Bay, Long Island, were determined in position for the Bureau of Lighthouses and also a number of points for use in the survey of a new channel between Robins Island and Cow Neck.

In this work four old triangulation stations were recovered and observed upon and two of them occupied. Five new stations were occupied, observations of horizontal angles made, and signals erected. Seven other points were determined as tertiary triangulation stations but not occupied, and four other points were sufficiently well determined for the purposes of a hydrographic survey.

CONNECTICUT AND NEW YORK.

[H. P. RITTER.]

SUMMARY OF RESULTS.—Topography (chart revision): 6 square miles of area surveyed, 18 miles of general coast line, 10 miles of roads, 1¼ topographic sheets finished. Hydrography: 0.5 square mile of area covered, 14.5 miles run while sounding, 139 positions determined, 657 soundings, 2 tide stations established, 3 bench marks established, 12 buoys located, 1 hydrographic sheet finished.

During the first half of the fiscal year the topographic revision of Chart 269 (Stamford Harbor to Little Captain Island) was completed, and the revision of Chart 270 (Little Captain Island to Rye Neck) begun. About one-quarter of the field work for the revision of that chart was completed by the end of December.

The officer engaged on this work was called on to appear as an expert witness before the superior court of the State of New York in regard to certain topographic surveys by the Coast and Geodetic Survey.

He also was temporarily in charge of the office of the inspector at New York for short periods on several occasions.

Chart revision work was continued until the latter part of June. In April an examination was made of a reported rock in East River, N. Y.

A hydrographic survey was made to locate the newly dredged channel between Little and Great Peconic Bays. In connection with this work a tide staff was erected and tide observations were recorded

between May 12 and June 12. The positions of the buoys in the channel were determined. This work was completed June 15 and arrangements were made for beginning a series of current observations in the Potomac River in cooperation with certain investigations undertaken by the United States Public Health Service relating to the pollution of the river water by sewage.

RHODE ISLAND.

[H. A. SEBAN.]

In August, 1912, the positions of five post lights temporarily placed on the breakwater at Point Judith, R. I., were determined by triangulation, using the line Point Judith Lighthouse to North Light, Block Island, as a base.

The breakwater was at that time being repaired and all the beacons were post lights placed there temporarily. All of these were determined in position as well as the wireless tower, and an angle required by the wire drag party was observed.

RHODE ISLAND, MARYLAND, AND NORTH CAROLINA.

[J. B. BOUTELLE, Commanding Steamer *Endeavor*.]

SUMMARY OF RESULTS.—Triangulation: 191 square miles of area covered, 10 old stations recovered, 9 new stations selected, 35 signals built, 22 stations occupied for horizontal measures, 68 geographic positions determined. Topography: 24.5 square miles of area surveyed, 90.5 miles of general coast, 70 miles of shore line of creeks, 1 topographic sheet finished. Hydrography: 161.7 square miles of area covered, 2,025.4 miles run while sounding, 11,468 positions determined, 142,720 soundings, 6 tide stations established, 4 hydrographic sheets finished.

Between July 1 and August 28 the party on the steamer *Endeavor* continued hydrographic work in Chesapeake Bay in the area from Kedges Strait to Barren Island, the sounding lines extending from the shore to beyond the 4-fathom curve. Lines were run approximately parallel with the shore line and about 100 meters apart and crossed at every 400 meters.

No considerable changes were found to have occurred since the previous surveys.

Between September 11 and November 15 the party on the steamer *Endeavor* was engaged in the revision of the hydrography of Narragansett Bay, R. I.

Signals were erected and determined in position over the area extending through the western passage from Whale Rock Lighthouse to Hope Island. Tide gauges were established at West Jamestown, Dutch Harbor, and at Wickford and connected with the old Coast and Geodetic Survey bench mark at Jamestown and with one another. Various new wharves, a small portion of the shore line, and a number of hydrographic signals were determined with the plane table.

Sounding lines were run north and south approximately 100 meters apart and crossed at intervals of about 200 meters, and in places where further examination was found necessary lines were run 50 meters or a less distance apart.

Considerable change in the depths and contours was found in the southern end of the Western Passage. Numerous uncharted rocks were located near the shore line and a ledge with a depth of 23 feet on it was found near the middle of the channel near Plum Beach Lighthouse.

On the northwest side of Hope Island is a very dangerous rock, with from 6 to 8 feet of water on it, on the eastern side of the channel. Several vessels have struck this rock. A recently discovered rock with 8 feet of water on it was located on the north side of the entrance to Wickford Harbor south of White Rock Beacon. This rock has been marked by a red spar buoy.

The steamer *Endeavor* began work on the coast of North Carolina in the vicinity of Beaufort on January 11. After several old stations had been found and signals erected over the area covered by the survey, the triangulation was extended to the western end of Harker's Island, up North River and into Bogue Sound to a point 1 or 2 miles west of Morehead City. Topography and hydrography were then begun over the same area, the topography consisting mainly of shore line. Very little change was found to have taken place since the former surveys except in the vicinity of Beaufort Inlet and the channels leading into that inlet. One shoal was formed, an extension of Shark Shoal on the east side of the channel between Morehead City and the inlet having but 5 feet upon it where the surveys by the United States Engineers in 1908–9 show about 21 feet. On the south side of the channel leading from the inlet toward Back and Core Sounds there was a channel of 12 to 14 feet in 1908 which has since filled up to 7 feet, at low water. The currents in the vicinity of the inlet are very strong and the sea breaks heavily over these shoals and often across the channels causing frequent changes both in depth and location. During January and February a dredge was at work on the inlet bar making a 20-foot channel over it. Soundings taken April 21 and 22, 1913, show a least depth of 17 feet over this bar.

The dredged channels leading from Beaufort Harbor were sounded as far as their junction at Russell Creek Light, and thence continued into Core Creek by the party on the steamer *Hydrographer*. All lights and range beacons were determined in position.

On April 17 the *Endeavor* and the *Hydrographer* made a search for a 2-fathom shoal reported 6 miles west-southwest of Cape Lookout Shoals buoy. Lines of soundings were run over an area of 2 miles or more in the supposed location of the shoal and sufficiently to entirely disprove the existence of such an obstruction. Cape Lookout Shoals buoy and Cape Lookout Lightship were determined in position, the latter being found 3 miles east and one-half mile north of its charted position. Work was closed in this vicinity on April 24.

On May 27 work was begun at Point Judith, R. I., for a survey of the Harbor of Refuge and vicinity. The necessary triangulation points having been established, the shore line topography was run by plane table on a scale of 1/5,000 from Point Judith on the east to Rocky Point on the west of the breakwater. A tide gauge was set on the inside of the breakwater near Point Judith and connected with a bench mark of the United States Engineers and the Coast and Geodetic Survey.

Sounding lines were run outside of the breakwater 100 meters apart for about 1 mile south and around Point Judith on the east to Rock Point on the west. Inside the breakwater the lines of soundings were run 50 meters apart, special attention being given to the character of the bottom.

On June 19 work was resumed on the resurvey of Narragansett Bay. Search for old stations and signal building were begun but the work was interrupted for the purpose of making certain necessary repairs to the vessel.

RHODE ISLAND AND NEW YORK.

[E. F. DICKINS.]

SUMMARY OF RESULTS.—Topography: 1 square mile of area surveyed, 5 miles of general coast line surveyed, 1 topographic sheet finished. Hydrography: 1½ square miles of area covered, 65 miles run while sounding, 747 positions determined, 1,398 soundings made, 1 tidal station established, 1 hydrographic sheet finished.

An officer of the Survey has been engaged during the year on inspection duty for the region included between Narragansett and Delaware Bays. He was temporarily detached in July to make a survey in the vicinity of Hog Island, R. I.

The duties of the inspector are to obtain information for the correction of Charts, Notices to Mariners, and other publications of the Survey; to furnish information in regard to charts, sailing directions, and tides; to receive and ship instruments for the use of field parties; to keep in touch with the maritime public and navigators and to find out their needs.

In July a hydrographic resurvey was made of the channel between Hog Island, Bristol Island, and Rhode Island in Narragansett Bay, including Hog Island Shoal, on which the U. S. S. *Louisiana* had recently grounded, and which was reported to have extended to the southward since the last survey. The shore line of the adjacent portions of the islands was rerun and the whole area sounded over. The results of the resurvey establish the fact that an extension of Hog Island Shoal to the southward has taken place, and in view of this condition recommendation was made that the buoy marking this obstruction be moved to the southern extremity of the shoal.

NEW YORK, NEW JERSEY, AND PENNSYLVANIA.

[C. M. CADE.]

In January determinations were made of the positions of wireless telegraph stations and prominent objects useful as aids to navigation, as follows:

In New York City: Marconi Wireless Station on Wanamaker Building determined by triangulation, Telefunken Wireless Station on tower of Trinity Building determined by triangulation, two towers on Bush Terminal Co.'s Building determined by triangulation, and the former station of the United Wireless Co., at 42 Broadway, determined approximately. In Philadelphia: Two towers on Wanamaker Building determined topographically. In Chester, Pa., a tall chimney below Marcus Hook determined by triangulation.

In Camden, N. J., the United Wireless Station (abandoned) on tall water tank at New York Ship Yards was determined approximately. At Cape May, N. J., the position of the Marconi Wireless Station was determined by triangulation.

NEW YORK, NEW JERSEY, PENNSYLVANIA, DELAWARE, MARYLAND, VIRGINIA, GEORGIA, FLORIDA, ALABAMA, MISSISSIPPI, AND LOUISIANA.

[W. E. PARKER.]

SUMMARY OF RESULTS.—Triangulation: 25 square miles of area covered, 39 stations in supplemental scheme occupied for horizontal measures, 54 geographic positions determined.

Between October 30 and November 9, with the permission of the Bureau of Lighthouses, apparatus for making current observations was installed on eight light vessels between Fire Island Light, off New York Entrance, and Winter Quarter Shoal, off the coast of Virginia. Observers on each of the vessels visited were instructed in the method of making the observations required.

Between January 13 and February 17 the positions of wireless telegraph stations were determined by triangulation at Norfolk and Virginia Beach, Va., Savannah, Ga., and at Jacksonville, Palm Beach, Knights Key, and Tampa, Fla. At Fernandina, Fla., the automatic tide gauge was repaired and the tide staff connected by leveling with bench marks in the town.

Between February 18 and March 15 a trigonometric determination was made of the positions of aids to navigation in Tampa Bay and of such natural and artificial objects on the shores of the bay as may be useful to navigators or to members of the Lighthouse Service in placing buoys.

On March 16 an examination of the Gulf coast was begun in order to obtain data for an Inside Route Pilot of the waters to the westward of Key West, Fla. The coast harbors and inland passages were traversed between Tampa, Fla., and New Orleans, La. The route was covered thoroughly and all places that could be entered safely with the launch, that served to transport the party, were examined.

A second inspection was made of the tide gauge at Fernandina, Fla., which had been accidentally damaged.

Field work was closed on May 8.

NEW JERSEY, PENNSYLVANIA, DELAWARE, VIRGINIA, AND NORTH CAROLINA.

[J. R. BENTON.]

STATIONS OCCUPIED.—*Delaware:* Clayton (or Smyrna), Delaware City, Middletown, Newcastle, and Seaford. *New Jersey:* Berlin, Elmer, Moorestown, Swedesboro, Williamstown, Woodbury, and Woodstown. *North Carolina:* Enfield, Franklinton, Littleton, Raleigh, Wake Forest, and Whitakers. *Pennsylvania:* Avondale (or Kennett Square) and Media.

During the season between August 2 and September 11 and between June 16 and 30 magnetic observations were made at the stations named, all of which were new stations except Seaford, Del., and Raleigh, N. C. The stations were permanently marked. At Swedesboro observations were made over a triangulation station. At Moorestown, N. J., a meridian line was run and temporarily marked.

NEW JERSEY AND PENNSYLVANIA.

[STEHMAN FORNEY.]

SUMMARY OF RESULTS.—Reconnoissance: 14 square miles of area covered, 198 lines of intervisibility determined, 99 points selected for scheme. Triangulation: 14 square miles of area covered, 93 signal poles erected, 78 stations occupied for horizontal measures, 221 geographic positions determined. Topography: 22.75 square miles of area surveyed, 57.5 miles of shore line of rivers, 15.5 miles of shore line of creeks, 1.75 miles of shore line of ponds, 109.25 miles of roads, railroads, and trolley lines, 2 topographic sheets finished. Hydrography: 2 tide stations established.

The survey of the Delaware River from House of Correction, Pa., to Trenton, N. J., which was in progress at the beginning of the fiscal year was completed on February 28. The work done includes the necessary tertiary triangulation and the topography on a scale of 1/40,000, included on two topographic sheets.

Having closed work on the Delaware River this party began a resurvey of Newark Bay, N. J., on March 28.

Three of the triangulation stations used in the triangulation of greater New York were recovered, viz, Bogart, Summerfield M. E. Church, and Bergen Point, and from these a scheme of tertiary triangulation was completed from Bergen Point up Newark Bay into the entrance of the Passaic and Hackensack Rivers. The topographic resurvey at Bergen Point was begun.

DELAWARE, MARYLAND, VIRGINIA, SOUTH CAROLINA, GEORGIA, AND FLORIDA.

[W. C. HODGKINS, Commanding Steamer *Bache*.]

SUMMARY OF RESULTS.—Triangulation: 136 square miles of area covered, 17 signal poles erected, 21 stations occupied for horizontal measures, 15 geographic positions determined. Magnetic work: 4 sea stations at which ship was completely swung. Topography: 43 miles of general coast line surveyed, 3 topographic sheets finished. Hydrography: 3,677 square miles of area sounded, 2,500 miles run while sounding, 5,289 positions determined, 32,795 soundings, 2 tide stations established, 4 hydrographic sheets finished.

On July 1, 1912, the steamer *Bache* was at Brunswick, Ga., engaged in the offshore hydrography needed to supply deficiencies in the charts of the coast from St. Andrew Sound on the south to Sapelo Island on the north with some further work to the northward and eastward off Tybee and Port Royal entrances. The hydrography of that region was continued until August 17, when the *Bache* proceeded to Norfolk, Va., taking soundings between Port Royal and Charleston entrances.

An examination of the vessel at Norfolk showed the necessity for extensive repairs which were made at Boston in September and October.

The next work done by the *Bache* was an examination of the area to the northeastward of Winter Quarter Shoal light vessel, in which dangers were reported to exist. A tide staff was established on Delaware Breakwater and an observer placed in charge. Two floating signals were moored on a line extending northward from the light vessel and with that vessel these were used as signals for locating the positions of the soundings. It was found that the reported dangers

do not exist in the area examined and in question. Work in that region was closed December 7 and the vessel then began an examination at Chesapeake entrance for a shoal lump reported by the Virginia Pilots' Association as existing about 3 miles to the northward and eastward of Cape Henry. The examination of the locality proved that no such shoal exists.

Offshore hydrography was then resumed on the coast of North and South Carolina.

On January 4 the *Bache* proceeded to the Savannah River, where field work was begun by setting up a tide staff at Fort Screven wharf, Tybee Island, and connecting it with the established bench marks.

From that time until March 12 the party was engaged in running lines of soundings generally in an east and west direction and from 2 to 5 miles apart to develop the area off the coast of Georgia, within which few soundings had previously been obtained, although the depths are not great, and lying northward of Sapelo Sound and outside of the belt of closely developed hydrography.

Beginning at points about 5 miles offshore, it was generally found necessary to run lines from 20 to 30 miles long and only occasionally near the eastern end of a line did the depth reach 20 fathoms.

On March 12 the *Bache* sailed from Charleston to the position of the wreck of the British steamship *Lugano*, stranded on Long Reef, Fla., to the southward of Fowey Rocks, and to survey the north end of the Florida Reefs off Miami. The position of the wreck of the *Lugano* was determined on March 15.

The hydrography of the north end of Florida Reefs was completed on May 26 in spite of unfavorable weather conditions. For this work it was necessary to determine by triangulation a few additional stations and to check the positions of some of the beacons which had been destroyed by hurricanes and afterwards rebuilt. The shore line of the outer coast from Cape Florida northward to latitude 25° 50′ was resurveyed by plane table while the hydrography was in progress.

After closing work off Miami the *Bache* at once proceeded to the vicinity of Jupiter Inlet where search was made for reported shoals off that inlet and off St. Lucie Island. The reports of dangers in these localities were found to be erroneous.

The position of a conspicuous stand pipe at Hobe Sound was determined by triangulation.

The regular work of the party on the coast of Georgia and South Carolina was resumed on April 9 and continued until June 14, by which date the hydrography within the limits assigned to the vicinity of the shoals off Cape Romain was completed. Additional work of triangulation in Ossabaw Sound was also done to fix the position of a sea coast signal on the north end of Ossabaw Island.

Work was closed June 15 and the vessel proceeded to Boston for repairs.

MARYLAND.

[GEORGE HARTNELL and SAMUEL G. TOWNSEND.]

At the magnetic observatory at Cheltenham, Md., the recording instruments were kept in continuous operation throughout the year. The absolute observations for declination, horizontal intensity, and

dip were made as usual. Time from sun observations was taken at convenient intervals. Special observations were made for determining the moment of inertia of magnetic No. 26 for the comparison of earth inductors, to determine effect of adjustment, and to place the inductor in the meridian.

The seismograph was in continuous operation except for a delay of a few days for clock repairs. Some necessary repairs were made to the observatory buildings.

VIRGINIA.

[O. W. FERGUSON, Commanding Schooner *Matchless*.]

SUMMARY OF RESULTS.—Reconnoissance: 55 square miles of area covered, 405 lines of intervisibility determined, 155 points selected for scheme. Base lines: 3, secondary, measured. Triangulation: 55 square miles of area covered, 154 signal piles erected, 74 observing scaffolds and tripods built (with an average height of 6 feet), 162 stations occupied for horizontal measures, 8 old stations of United States Engineers recovered, 162 geographic positions determined. Leveling: 22 elevations determined by leveling, 17.7 miles of levels run. Azimuth: 1 station occupied for observations of azimuth on 1 night. Topography: 61.5 square miles of area surveyed, 118.3 miles of shore line of rivers, 76.4 miles of creeks, 134.2 miles of roads and railroads, 4 topographic sheets finished. Hydrography: 16.3 square miles of area sounded, 331.9 miles run while sounding, 3,063 positions determined, 14,867 soundings, 10 tide stations established, 5 current stations occupied, 5 hydrographic sheets finished.

During the first half of the fiscal year, after the completion of repairs to the vessel at Baltimore, the schooner *Matchless* was employed on the survey of the Pamunkey River, Va., this work including triangulation, topography, and hydrography.

The triangulation was begun a few miles above Westpoint at stations Creek and Gas and carried to Northbury Landing. Above Northbury Landing a meander line was run to 5 miles above New Castle at the head of navigation.

Points for the topography were located by sextant angles where, on account of the dense undergrowth, the plane table could not be used. The limits of marsh and high ground were located; also all roads, railroads, creeks, sloughs, fences, and buildings near the river. The topography was completed to the limits of the survey.

The hydrography of the river was completed to the head of the survey 5 miles above New Castle, all important features being thoroughly developed.

Tide observations were made at Gloucester Point, Morgans Wharf, Westpoint, Lester Manor, White House, New Castle, and Carters Landing, Northbury Landing, and tidal bench marks were established.

Current observations were made on three days.

Magnetic declination was observed at four stations, viz, Westpoint, Lester Manor, Northbury Landing, at a station above New Castle Bridge, and at another below that bridge.

The survey of the Pamunkey River was afterwards completed to the head of navigation 57 miles above Westpoint.

Some levels were run in Richmond to connect the tidal bench marks with a permanent bench mark of the Coast and Geodetic Survey.

The hydrographic survey of the south branch of Elizabeth River, Va., from the naval magazine to the Chesapeake and Albemarle Canal lock was the next work undertaken. This survey was completed by April 5. In the course of this work a line of levels 12 miles in length was run to connect the various tidal bench marks in this locality, and tide observations were made during the progress of the survey.

The survey of the eastern branch of Elizabeth River, including the triangulation, topography, and hydrography, was nearly completed at the close of the year.

The hydrographic survey was carried into all creeks available for boat navigation.

Field work was temporarily suspended in June and the *Matchless* was taken to Baltimore for repairs.

VIRGINIA AND NORTH CAROLINA.

[H. C. GRAVES, Commanding Steamer *Hydrographer.*]

SUMMARY OF RESULTS.—Triangulation: 2 stations occupied for horizontal measures. Magnetic work: 5 sea stations occupied for magnetic declination. Topography: 1 square mile of area covered, 9.25 miles of general coast line run. Hydrography: 1,689 soundings made.

From July 1 to August 13 the party on the steamer *Hydrographer* was engaged in coast pilot work on the coasts of North Carolina and Virginia for the revision of Coast Pilot, Part VII, from Cape Henry to Key West. Hydrographic examinations were made at Winyah Bay, Cape Fear River, Beaufort Harbor, and the intervening coast. A topographic and hydrographic survey was made of Lookout Bight, N. C. Coast pilot work was done on the sounds and tributaries between Beaufort, N. C., and Norfolk, Va. Three uncharted shoals were located and a number of lighthouses and buoys in these waters were determined in position.

The ship was swung at 32 headings to determine compass deviation at 5 points along the coast.

VIRGINIA, KENTUCKY, TENNESSEE, AND ARKANSAS.

[DON C. SOWERS.]

STATIONS OCCUPIED.—*Arkansas:* Arkadelphia, Arkansas City, Ashdown, Brinkley, Eldorado, Fordyce, Hamburg, Hampton, Hot Springs, Lake City, Lewisville, Magnolia, Malvern, Nashville, Prescott, Stuttgart, Varner, and Washington. *Kentucky:* Albany, Alexandria, Bedford, Burkesville, Burlington, Carrollton, Falmouth, Greenup, Hodgenville, Independence, Maysville, Morgantown, Mount Olivet, Mount Vernon, Newcastle, Nicholasville, Tompkinsville, Vanceburg, Warsaw, Williamsburg, and Winchester. *Tennessee:* Byrdstown, Carthage, Celina, Dover, Gainesboro, Humboldt, Lebanon, Livingston, and Sneedville. *Virginia:* Gloucester, Heathville, Independence, Isle of Wight, King William, King and Queen, Lancaster, Lynchburg, Mathews, Montross, Saluda, Tappahannock, and Warsaw.

Between July 1 and November 30 magnetic observations were made at the above-named stations in Arkansas, Kentucky, Virginia, and Tennessee.

Five old stations were occupied. All but six of the stations occupied were marked by stone posts with brass plates set in the top. A

few were lettered U. S. C. & G. S. 1912. In most cases the posts were set so as to project 2 or 3 inches above the surface of the ground.

The average cost per station, including the observer's salary, was $24.75.

NORTH CAROLINA.

[H. A. SEBAN.]

Under instructions dated February 6 determinations were made by triangulation of the positions of 13 permanent beacons or range lights on Cape Fear River from the mouth of the river to Reeves Point.

A scheme of triangulation was carried up Cape Fear River as far as Reeves Point. In this scheme the stations established and marked by the Corps of Engineers, United States Army, were used whenever practicable. Two new stations were established.

The position of the wreck of the *Condor* off Carolina Shoal Beach was determined, and various changes in topographic details were noted for the correction of the charts.

Information concerning tidal bench marks was obtained from the United States Engineers' office at Wilmington. A blue print showing the route of the Wilmington, Brunswick & Southern R. R. from Navassa to Southport was furnished by Mr. Z. W. Whitehead of Wilmington, N. C., the builder of the road. The position of the shore end of the 300-foot terminal dock at Southport under construction by that road was determined.

GEORGIA.

[R. R. LUKENS.]

The location of aids to navigation from Warsaw Sound northward was begun February 12. A reconnoissance was made, old stations recovered, and signals erected and the occupation of stations begun by February 24. This work was completed and the revision of the triangulation of the upper Savannah River begun on March 10.

The old triangulation station on Fort Oglethorpe was not recovered. A new station was established close to the old location. The line "Proctor" to "R. R. Draw" was used as a base, and a scheme laid out to connect with the wireless tower at Savannah and also with several stations established by the Corps of Engineers, United States Army. Signals were erected and five stations were occupied when work was closed in accordance with instructions.

Two beacons were erected at the mouth of Warsaw Sound for use by the officers of the Bureau of Lighthouses in determining the positions of buoys off the sound.

The positions of the new lights at the mouth of the Savannah River were determined.

GEORGIA AND FLORIDA.

[C. M. CADE.]

SUMMARY OF RESULTS.—Base lines: 1 secondary traverse 3 miles in length measured. Triangulation: 10 signal poles erected, 6 permanent beacons erected, 1 observing tripod and scaffold built and 4 repaired (average height 16 feet), 51 stations in main scheme occupied for horizontal measures, 72 geographic positions determined.

Between February 10 and May 31 the geographic positions of a number of aids to navigation and permanent objects on the shores of the St. Johns River were determined, using the triangulation of the United States Engineers, as adjusted to the datum of the Coast and Geodetic Survey. A hired launch was used for the transportation of the party. Many of the old stations were found standing, so that little signal building was required. In all, there were determined in position 32 pile lights and day marks, 14 permanent structures carrying lights, and 13 objects on shore, such as water tanks, chimneys, houses, etc., that will probably be available for many years.

The stations along the St. Johns River were marked by iron pipes driven into the ground.

After the completion of this work the determination of positions of aids to navigation and prominent objects in St. Catherines Sound, Ga., was undertaken. For buoy work off St. Catherines three large tripod signals, built by the steamer *Bache*, were determined in position by means of a traverse line 3 miles in length.

The next work undertaken was the determination of points for Sapelo Bar. An old station of the Coast and Geodetic Survey was recovered and marked close to a signal erected by the party on the steamer *Bache* to serve as the northern object. The quarantine station off the north end of Blackbeard Island, or a signal erected by the *Bache* on the northeast point, is available for use as the center object. A third signal 2.25 miles to the southward was erected and determined.

St. Andrews Sound was the next point visited. Here two signals were built and determined for use in locating buoys, Little Cumberland Island Lighthouse forming the third point. Four three-pile day marks in the sound were also determined.

At St. Simons Sound use was made of two signals of the United States Engineers. On Jekyl Island a signal which had been used as a transit station was boarded up, concreted, and marked for use in locating buoys on the bar. St. Simons Light may be used as the center object. A new signal was built and determined on the south point of Postells Creek on St. Simons Island, and three lights in St. Simons Sound were determined.

GEORGIA, ALABAMA, MISSISSIPPI, AND ARIZONA.

[OSCAR H. GAARDEN.]

STATIONS OCCUPIED.—*Alabama:* Eutaw,* Haynesville,* Mobile,* and Prattsville.* *Arizona:* Tucson. *Georgia:* Dawson,* Georgetown,* and Vienna. *Mississippi:* Collins,* Hattiesburg,* Lucedale,* New Augusta,* Paulding, and Raleigh.*

Between July 1 and August 12 magnetic observations were made at the stations mentioned by the observer named. Meridian lines were established at the stations marked with asterisks.

From August 12 to November 1 Mr. Gaarden was at the magnetic observatory at Tucson, Ariz., engaged in bringing up to date the accumulated records and in instructing in his duties the new observer placed in charge of that observatory.

LOUISIANA.

[J. H. PETERS.]

SUMMARY OF RESULTS.—Triangulation: 692 square miles of area covered, 32 signal poles erected, 29 observing tripods and scaffolds built, 33 stations occupied for horizontal measures, 8 stations occupied for vertical measures, 106 geographic positions determined, 5 elevations determined trigonometrically. In January the positions of 5 radio stations along the Gulf coast were determined by triangulation.

Between February 26 and May 30 a revision was made of the triangulation of Atchafalaya, Cote Blanche, and Vermilion Bays and to determine the geographic position of Timbalier Light.

Owing to the impracticability of recovering a sufficient number of the old points it was found necessary to lay out an entirely new scheme of triangulation throughout this region.

Beginning with the line "S. W. Reef"—"Belle Isle 1999," with "Deer Island 1855" reference mark as the third point the triangulation was extended eastward one figure to Point Au Fer and thence westward seven figures through Atchafayala, East Cote Blanche, West Cote Blanche, and Vermilion Bays to Southwest Pass and the mouth of the Vermilion River. Ten supplementary figures were constructed to control the small bays and bayous adjacent to the main scheme.

Of the previous triangulation only one station, in addition to the three previously mentioned, was recovered and in that case the station mark had been moved so as to make its precise original location uncertain. This was station Cote Blanche 2, 1890.

It was necessary to build tripods of an average height of 20 feet at every station in the scheme at which observations were taken. Stations and reference points located in marshy ground were marked by piles driven in the ground and capped with a drain pipe and the intervening space filled with cement. A brass disk was placed to indicate the center of the station. The mark extends about 2 feet above the ground.

During the progress of the work connection was made with stations established by the Corps of Engineers, United States Army, and with those of a private survey adjacent to Atchafalaya Bay.

Most of the old triangulation stations were found to have been destroyed by the receding of the shore line.

Thirteen stations are known to have been destroyed, 5 others were searched for but not found, 17 new stations were established in the main scheme, 15 supplementary stations were established and 70 additional geographic positions were determined.

The positions of several aids to navigation were determined and notes were furnished in regard to changes in shore line and depths for use in correcting the charts of the localities covered.

TEXAS.

[E. H. PAGENHART.]

During the period between February 6 and May 6 a scheme of tertiary triangulation was completed between Isabel, Tex., and Baffins Bay, Tex.

In this work as many of the old stations as practicable were recovered and marked, new stations supplementary to the old work were established where necessary to reach all parts of the area covered, and to connect with the stations established in 1912 south of Baffins Bay. A small scheme was carried from old stations in the vicinity of Isabel north along the mainland and the off-lying islands as far as triangulation station Avoca 2. From this point the scheme spans the Laguna, which is about 5 miles wide, and extends northward to a connection with stations Salt Murdock, Griffin 2, and Shells 2 (Trueblood, 1912).

Work was next begun in Topo Bay and the observing was carried up the mainland to station Salt and thence down Padre Island to the station Nouvest. An extra station, New, was established to strengthen the scheme. Old station Avoca was not recovered and Avoca 2 marked by the 1912 party was used. The old stations recovered were Cameron, Fox, Colorado, Rifle, Lomalto, and Topo. Of these, Cameron and Topo had been remarked in 1905. The others were remarked. The old stations known to have been destroyed are Snipe, Armadillo, Cat, Pelican, Bonnet, Coyote, Black Hill, and probably Avoca and Indian. The new stations, Nouvest, Buoy, Gun, and Gap, established on Padre Island were marked only by timbers or planks set about 4 feet in the sand and projecting about 3 feet.

TEXAS, MISSOURI, AND OKLAHOMA.

[FRANK NEUMANN.]

STATIONS OCCUPIED.—*Missouri:* Charleston,* Doniphan, Hillsboro, New Madrid, St. Louis, Springfield,* and Waynesville. *Oklahoma:* Altus,* Durant,* Frederick, Hobart, Hugo. Idabel, Madill, Mangum, Mountain Park, Norman, Pauls Valley, Sulphur, Taloga, and Vinita. *Texas:* Angleton, Austin, Bay City, Bastrop, Beeville,* Brenham, Brownwood, Bryan, Burnet,* Cold Spring,* Comanche, Columbus,* Floresville, Giddings,* Glen Rose,* Goldthwaite, Hamilton,* Hemphill,* Huntsville,* Kountze, Linden,* Lockhart, Newton, Rockwall,* Refugio, Richmond, San Augustine, Seguin, Sinton, and Woodville.*

The foregoing magnetic stations were occupied during the period from July 1 to November 15.

Meridian lines were established at the stations marked with asterisks.

At each station a complete set of magnetic observations were made and the latitude and longitude determined approximately.

Charleston and Springfield, Mo.; Pauls Valley, Mangum, and Vinita, Okla.; and Austin and Beeville in Texas, were repeat stations.

INTERIOR STATES.

MONTANA, NORTH DAKOTA, SOUTH DAKOTA, AND WYOMING.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 50 miles, 650 square miles of area covered, 19 lines of intervisibility determined, 44 points selected for scheme. Base lines, primary, length of, 10,600 meters. Triangulation: 8,158 square miles of area covered, 40 signal poles erected, 10 observing signals and scaffolds built (heights from 8 to 60 feet), 80 stations in main

scheme and 8 in supplemental scheme occupied for horizontal measures, 56 stations occupied for vertical measures, 99 geographic positions determined, 63 elevations determined trigonometrically. These statistics include some work done in the spring of 1912.

The party engaged on the triangulation along the one hundred and fourth meridian from the Canadian boundary to the Black Hills had completed the section from North East Base to Marmon, a distance of about 40 miles, by June 30, 1912. During this period the Ambrose Base was measured and 12 stations, two of which were azimuth stations, were occupied.

The remaining portion of the triangulation, from Marmon to station Laird, a distance of 290 miles, was continued between July 1 and December 3 to a junction at the figure Crow-Cambria-Alkali-Inyankara-Laird, with the triangulation by party working northward from the thirty-ninth parallel, in Colorado.

Azimuth observations were made at 7 stations, and the position of the Bowman longitude station was determined. Connection with other surveys was made at eight points.

Most of the triangulation stations were occupied at night.

Double-zenith distances were measured over all lines in the main scheme, with one exception. Nonreciprocal observations were made over three lines.

COLORADO, MONTANA, NEBRASKA, NORTH DAKOTA, SOUTH DAKOTA, AND WYOMING.

[GEORGE D. COWIE and HARRY A. SERAN.]

SUMMARY OF RESULTS.—Longitude: 5 longitude stations occupied.

Between August 29 and November 10 two cooperating parties determined the difference of longitude between Omaha, Nebr., and the following places: Mondak, Mont., Bowman, N. Dak., Provo, S. Dak., Wheatland, Wyo., and Watkins, Colo. The Coast and Geodetic Survey longitude station of 1907 on the Omaha High School grounds was used and it was connected by triangulation with the 1869 to 1882 land survey station, the new Omaha Hill School, and with prominent landmarks in the vicinity.

COLORADO, WYOMING, SOUTH DAKOTA, AND TEXAS.

[C. V. HODGSON.]

SUMMARY OF RESULTS.—Reconnoissance: 16 lines of intervisibility determined, 4 points selected for scheme, base lines; primary, length of, 14,559 meters. Triangulation: 10,505 square miles of area covered, 77 stations in main scheme and 12 in supplemental scheme occupied for horizontal measures, 79 stations occupied for vertical measures, 142 geographic positions determined, 142 elevations determined trigonometrically. Leveling: 9 miles of levels run. Latitude, longitude, and azimuth work: 1 station for determination of longitude by exchange of telegraphic signals occupied on 3 nights, 11 stations occupied for observations of azimuth, on 14 nights. These statistics include work done in May and June, 1912.

At the beginning of the fiscal year the triangulation along the southern part of the one hundred and fourth meridian arc from the thirty-ninth parallel near Colorado Springs, Colo., to the Canadian

boundary had been extended southward from Guernsey, Wyo., to Cheyenne, Wyo. Work was continued after that date until its final completion on November 23. The weather conditions during the greater part of the season were unfavorable for rapid progress. Fog in the mountains and haze and smoke in the valleys greatly lessened the time available for observing.

At the south end of the work two of the reconnoissance lines were found to be obstructed, necessitating a change in the figures and a reconnoissance for new stations. The first entailed the reconnoissance for and occupation of one new station (Russell) and the reoccupation of one station for the new lines; but the second obstructed line, that from Morrison to Bison, made necessary the breaking up of the southernmost quadrilateral and a three-sided central-point figure, the establishment of three new stations, the reoccupation of two stations for new lines, and the substitution of the line Pikes Peak-Divide for the line Pikes Peak-Bison as a line common to the previous primary triangulation and the one hundred and fourth meridian work.

A second observing party under Mr. C. M. Cade was organized for work at the north end of the scheme, without waiting for the completion of the work at the southern end. Observing at the north end was not completed until October 4.

During the period from October 1 to 8 a primary base line was measured at Provo, S. Dak., and azimuth was observed on two nights. From that time until the close of the season two separate observing parties were maintained.

On November 14 a junction was effected with the work of the party under Assistant E. H. Pagenhart working between the Canadian boundary and Guernsey, Wyo., the last stations occupied by the southern party being Crow and Cambria. Four stations near Cheyenne were reoccupied between November 20 and 23.

Primary azimuths were measured during the season at stations Ragged, Twin, Dewey, Boulder, Willow, Watkins, and Provo.

Between February 24 and June 1 a primary triangulation was made from Alice, Tex., to the Rio Grande and along the Rio Grande from the ninety-eighth meridian to Point Isabel. Connection was made with four reference points of the survey by the United States and Mexican Boundary Commission, but on account of disturbed conditions in Mexico the connection with the triangulation along the ninety-eighth meridian by the Mexican Geodetic Commission was not completed.

During the period mentioned 34 primary stations were occupied and 3 azimuths were measured, or an average of more than 12 stations per month. During the month of April 15 stations were occupied.

The reconnoissance for this work was executed and the signals erected by a separate party.

This triangulation is 150 miles in length and covers approximately 1,300 square miles.

Notwithstanding the fact that the climatic and other conditions were most favorable for rapid progress the completion of so extensive a scheme of triangulation in so short a time is worthy of remark as an achievement probably never before equaled in work of this character.

On the completion of the necessary observations in the triangulation a determination was made of the telegraphic longitude at triangulation station Donna (Texas), using Austin as a base station. Mr. George D. Cowie cooperated in this work. Signals were exchanged on the nights of May 30, May 31, and June 1 with satisfactory results, and work was closed for the season.

COLORADO, NORTH DAKOTA, SOUTH DAKOTA, TEXAS, AND WYOMING.

[J. S. BILBY.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 175 miles, 1,450 square miles of area covered, 80 lines of intervisibility determined, 36 points selected for main and 4 for supplemental scheme. Base lines: 1 (14,600 meters in length) prepared for measurement. Triangulation: 42 signal poles erected, 34 observing tripods and scaffolds built with average height of 43.02 feet, and 40 with heights from 4 to 60 feet; 24 superstructures, average height 24 feet; 2 light stands, average height 10 feet.

The two parties organized in April, 1912, to build the signals and prepare for the observing parties the stations located by reconnoissance during the season of 1911 between the thirty-ninth parallel in the vicinity of Colorado Springs and the Canadian border, had made the following progress by June 30. The northern party had reached Sentinel Butte, N. Dak., and had prepared a base-line site and assisted in measuring the base at Ambrose, N. Dak. During the same period the southern party had completed signal building from Manville, Wyo., southward to the vicinity of Colorado Springs.

Work was continued after July 1 and by August 28 all of the stations had been prepared and the Provo base made ready for tape measurement. Stands or signals were built at 40 stations and each station marked.

From September 1 to the close of the season in November the signal-building party cooperated with one of the parties engaged in triangulation so as to permit the maintenance of a double observing party. This work is noticed under another head.

Between January 11 and June 10 a reconnoissance was made for a primary triangulation to extend from the vicinity of Alice, Tex., to the Rio Grande opposite the northern end of the scheme of triangulation extended along the ninety-eighth meridian by the Mexican Government, and also for a primary triangulation extending down the Rio Grande from the approximate location of the ninety-eighth meridian to Point Isabel, Tex. At the latter point provision was made for a connection with the primary triangulation in the vicinity of Point Isabel. The necessary signals were erected for the use of observing parties, and provision made for a connection with the scheme of triangulation, and also with four monuments of the topographic survey of the Rio Grande made by the International Boundary Commission, United States and Mexico.

The line Alice West Base-Wood with East Base as the third point was selected as the base from which to start the work, and the scheme follows generally the line of the railroad to the Rio Grande and Point Isabel. At the latter place connections were made with West Base-Arista, East Base being used for the third point. Unsettled conditions in Mexico prevented the connection with the triangulation

along the ninety-eighth meridian done by the Geodetic Commission of Mexico.

The signal building was conducted by a subparty during the progress of the reconnoissance and afterwards by the full party. An observatory was built at Point Isabel longitude station.

TEXAS.

[WILLIAM BOWIE.]

In April the inspector of geodetic work proceeded to Texas for the purpose of inspecting the work of several triangulation parties operating in that State. Owing to unsettled conditions in Mexico the connection between the systems of triangulation by the Coast and Geodetic Survey in the United States and that executed by the Mexican Geodetic Commission was not completed, but such preliminary arrangements for that purpose as were possible were made. The several triangulation parties and the signal building parties were visited and their work found to be in satisfactory condition.

COLORADO, IOWA, KANSAS, MISSOURI, NEBRASKA, AND SOUTH DAKOTA.

[H. E. MCCOMB.]

STATIONS OCCUPIED.—*Colorado:* Central City, Golden, and Greeley. *Iowa:* Adel, Clarion, Des Moines, Estherville,* Forest City,* Humboldt (for Dakota City), Orange City, Rock Rapids, Sibley, and Toledo.* *Kansas:* Leavenworth. *Missouri:* Grant City, Independence, Liberty, Oregon, Platte City, Richmond, Rockport, Savannah,* and St. Joseph. *Nebraska:* Beaver City, Lincoln, Madison, Nebraska City, and Trenton. *South Dakota:* Elk Point, Fairfax,* and Yankton.

Magnetic observations were made at the stations named between July 1 and September 14 and between June 14 and June 30. Meridian lines were established at the stations indicated by asterisks. The stations were marked with stone posts marked with brass plates and sunk level with the ground.

Old magnetic stations were occupied at Nebraska City, Nebr., Des Moines and Sibley, Iowa, and Yankton, S. Dak.

Local surveyors displayed much interest in the work and requested copies of the observations.

NEVADA.

[JOHN H. PETERS.]

By July 1, 1912, the line of precise leveling eastward from San Francisco, Cal., had been extended to summit of the Sierra Nevada Mountains, a distance of 266 miles, leaving 323 miles to be completed in order to make the necessary connection at Beowawe, Nev. The work was continued eastward to Marmol, Washoe County, Nev., a station on the Southern Pacific Railway near the eastern point of the grade going into the mountains. This point was reached on July 13, 1912. The party then proceeded to the eastern end of the uncompleted portion of the line, and work was resumed at Beowawe, Nev.,

working westward, along the Southern Pacific Railway to Marmol, which point was reached on October 25, 1912.

Connection was made during the progress of the work with such bench marks of other surveys as could be conveniently reached. The permanent bench marks used were of two types, viz, first a brass disk bench mark set in permanent existing structures of concrete or masonry, and second a stone post 6 feet long and 6 by 4 inches in its other dimensions, set in the ground and with 4 to 6 inches of its top projecting above ground. The usual brass disk was set with cement in the top of this stone with the top surface of the disk flush with the top of the stone.

Along the portion of the line between San Francisco and Sacramento the average distance between bench marks was 2.2 miles. Over the remainder of the line it was 3.6 miles.

A motor velocipede car and a hand car were used for the transportation of the party.

From experience gained in this work it is concluded that the larger percentage of nonchecks on steep grades is due to atmospheric refraction caused by inequalities in temperature and that a very small percentage is due to the inclined footing of the rods.

ARIZONA.

[A. F. BEAL, O. H. GAARDEN, and LLOYD W. WEED.]

Work at the magnetic observatory at Tucson, Ariz., was continued under the direction of Mr. L. W. Weed until September 18, when the charge of the observatory was transferred to Mr. A. F. Beal. Mr. A. H. Gaarden was attached to the observatory from August 12 to November 1, and aided in instructing the new observer.

The usual absolute determinations of declination and intensity were made, scale values determined, and meteorological observations recorded twice a day. The usual Weather Bureau reports were made daily. The magnetograph was kept in operation with but slight interruption, and a continuous record with the seismograph has been maintained.

Disturbances were recorded and special rapid-rate observations with the magnetograph were taken on certain term days.

Time observations were taken with the sextant and these were checked at various times by telephonic time signals and by observations of star transits. A meridian line 1,027.24 feet in length was established.

PACIFIC COAST.

WASHINGTON.

[R. B. DERICKSON, Commanding Steamer *Gedney*.]

In November a detailed topographic and hydrographic survey was made at Tacoma, Wash., of the Milwaukee railroad docks and ships, the mouth of the Puyallup River, and the St. Paul Lumber Co.'s dock. This survey extended out to about the 20-fathom curve in Commencement Bay. A new light and a fog signal were located. The tidal bench marks established in this work were connected by leveling with

the city bench marks. At Olympia, Wash., a survey was made of the water front and of the shoal waters at the head of Budd Inlet. Tides were observed and the elevation of bench marks determined. Four old triangulation stations were recovered and marked. The positions of several new wharves between Olympia and Seattle were determined and soundings were made alongside the wharves.

[F. H. HARDY.]

In March the positions of the wireless telegraph station at Friday Harbor, San Juan Island, Wash., were determined.

[H. A. SERAN.]

Between May 27 and the close of June revision work for the correction of the existing surveys of Puget Sound, Wash., was in progress. This work includes determinations of the positions of wharves and prominent buildings in and around the principal ports.

A resurvey of Semiahmoo Peninsula was made and the new wharves and prominent buildings in Bellingham were determined. The water front of Anacortes and the shore line of the southern end of Guernes Island were rerun. The wharves at Coupeville were located and a resurvey was made of Neah Bay, the new wharves at Port Angeles and Ediz Hook were determined, a resurvey was made of Point Wilson and arrangements were made to obtain copies of surveys by the Corps of Engineers, United States Army, of Admiralty Head and Marrowstone Point.

All of the resurveys and determinations mentioned were made with the plane-table. Sufficient shore line was run to enable the features determined to be transferred to the original sheets.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Reconnoissance: 300 square miles of area covered, 19 lines of intervisibility determined, 6 points selected for scheme, 1 signal pole erected, and 3 observing tripods and scaffolds built.

In the spring of 1913 instructions were issued for a triangulation connecting the survey of the Strait of Fuca with the triangulation in the vicinity of Grays Harbor, stations to be established along the coast at intervals of about 10 miles.

Reconnoissance was begun from stations Vancouver, Arched Rock, and Slip of the triangulation of Fuca Strait and by June 30 was extended south through six stations to the Quillayute River. Signal building was carried on by a separate construction party. Four stations were prepared. On heavily wooded peaks the stations were built above the trees instead of cutting lanes to clear the lines of sight. Pack animals were used to transport the party outfit, and a launch was used along the coast.

OREGON.

[EDGAR E. SMITH.]

In February the geographic positions of wireless telegraph stations at Portland and Astoria, Oreg., were determined by triangulation. At

Portland two new triangulation stations were established and two old ones recovered. The towers of the Federal Wireless Telegraph Co. in Lents and those of the Young Men's Christian Association in Portland were determined.

In Astoria three triangulation stations were occupied. The positions of the towers of the Marconi Wireless Telegraph Co. at Astoria and of the Navy wireless station at North Head were determined.

[E. B. LATHAM.]

On April 28 work was begun on the determination of the geographic positions of aids to navigation and prominent objects along the Columbia River. In this work the triangulation stations established by the Corps of Engineers, United States Army, were utilized. Transportation for the party was furnished by the commanding officer at Fort Stevens. Similar facilities were offered by the lighthouse inspector of the district.

It was found impracticable to recover or use the triangulation stations previously determined by the Coast and Geodetic Survey.

Observations for determining the positions of all lights from the entrance of the river to stations Cathlamet and Bugby-Hole Light were made by the end of June.

CALIFORNIA.

[F. WESTDAHL.]

The work of the San Francisco suboffice includes correspondence relating to matters of interest to the survey on the Pacific coast, attending to the forwarding of instruments and supplies sent from the office at Washington, making arrangements for the transportation of officers traveling to or from Pacific coast points or the Philippine Islands, furnishing information concerning charts and publications, and other miscellaneous duties.

A resurvey of the immigration station on Angel Island, San Francisco Bay, was made by Mr. O. J. Bond, jr. The work done consisted in the mapping of improvements such as houses, roads, and wharves and releveling over the portions where grading had been done.

Mr. Bond also determined by triangulation the positions of two towers, suspending an electric power cable over the entrance to Oakland Harbor, and of a new wharf in Monterey Bay.

The position of the Marconi wireless tower at Marshfield, Oreg., was determined by the officer in charge of the suboffice.

Information relative to the coasts of California and Oregon for insertion in a new edition of the table of depths for channels and harbors was gathered.

The construction of a whaleboat for use by a survey party in the Hawaiian Islands was ordered and the boat when completed was inspected and forwarded.

Tidal observations with an automatic gauge at Sausalito were continued during the year.

[FREMONT MORSE.]

SUMMARY OF RESULTS.—Reconnoissance: 29.8 square miles of area covered, 61 lines of intervisibility determined, 17 points selected for scheme. Triangula-

tion: 29.8 square miles of area covered, 10 signal poles erected, 33 stations occupied for horizontal measures (16 topographically), 33 geographic positions determined (13 topographically).

In January and February determinations were made either trigonometrically or by topographic methods of the positions of wireless telegraph towers as follows: Eureka (two towers), Sacramento, San Francisco (two Marconi towers), San Francisco (two Federal towers), San Luis Obispo, East San Pedro, Avalon, Los Angeles (two towers), and San Diego.

The position of a new lighthouse established at the end of San Pedro Breakwater was determined by triangulation.

ALASKA.

[F. L. ADAMS.]

The magnetic observatory at Sitka, Alaska, continued in operation throughout the year.

The Eschenhagen magnetograph and the Bosch-Omari siesmographs made continuous records and the required absolute observations, scale-value determinations, and daily meteorological observations were made.

Special rapid-rate registration was carried out on specified term days in each month in accordance with requests for international cooperation.

The observatories and instruments are in good condition.

Fourteen earthquakes were recorded between July 1 and December 31 and 13 between January 1 and June 30. There were few magnetic disturbances in this period.

[R. M. PATTON, Commanding Steamer *Explorer*.]

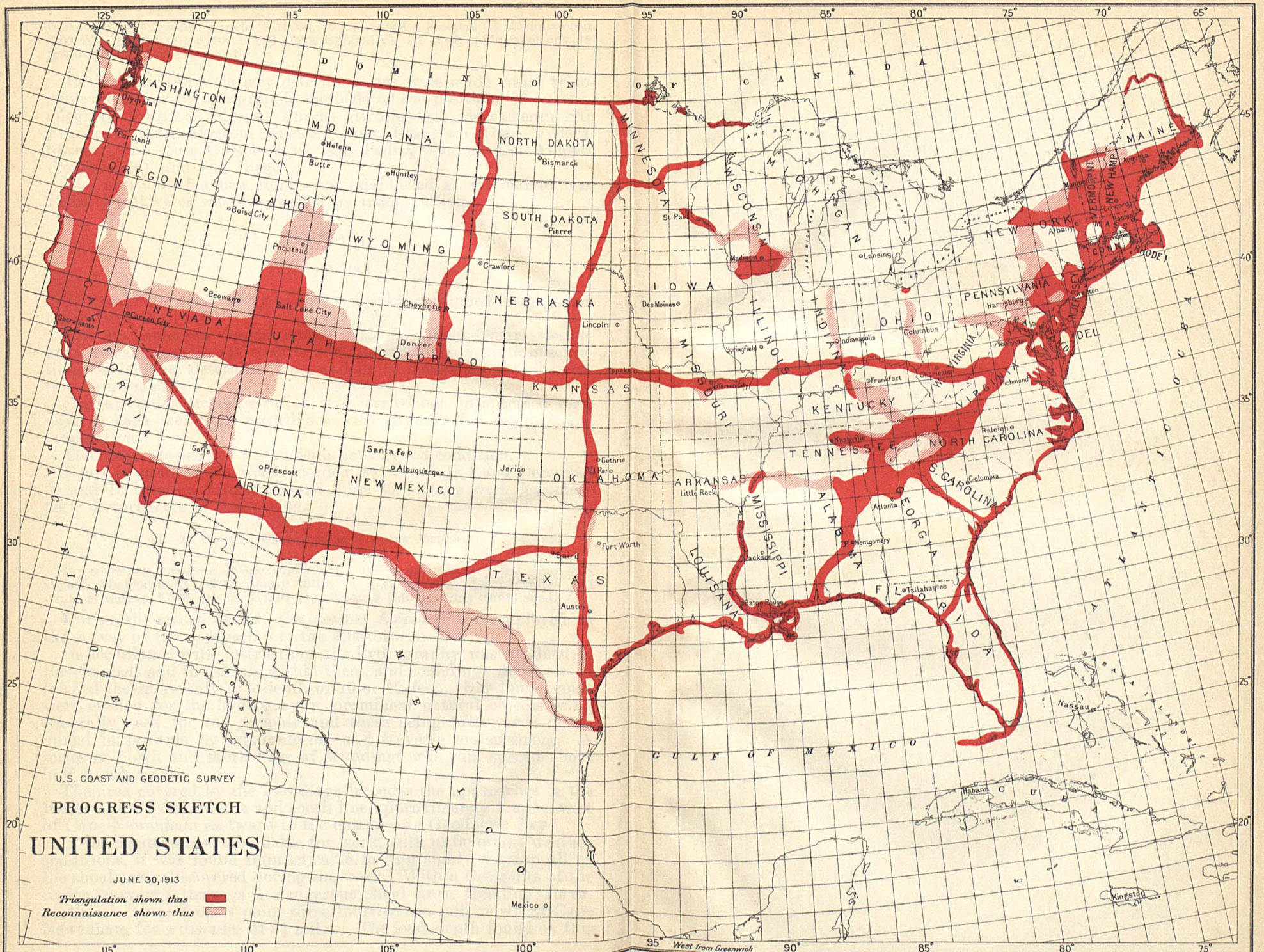
SUMMARY OF RESULTS.—Topography: 87.7 miles of general coast line surveyed. Hydrography: 356½ square miles of area covered, 1,444.7 miles run while sounding, 5,776 angles, 17,119 soundings, 4 tide stations established.

During the season of 1912 the steamer *Explorer* was employed on the survey of the approaches to the Kuskokwim River.

In accordance with instructions the hydrography was confined to the channels and the shoals within them, and soundings were carried toward the shore only to a depth of 10 or 12 feet. But four signals were erected for the hydrography, prominent natural objects being generally used for the purpose and these being afterwards determined in position by triangulation and traverse measurement. A series of north and south lines of soundings was run, spaced about half a mile apart.

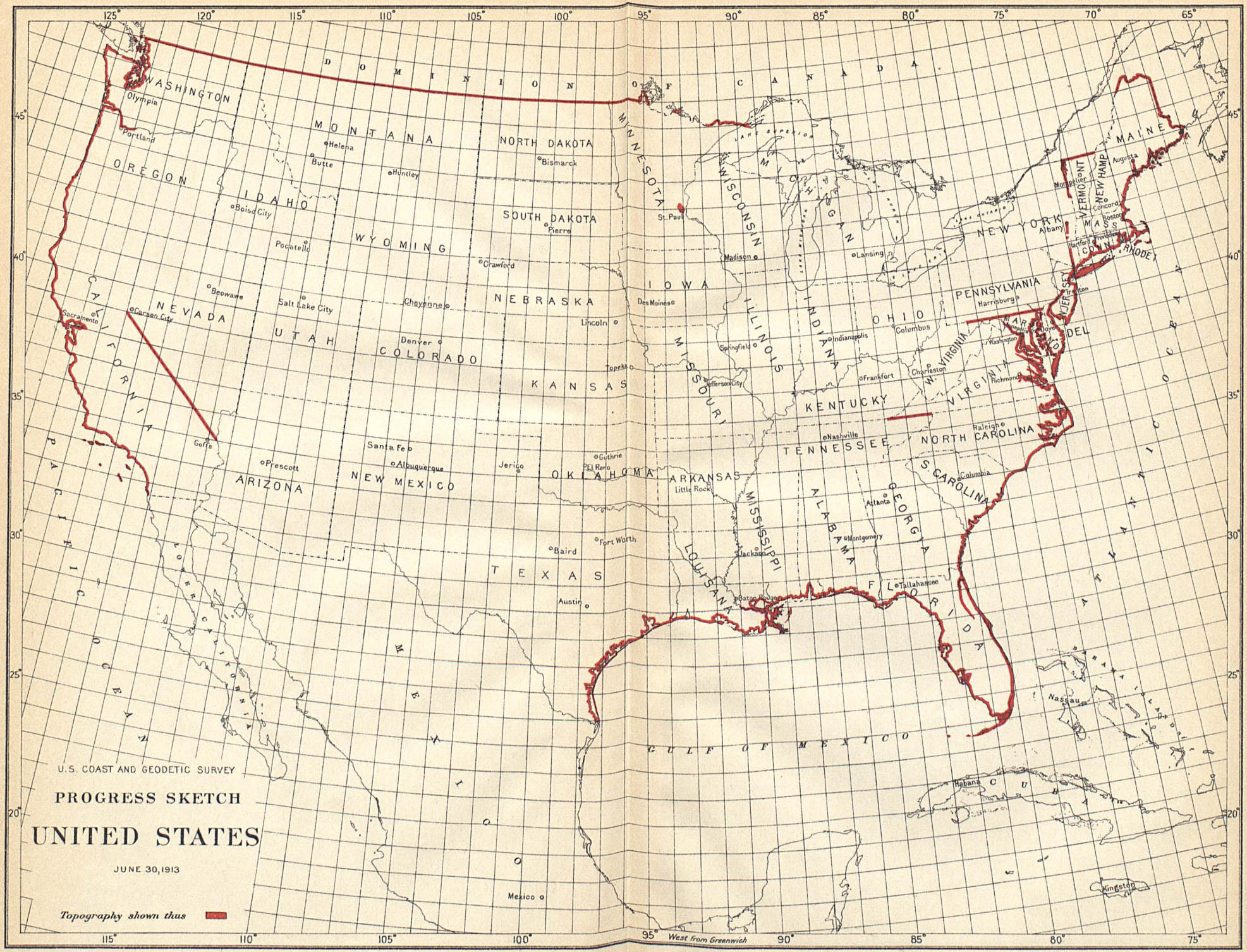
The area covered by the soundings includes the approaches to the Kuskokwim from a north and south line approximately 5 miles west of Cape Newenham eastward to the entrance to Goodnews Bay.

In the limited season available for work, with unfavorable weather conditions, it was found impracticable to thoroughly develop all of the shoal areas discovered during the work. Within the limits of the region surveyed there is a dangerous shoal area, trending north-northeast (true) from a point three-fourths of a mile north of Cape Newenham for a distance of 9¼ miles. The least depth found on this



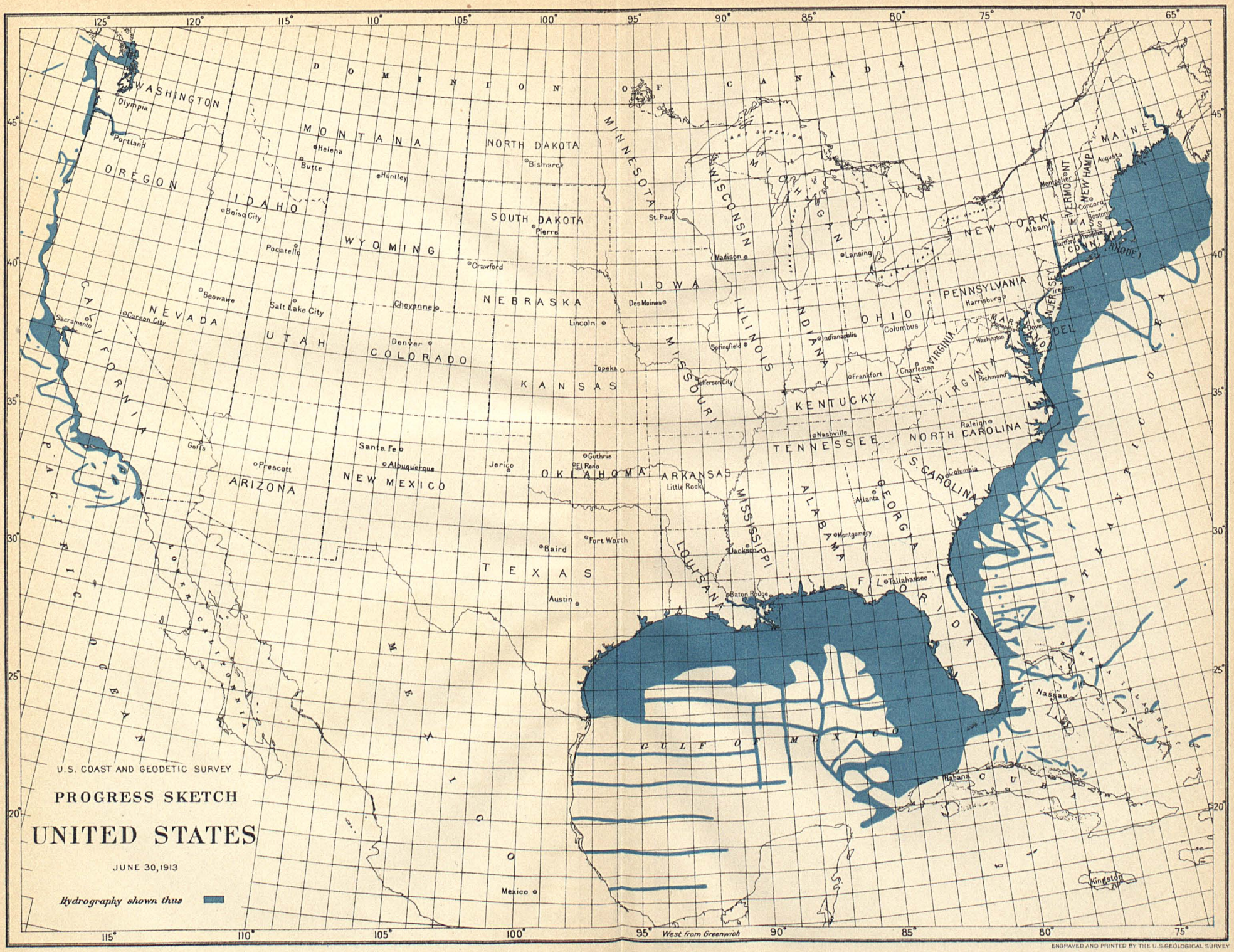
ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.

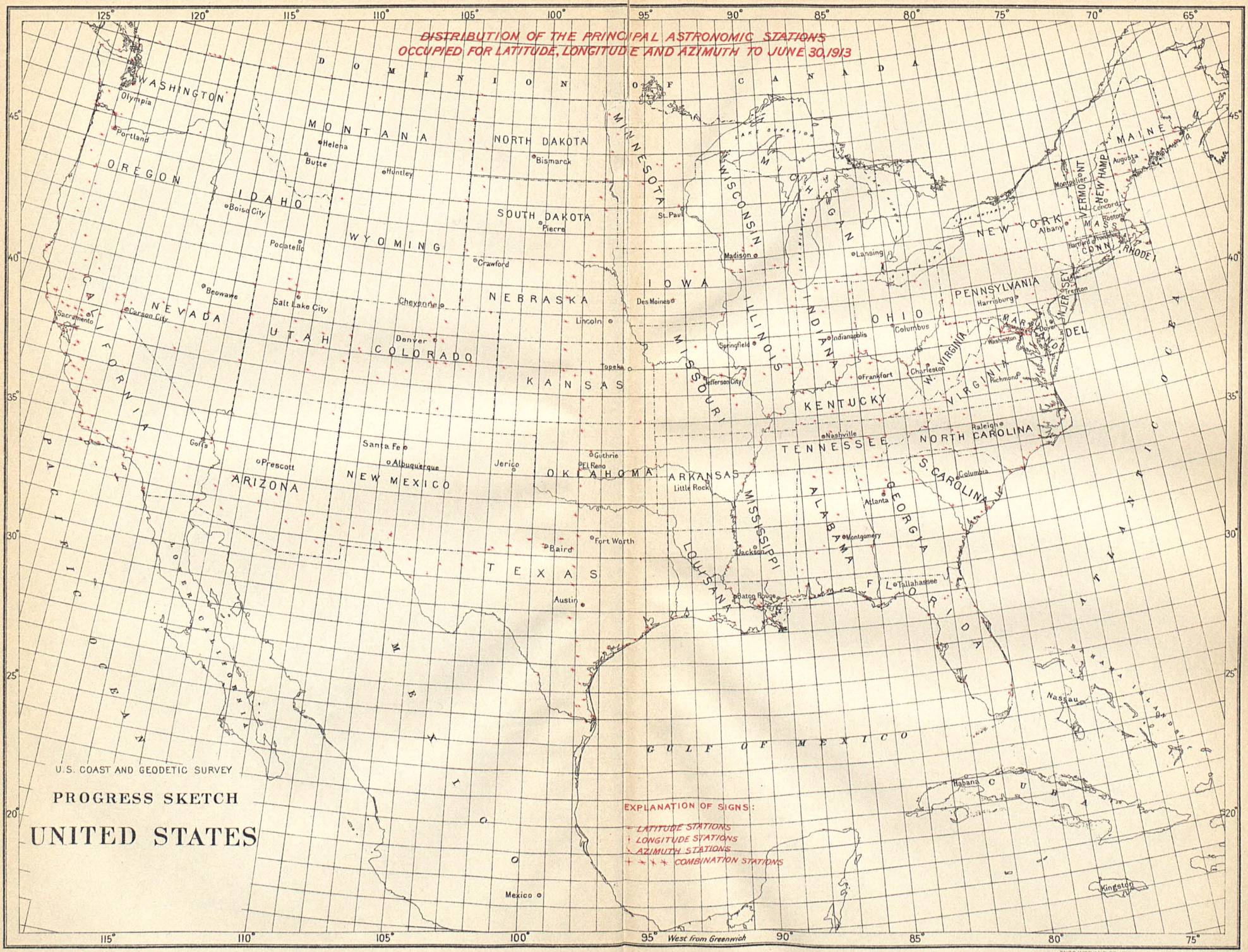


ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.

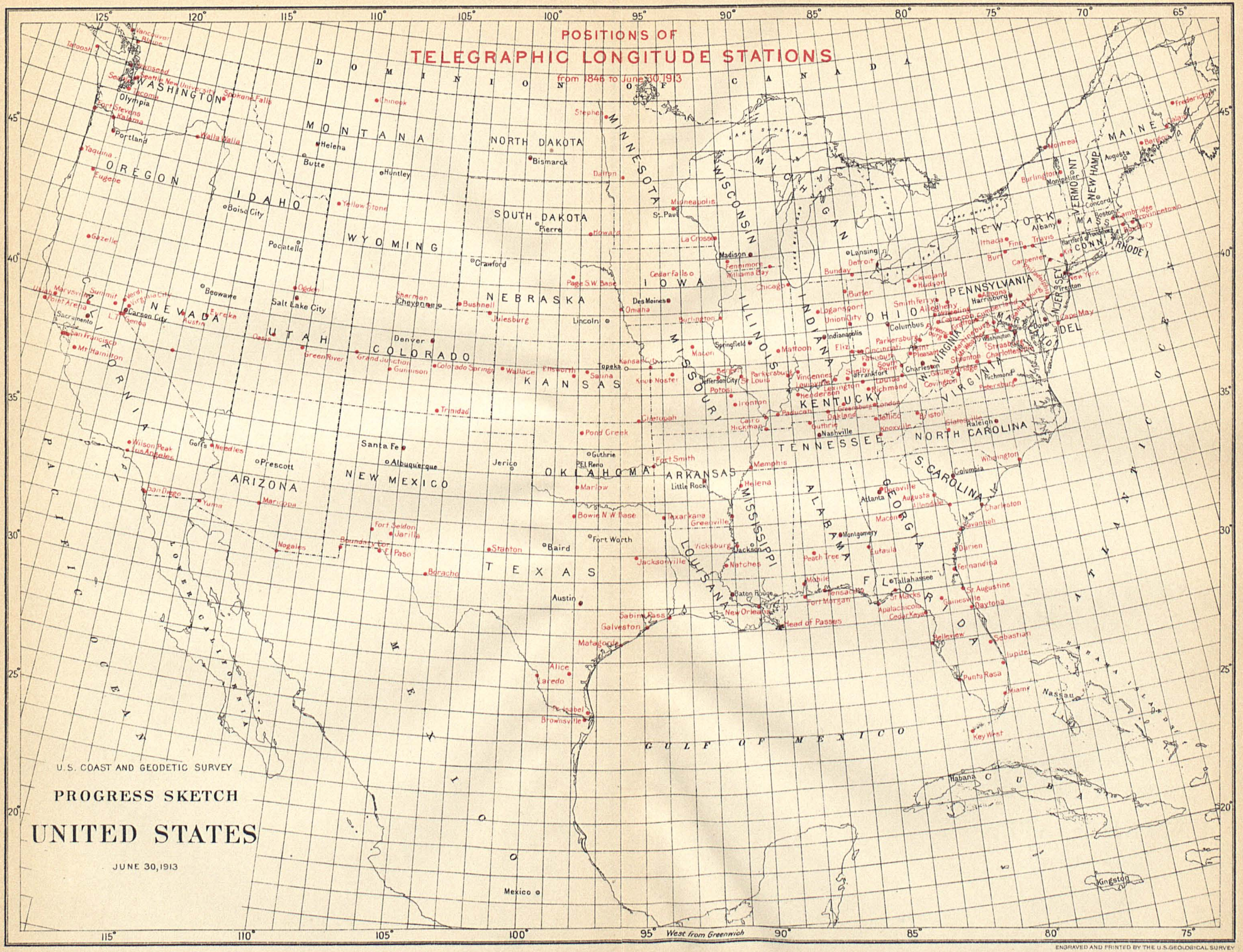


ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY



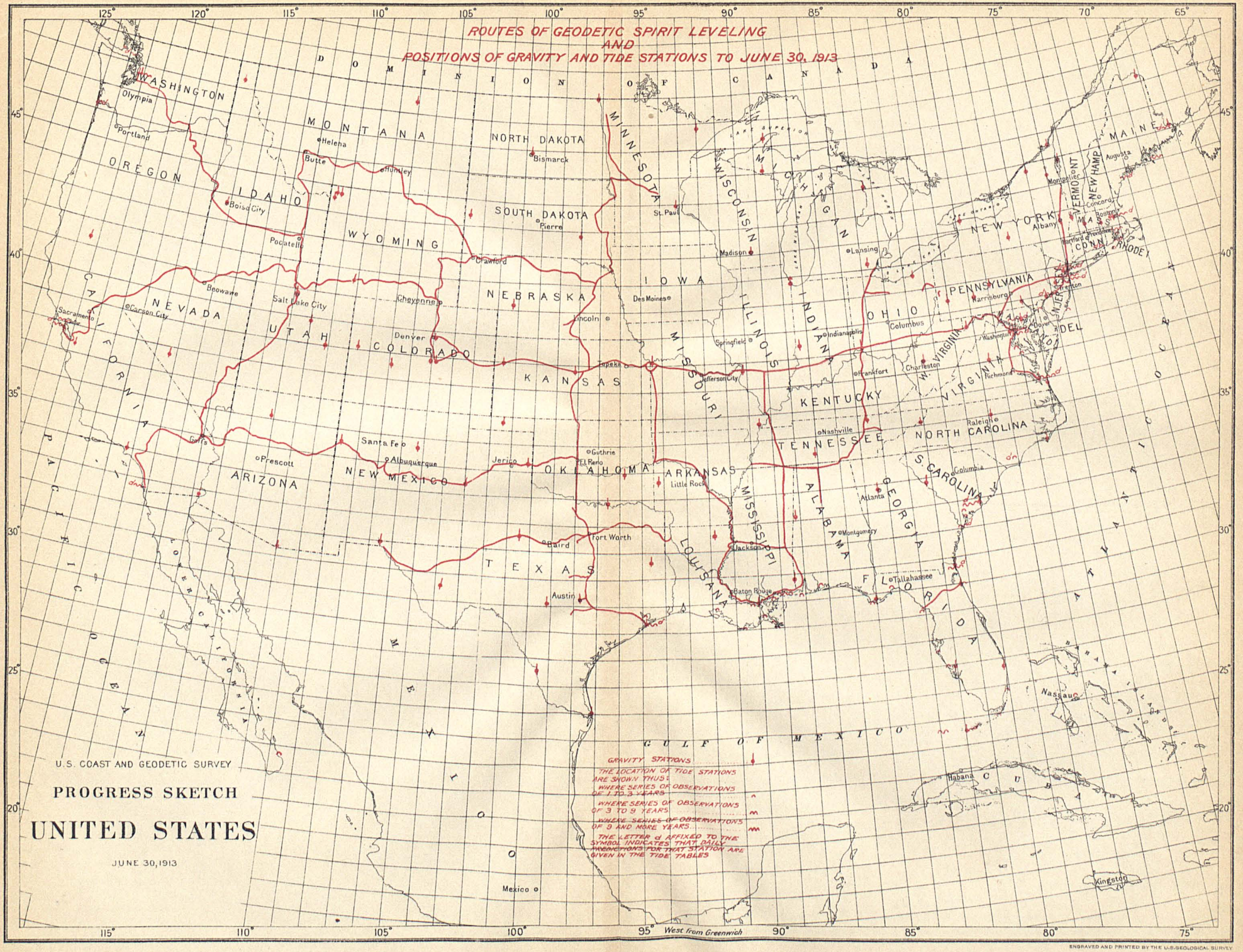
ENGRAVED AND PRINTED BY THE U.S.GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.



U.S. COAST AND GEODETIC SURVEY

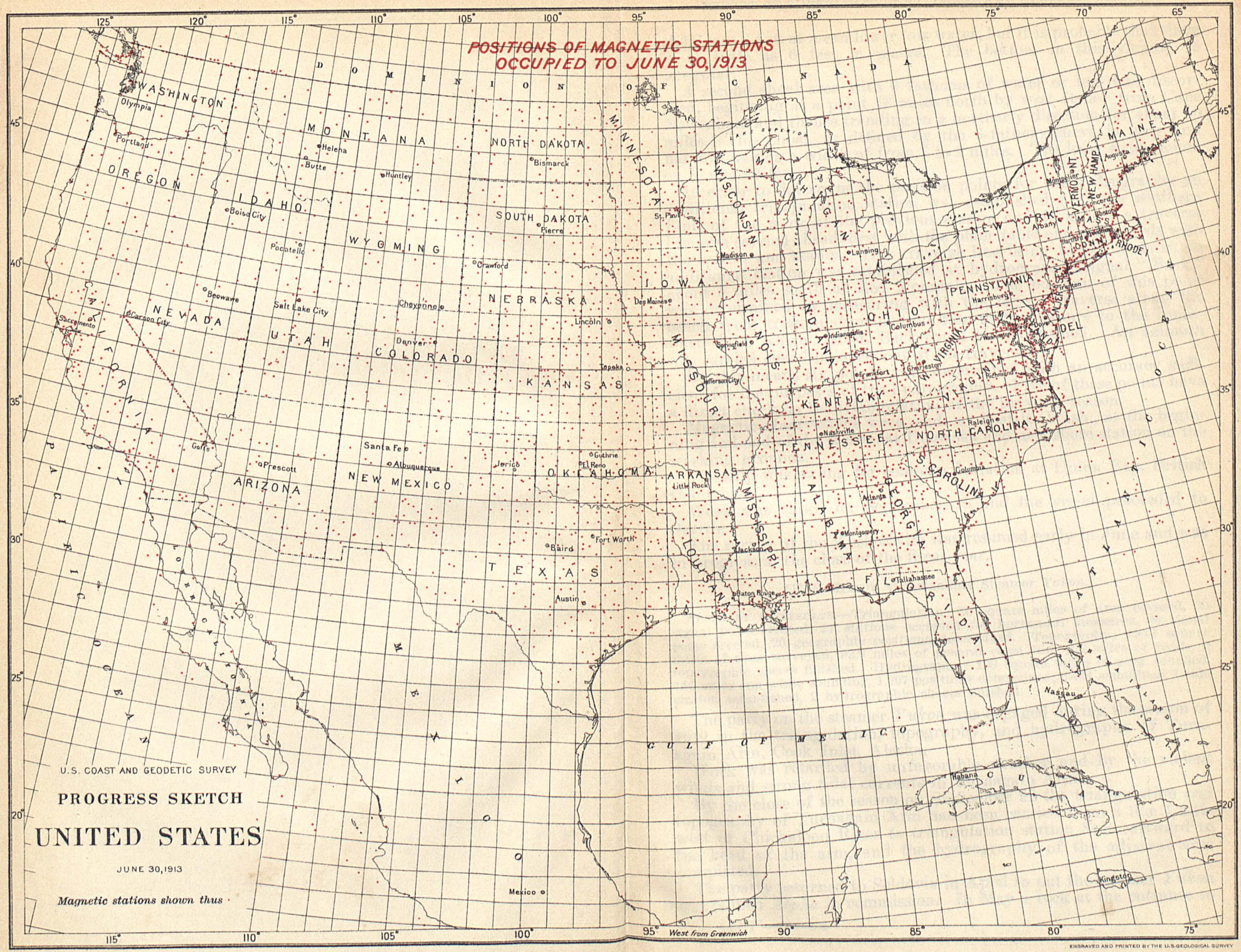
PROGRESS SKETCH

UNITED STATES

JUNE 30, 1913

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.

shoal was 8 feet at mean lower low water, but it is probable that there is as little as 6 feet in places. The bottom in this vicinity is irregular.

A second shoal area with 6 fathoms of water or less was discovered, beginning at a point 13 miles north by west (true) from Cape Newenham and thence trending in a northerly direction for about 10 miles. This shoal, as defined by the 6-fathom curve is long and narrow, having a width of from 1 to 2 miles. The least water found on it was 22 feet.

In order to determine the position points for the hydrography an additional triangulation station was established near the southern limit of the work of the previous season, and from this a traverse line was carried ahead, first with the plane table and afterwards with the transit and stadia. This traverse line being found in error, an additional station was established at hydrographic signal "Back," about 5 miles south of Red Mountain. The position of this point was determined by measuring with the tape a traverse along the beach from triangulation station Loz to two points to the southward from which station Back could be determined. An azimuth was carried ahead independent of the traverse.

By this means six points were determined with an accuracy sufficient for the purposes of the hydrography. Five of these points have a direct check on the triangulation of the previous season.

Magnetic observations were made at Seattle, Wash., at the beginning and end of the season, at Unalaska and at a shore station on the working grounds.

The ship was swung for compass deviation at Union Bay, British Columbia.

Work was closed on September 18 and the vessel proceeded to Seattle.

The survey of the Kuskokwim was resumed early in June and was in progress at the close of the fiscal year.

[F. H. HARDY, Commanding Steamer *Yukon*.]

SUMMARY OF RESULTS.—Triangulation: 50 square miles of area covered, 30 signal poles erected, 27 stations occupied for horizontal measures, 30 signal poles erected, 26 geographic positions determined. Topography: 170.7 square miles of area surveyed, 92.9 miles of general coast line, 8.5 miles of roads, 2 topographic sheets finished. Hydrography: 190 square miles of area sounded, 444 miles run while sounding, 1,297 positions determined, 6,464 soundings, 1 tide station established, 2 hydrographic sheets finished.

The party on the steamer *Yukon* was engaged during the season of 1912 in the triangulation, topography, and hydrography of Turnagain Arm, Cook Inlet, Alaska.

Work was retarded by unfavorable weather and by the violent winds and strong tidal currents in Turnagain Arm.

By the close of the season on September 22 the triangulation and topography of Turnagain Arm had been carried from a line 1 mile west of Chickaloon River to triangulation station Salt eastward to the head of the arm, and the hydrography of the adjacent area completed.

The party returned to Seldovia in April to put the steamer *Yukon* and launch *Alpha* in commission. In May a rock at the entrance to

Coal Bay, Port Graham Harbor, was located. Field work of hydrography in Kuskokwim Bay was begun on June 10 and was in progress at the close of the fiscal year.

[C. G. QUILLIAN, Commanding Steamer *McArthur*.]

SUMMARY OF RESULTS.—Triangulation: 65 square miles of area covered, 26 signal poles erected, 14 stations occupied for horizontal measures, 10 geographic positions determined. Topography: 68 square miles of area surveyed, 159.5 miles of general coast line, 2 topographic sheets finished. Hydrography: 749 square miles of area covered, 905.2 miles run while sounding, 3,963 positions determined, 6,025 soundings, 3 tide stations established, 3 hydrographic sheets finished.

On July 1 the party on the steamer *McArthur* was engaged in surveys on the coast of southwestern Alaska.

The work done during the season included a complete topographic survey of Aialik Bay on a scale of 1/40,000, a hydrographic survey of the bay plotted on the same scale, also complete excepting a small area immediately outside of the Chiswell Islands, and soundings for about 15 miles off the entrances to Aialik Bay and Resurrection Bay. During the course of this work two automatic tide gauges were kept in operation for three months, observations for magnetic declination were made on Aialik Bay at Seward, and the contours were sketched in on the western side of the peninsula which terminates in Cape Resurrection.

Only sufficient triangulation was executed to control the topographic work and the majority of the signals were located with the plane table.

The weather during the season was unfavorable for rapid progress and owing to the exposed situation of this portion of the coast the time available for surveying operations was limited.

Between October 6 and 14 a hydrographic examination was made of Nakat Harbor.

Work was closed for the season on October 14 and the vessel sailed for Seattle, arriving October 18.

On her way to the working ground in Cook Inlet the steamer *McArthur* stopped to make a reconnoissance survey of Burnett Inlet, extending from a small island on the eastern side to the upper end of the islands just above the cannery.

The shore line was run in on a scale of 1/10,000 on a plane-table traverse. Sounding lines were spaced 200 meters apart in the area immediately off the cannery and slightly wider apart, further out. A shoal previously reported was located and another shoal with 15 feet of water on it was discovered. Points for the survey were located by a plane-table triangulation. A number of points were marked for future reference. Azimuth observations were made from a station on the cannery wharf. Magnetic observations were made with compass declinometer and the ship was swung to give the magnetic declination.

Upon the completion of this work the *McArthur* proceeded to Seward, Alaska, touching at Juneau to inspect the tide gauge there.

The position of the city dock at Petersburg was determined and located on the chart. The tide gauge at Juneau was inspected and put in order and the gauge was connected by leveling with the tidal bench marks.

A party was established in camp for the survey of Iniskin Bay. The main party then proceeded with signal building and reconnoissance with the object of extending the triangulation into Kamishak Bay. A base line 1,000 meters in length was measured at Iniskin Bay and the local triangulation was taken up by the camping party. Topography was begun as soon as sufficient stations were determined. By June 30, 16 stations had been built in Kamishak Bay and 7 of them had been occupied, 2 tide gauges had been established, and about 16½ miles of topography had been completed.

([R. B. DERICKSON, Commanding Steamer *Gedney*.])

SUMMARY OF RESULTS.—Triangulation: 392 square miles of area covered, 38 signal poles erected, 32 geographic positions determined, 22 stations occupied for horizontal measures. Magnetic work: 8 stations occupied for magnetic observations, 2 complete swings of ship for magnetic deviation. Topography: 117.3 miles of general coast line, 5 topographic sheets finished. Hydrography: 274.5 square miles of area sounded, 945.1 miles run while sounding, 3,666 positions determined, 4,778 soundings, 3 tide stations established, 5 hydrographic sheets finished.

During the period from July 1 to October 3, when work was closed for the season, the party on the steamer *Taku* was engaged in general surveys in Prince William Sound, Alaska.

The triangulation, topography, and hydrography of Port Wells which had been begun on June 19 were completed on August 26. Between August 30 and October 3 the party was engaged in the survey of Simpson Bay.

At Port Wells heavy rains were experienced and the weather conditions during the season were generally very unfavorable to work.

By July 5 the erection of signals for the triangulation was completed. The occupation of stations was then begun and by July 23 the triangulation was completed. All triangulation stations, both those in the main scheme and the intersection stations, were marked with C. & G. Survey disk marks cemented into drill holes in the rock, and descriptions of the stations were made to accompany the records.

The topography of Port Wells is included on two sheets, one on a scale of 1/20,000 and the other on 1/40,000 scale. This work was completed on August 26.

The hydrography was begun on July 27 and completed August 24. It includes Culross Island; east and west Twin Bays on the north side of Perry Island; the entrance to Perry Island Passage from Axil Lind Island on the north to Upper Passage on the south, and as far east as the surveyed area west of Naked, Storey, and Knight Islands, and through Perry Island Passage from Lone Island and the Dutch group of islands to the entrance to Port Wells. The only shoal of any size or importance extends for about three-fourths mile to the northward from the north end of Lone Island. Deep water, from 200 to 300 fathoms, lies north of this and between Lone Island and the Dutch group, affording a broad, deep entrance to Perry Island Passage. A rock, bare at low water, was located about one-fourth mile south of Fool Island. Deep water lies between this rock and Perry Island. Perry Island Passage is clear with depths of 100 to 300 fathoms.

Tide observations with automatic gauge and staff were made at a station in Culross Bay from July 19 to August 25, and three tidal bench marks were established. Observations for magnetic declination were made at station Tree on August 23. On August 29 magnetic observations were made at station Nibsy on Observation Island. On the way to Simpson Bay the ship was swung for compass deviation on August 30.

On August 31 work was begun on the survey of Simpson Bay. Signals were erected for the triangulation and a plane-table triangulation was carried to the head of the bay. A tide staff was erected in Simpson Bay and three tidal bench marks established. The survey of the north area of the bay was completed on October 3, when work was closed for the season.

Work was begun on Eshamy Bay in May, 1913. The signal building and observation of angles were completed on May 26 and the sounding was then begun. The weather was favorable and with two topographic and one hydrographic parties at work the survey from the entrance of Port Wells to Port Nowell was completed by June 27.

[R. B. DERICKSON, Commanding Steamer *Gedney*.]

SUMMARY OF RESULTS.—Triangulation: 85 signal poles erected. Topography: 166.5 square miles of area surveyed, 301.8, 3 miles of shore line of creeks, 4 miles of roads and railroads, 7 topographic sheets finished. Hydrography: 144.2 square miles of area sounded, 1,606.2 positions determined, 21,183 soundings, 10 tide stations established, 1 current station occupied, 8 hydrographic sheets finished.

At the beginning of the fiscal year the party on the steamer *Gedney* was engaged in the survey of Tlevak Strait in southeastern Alaska.

During the latter part of June the necessary triangulation points had been recovered, signals erected, and other preliminary operations completed. Supplemental points were determined where necessary with the plane table.

The topography was practically confined to the shore line and adjacent mountain peaks. The topographic survey extends from Mellen Rock on the north and Shoe Rock on the south entrance of Tlevak Strait and was carried along the north end of Long Island from near Shoe Rock to Howkan village, thence along the east coast of Dall Island from opposite Howkan village to the south end of Suemez Island. This embraces the entire west shore of Tlevak Strait with the exception of Buldy Bay (View Cove). On the north and east side of the strait the shore line was surveyed from near Mellen Rock and Jackson Island along the south end of Sukkwan Island to the McFarland Islands, including the largest of the McFarland Islands.

From the west entrance of Sukkwan Pass the topography was carried along the coast to the North Pass and thence along the shore line of Halibut Nose including the northernmost of the Corlies Islands and the group called Nichols Islands. The topography is included on two sheets on a scale of 1/20,000. An additional projection on a scale of 1/10,000 was completed, extending from Halibut Nose and North Bay on the south to the south end of Suemez Island in the north. The shore line from the south end of Suemez Island to Cape Flores was sketched in by the hydrographic party.

The only part of the season's work not completely controlled by triangulation is the channel of Sukkwan Straits, extending from its

west entrance to Tlevak Strait to the new town of Hydaburg, opposite Sukkwan Narrows. This work was taken up at the close of the season after Tlevak Strait had been completed from Cordova Bay to Bucareli Bay.

A topographic sheet on scale of 1/5,000 was constructed, three triangulation stations at the south end of the sheet were plotted, and from these a plane table and sextant triangulation was carried to the town of Hydaburg, a distance of 3 miles. Flags were placed along the shore line, which were used as signals by the hydrographic party. A reconnoissance and sketch of the North Pass of Sukkwan Straits from Tlevak Strait to the completed work at Hydaburg was plotted on a separate sheet which joins the work on both the 1/20,000 and 1/5,000 sheets.

The hydrographic work done during the season extends from Lacey Island and Shoe Rock at the southeast end of Tlevak Strait along the shores and in the bays at the north end of Long Island and the south end of Sukkwan Island, also the bays along the northeast coast of Dall Island with the exception of Buldy Bay (View Cove). The entire area between Sukkwan and Long Island was covered and that portion of the Strait along the east coast of Dall Island west of a line joining the McFarland and Nichols Islands, and from Nichols Islands to Halibut Nose, the entrance to Soda Bay and Channel extending from the Lively Islands, through Ulloa Channel to Bucareli Bay, giving a complete hydrographic survey of Tlevak Strait Channel from Cordova Bay to Bucareli Bay, a distance of 34 nautical miles and covering 4 hydrographic sheets. The soundings previously taken in Tlevak Strait were supplemented and the survey in that vicinity extended to the bays and channels northeast of the Narrows.

After completing the work in Tlevak Strait a hydrographic survey of Sukkwan Strait from its entrance to Tlevak Strait along the main ship channel to the anchorage off the town of Hydaburg was completed. This covers the most intricate portion of Sukkwan Strait.

Tides were observed during the season with staff gauges and with an automatic gauge.

Observations of currents were made during the progress of the hydrography and sufficient data gathered to determine the relation of slack waters in Sukkwan Narrows to the predicted high and low waters at Sitka.

Magnetic observations for declination were made at Turn Point and at the south end of Tlevak Strait.

As the result of information gained during this survey southbound vessels desiring a shorter inside route from Christian Sound can now make a saving of 25 to 30 miles by the Tlevak Strait route.

Vessels calling at the Klawak cannery, one of the largest canneries in southeastern Alaska, when bound for other ports on the west coast of Prince of Wales Island, have heretofore rounded the north and south ends of Prince of Wales Island, making an unnecessary detour of 170 miles between the ports of Sulzer and Klawak.

Work for the season was closed on October 12 and the vessel proceeded via Metlakatla and Ketchikan to Seattle arriving October 30.

In the spring of 1913 the survey of Kasook Inlet was completed. The position of a submerged rock at the north end of Grand Islands in Tlevak Strait was determined, and work was begun in Bucareli

Bay. Assistance was rendered the Pacific Coast Co.'s steamer *Curacao* in getting off a reef at the south end of Fish Egg Island, and when that vessel was afterwards wrecked on a submerged rock and beached in Tonawek Bay, the passengers and crew with express and mail matter were taken off and conveyed to Ketchikan by the *Gedney*. The rock on which the *Curacao* struck was afterwards located and determined in position.

Triangulation stations established in 1906 were recovered and signals erected through San Christoval Channel. Tidal observations were made in the progress of the work. The area from Catalina Island to northwest of Lazaratita Island was thoroughly surveyed and temporary ranges showing the axis of the main ship channel were erected. Old triangulation stations were then recovered, signals were built and the hydrography and topography were continued to the southward of Cape Lynch. This work was in progress at the close of the fiscal year.

[F. WESTDAHL, Commanding Steamer *Patterson*.]

SUMMARY OF RESULTS.—Triangulation: 1,100 square miles of area covered, 24 signal poles erected, 5 observing signals built, 28 stations occupied for horizontal measures, 9 stations occupied for vertical measures, 30 geographic positions determined. Magnetic work: 3 stations occupied for magnetic observations. Topography: 58 square miles of area covered, 135 miles of general coast line surveyed, 1 topographic sheet finished. Hydrography: 15 square miles of area sounded, 134 miles run while sounding, 1,093 angles measured, 1,773 soundings made, 3 tide stations established, 1 hydrographic sheet finished.

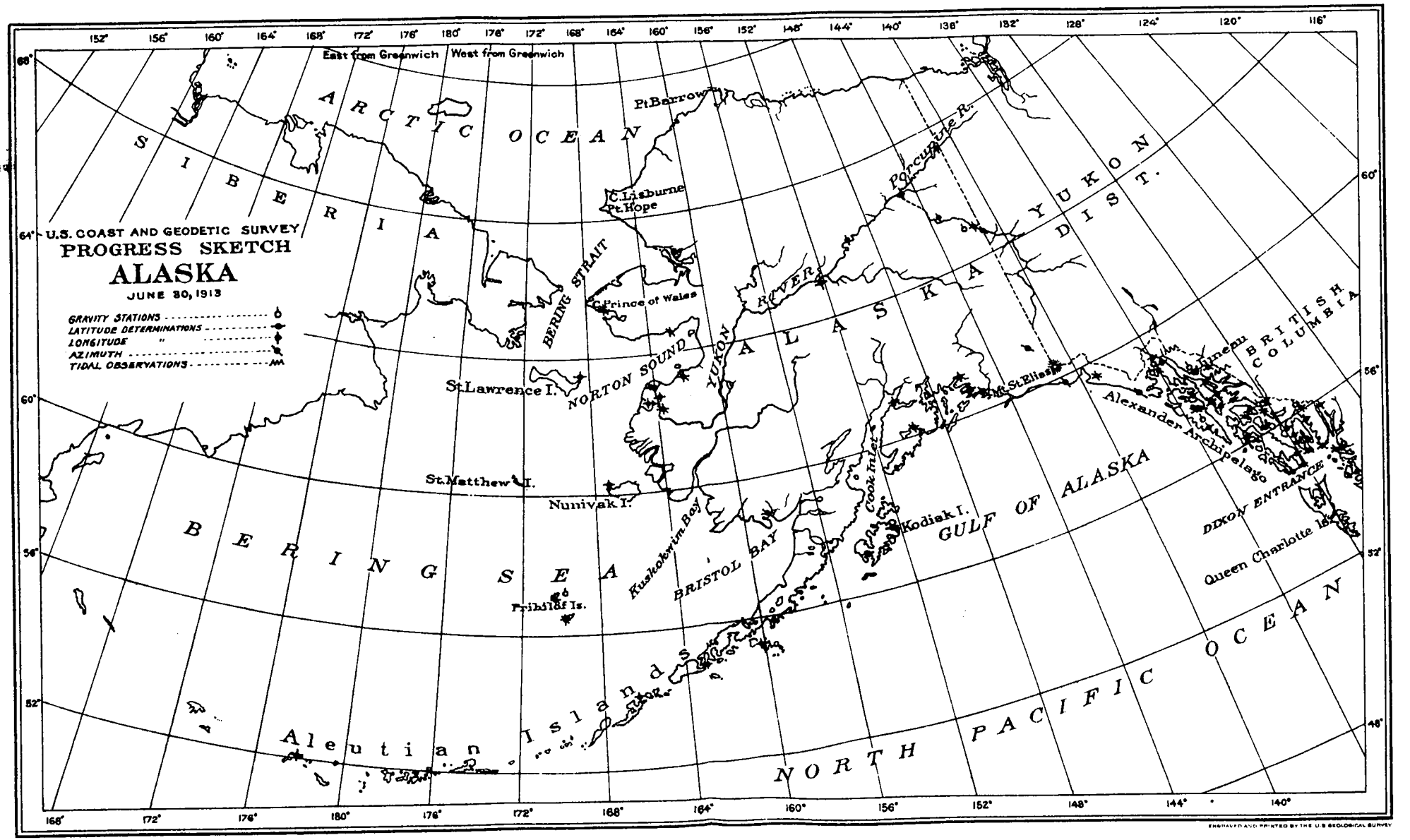
During the period from August 17 to October 23 the party on the steamer *Patterson* was engaged in general surveys in Clarence Strait, southeastern Alaska. The work done included triangulation, topography, and hydrography, but in accordance with instructions especial attention was paid to the advancement of the triangulation.

The triangulation was extended in a general northerly direction from the base Lazaro-Ken to a junction with previously established stations on Caamano Head, Grinall Island, and Island Point.

The topography was begun near Cape Chacon. A projection was prepared on a scale of 1/20,000 to reach from that point northward to Scott Point, including McLean Arm, Gardner Bay, and Kendrick Bay. Two more projections were prepared on the same scale, the first to cover Ingraham Bay and the southern part of Moira Sound, and the other the northern part of Moira Sound, but owing to unfavorable weather work was not completed on either of these sheets. The existing chart of Niblack Anchorage and the sailing directions for that harbor were found to require considerable correction.

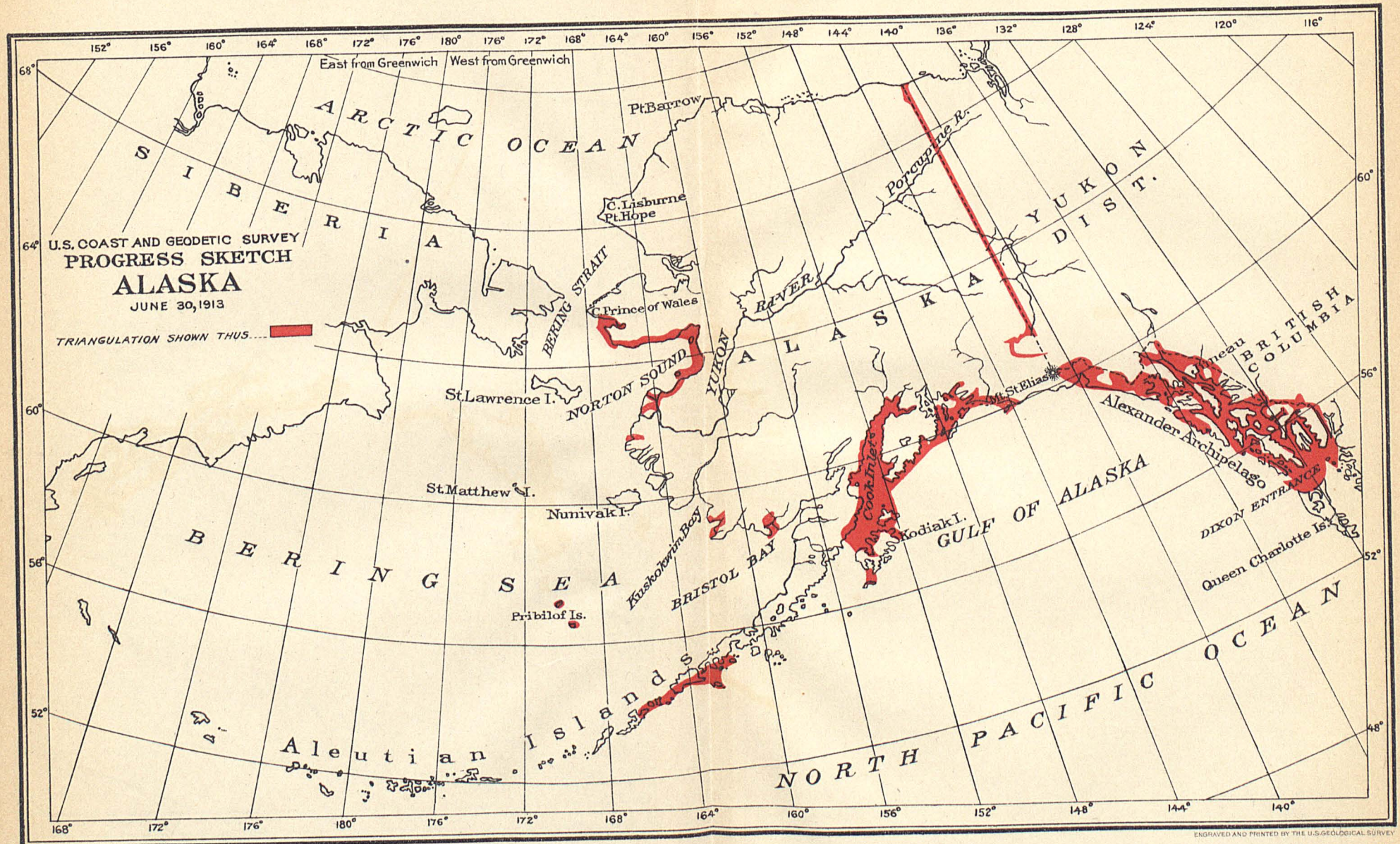
A limited hydrographic development was made of the inlets surveyed. They are all so deep that no more is needed. The shores are steep to, except at the head of the inlets, and there are few hidden dangers. The rocks exposed at low tide are, as a rule, flat-topped and smooth as if ice worn. Hydrographic work was done in McLean Arm, Gardner Bay, Kendrick Bay, in the bay north of Kendrick Bay, and Niblack Bay.

The rock shown on chart 8100, 1¼ miles southeastward from Wedge Island, marked as exposed at low tide, was carefully searched for but not found. Its removal from the chart is recommended. The reef southwest of Dall Head, marked "position doubtful" on the same chart, was found and its position determined.



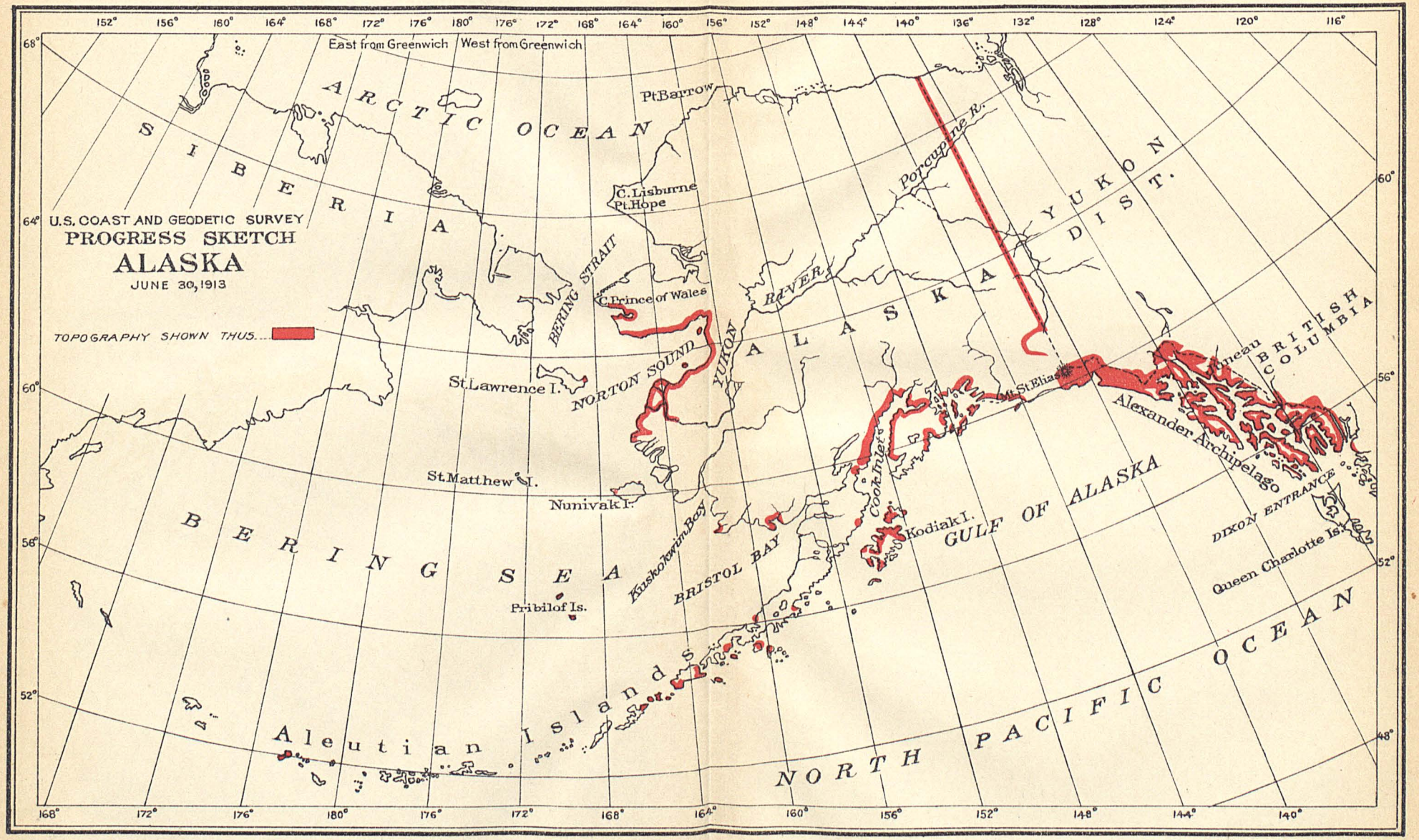
ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.

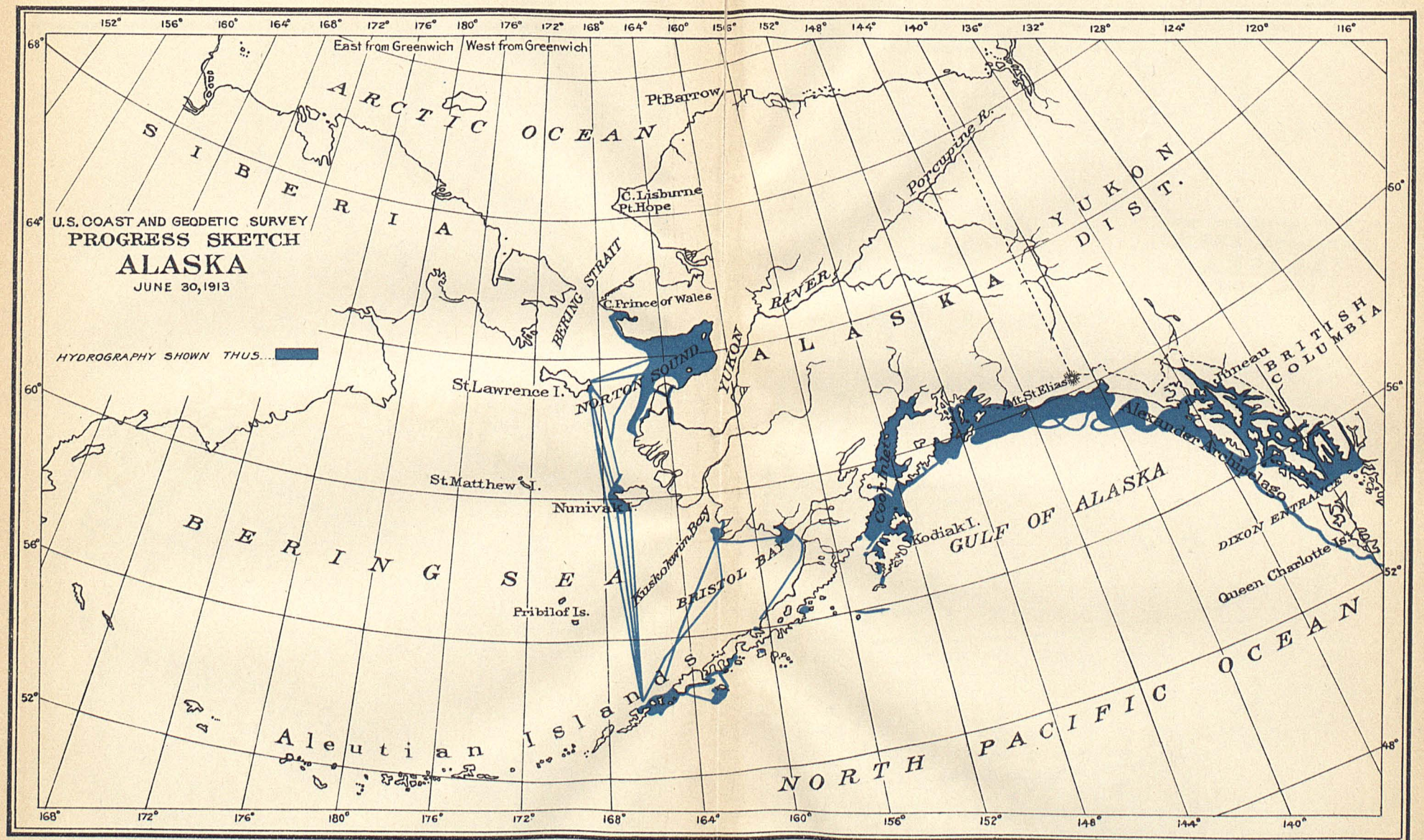


ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.

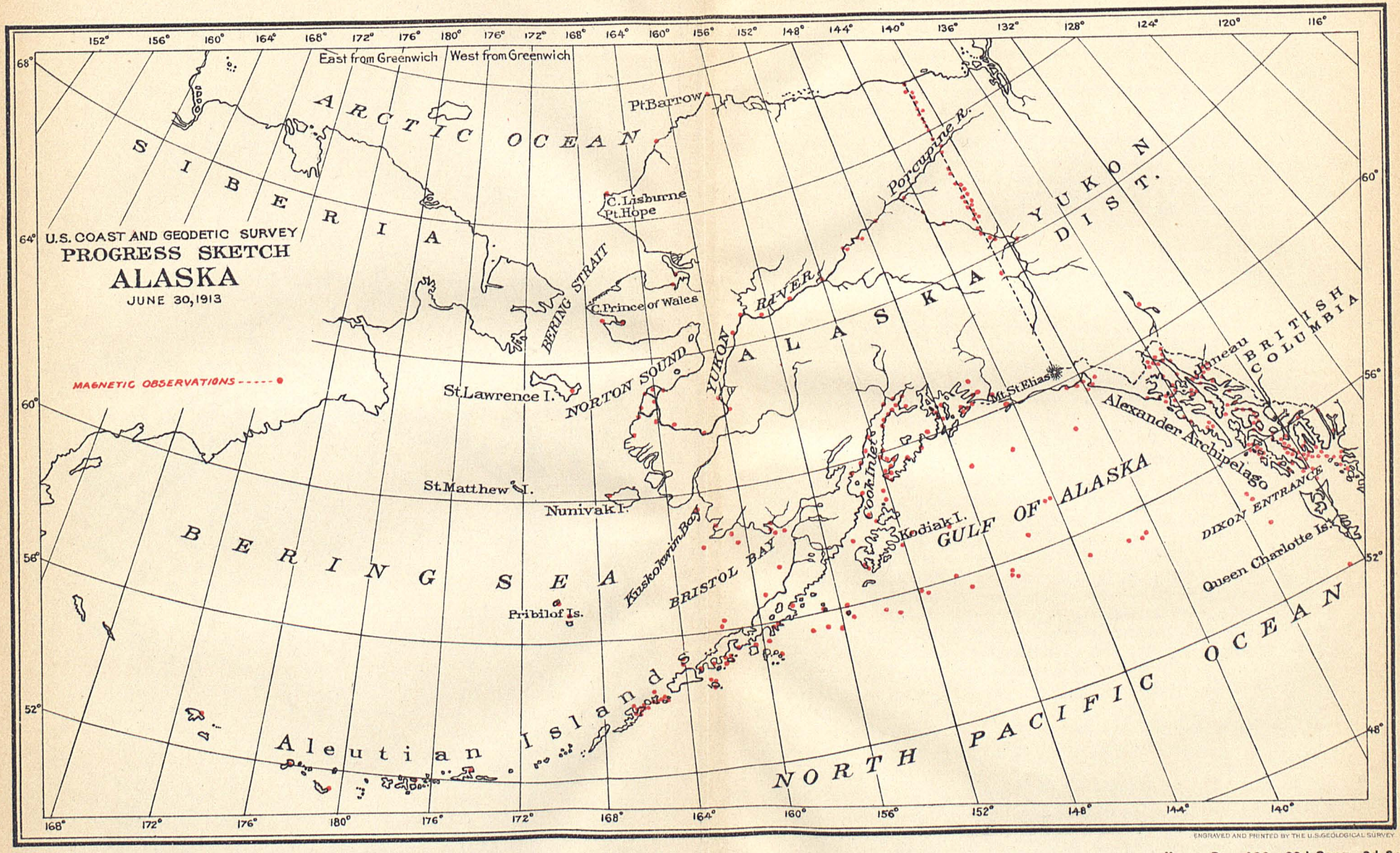


ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

House Doc. 400; 63d Cong., 2d Sess.

At Port Chester the depths at the anchorage shown on chart 8074 were found to be greater than the soundings on the chart would indicate.

Tides were observed at McLean Arm, Kendrick Bay, and Niblack Bay, but not for a sufficiently long period for the computation of a plane of reference.

Magnetic observations were made at Union Bay, British Columbia, and the ship was swung to determine the deviation of the compass.

Field work was closed on October 24 and the vessel sailed for Seattle, arriving October 31.

[J. B. MILLER, Commanding Steamer *Patterson*.]

SUMMARY OF RESULTS.—Physical hydrography: 102 surface temperatures taken at sea, three current stations occupied. Longitude: One longitude station occupied. Base measure: One secondary base line 0.8 kilometer in length. Magnetic work: Two ship stations occupied for magnetic observations and two shore stations occupied for magnetic observations.

The steamer *Patterson* began work in southeast Alaska in the early part of June and surveys were begun in two localities. For this purpose a party of 4 officers and 14 men with 3 power boats was put to work on a survey of the Shumagins while the steamer was engaged upon hydrography on Davidsons Bank, 60 miles southeastward and seaward from Unimak Pass, and 125 miles distant from the work of the detached party. The work in the Shumagins was begun in Zachary Bay on Unga Island, Humboldt Harbor on Popof Island, and the northern approach of both, and was extended eastward and southeastward through Popof Strait toward Nagai Island. The hydrography upon which the ship began work lies at a distance of about 40 miles offshore, southeast of Unimak Pass and southward and southwestward of Sannak Islands, and consisted of a search for two rocks which are indicated on the charts in the track of vessels approaching Unimak Pass from the southeast, but the existence of which is considered doubtful. This work was in progress at the close of the year. Tidal observations were begun at Sand Point in the Shumagin Islands with an automatic gauge to serve as a base station and subsidiary stations were occupied on the neighboring islands. Current observations were made at all open anchorages. No unusual or striking features of either tides or current were developed, the currents observed being moderate in strength, ranging from one-half to 2 knots. Magnetic observations were made at the base station at Seattle and at a new station at Sand Point in the Shumagin Islands. Observations were also made in Shelikof Strait between Semidi Islands and the mainland. The usual compass declimometer observations were carried through the Shumagin Islands.

OUTLYING TERRITORY.

PHILIPPINE ISLANDS.

[P. A. WELKER, Director of Coast Surveys.]

The Director of Surveys in the Philippine Islands, whose office is at Manila, has immediate direction of the details of the field and office work in these islands under general instructions from the Superintendent of the Coast and Geodetic Survey, makes plans for field

work, and issued instructions to field parties. The results of magnetic observations made in the field are reported and discussed in the office at Manila, and drawings for new charts are there prepared and transmitted to the office at Washington for publication. The general plan of the division of the expenses between the Government of the United States and the Philippine government, which has applied since January 1, 1902, was observed during the year.

The first half of the fiscal year was notable as being one of the most stormy and disastrous seasons that have been known in the Philippine Islands. Stormy weather prevailed during much of the time and the regions of the field surveying operations were visited by most severe typhoons on November 6, 25, and 26, and on December 15 to 16. The destruction caused in the paths of these typhoons has been made the subject of individual and press reports and no detail repetition is considered necessary. The many lives that were lost, vessels that were beached and foundered, and the great destruction to property on shore are all matters of record. The most serious loss to the Coast and Geodetic Survey was the foundering of one of the launches of the steamer *Pathfinder* in Cebu Harbor October 15; the stranding of the steamer *Marinduque* on the coast of Palawan November 6, necessitating the loss of the services of the vessel for two and one-half months; the destruction of the surveying signals in the localities of the work; and the great amount of time lost by the various vessels on account of the weather conditions being too stormy for field operations. In addition to the time lost at work may be mentioned the extraordinary repairs required to the steamers *Pathfinder* and *Marinduque*, which kept the former out of the field for five months and the latter four and one-half months, resulting in a considerable reduction in the output of work. Except during intervals when repairs were necessary to the vessels, the parties attached to the five steamers available for duty were continuously engaged in the field. There was also one shore party engaged for seven and one-half months during the year in making observations for the determination of the magnetic elements in the various parts of the islands.

A reference to progress sketch No. 15 will show that the surveys of the coast of the Philippine Islands have covered all of the localities which are at present of any considerable commercial importance, the remainder of the work being in localities many of which are dangerous for navigation but which at the present date are seldom visited by vessels engaged in trade. The unsurveyed regions are at such great distances from the base of supply and so far from the general lines of travel for merchant vessels that the matter of arranging for furnishing the various vessels of the Survey with coal, oil for motor launches, and general supplies has become a serious problem. The nearest base of supply for the *Pathfinder* is 260 miles, the *Romblon* 250 miles, the *Fathomer* 135 miles, the *Research* 130 miles, the *Marinduque* 90 miles. Some of these distances will greatly increase as the work progresses. The necessity for establishing coaling stations nearer the localities of work will therefore be recognized.

During the fiscal year 1913 there was completed the most extensive and probably the most important trigonometrical survey that has been executed in the Philippine Islands. The triangulation over the large water area bounded by Luzon, Burias, Mastate, Panay, and

Tablas Islands, thence extending via Mindoro and Panay across the Cuyos to the Calamianes and Palawan, thence northward over Apo Reef and Verde Island Passage to a connection with the former work in the Lubang Islands, was all completed during the fiscal year. This work involved lines as much as 91 statute miles in length, the longest that will be required for any survey in the Philippine Islands. It is gratifying to note that there is now a connected system of triangulation over the greater part of the coast of the Philippine Islands, which will permit the adjustment upon a uniform datum to proceed without any interruption. By reference to the progress sketch, it will be seen that little triangulation of a secondary class will be required in the future, the trigonometric work remaining for execution being almost entirely of a tertiary class.

During the fiscal year there has been the usual exchange of results and harmonious cooperation with the naval and military authorities, and the various bureaus under the government of the Philippine Islands.

During the year 1,018 square miles have been covered by reconnoissance, 12,916 miles of triangulation have been completed, and 945 miles of coast line surveyed, 923 square miles of topography have been surveyed, and 32¼ topographic sheets completed. The hydrographic work has covered 10,604 square miles, 22 tide stations have been occupied, and 47¾ hydrographic sheets have been completed. The general coast line surveyed during the year is about 5.2 of the total length. Since the beginning of the work about 63 per cent of the general shore line has been surveyed.

Among other matters that received the attention of the Director of Coast Surveys were the series of tide observations at the automatic tide-gauge stations at Manila, the compilation of a revised table of distances between ports in the Philippine Islands, the compilation of a list of Philippine geographic names, and the work of the Harbor Lines Commission, of which the Director is a member.

During the fiscal year sections 1 and 5 of the Philippine Islands Sailing Directions were revised and republished, five Notices to Mariners were prepared and published, and much original hydrographic information was obtained. The chief of the nautical division served as a member of the Lighthouse Board of the Philippine Islands.

The sale and distribution of the charts and other publications of the survey was attended to by the suboffice at Manila.

Five new maps of the Philippine Islands were compiled in the geographic division, and progress was made in the compilation of a number of other maps. Among these is a map of the entire Philippine Archipelago on a scale of 1/1,000,000 which will conform to the scale adopted by the International Geographic Congress for an atlas of the world.

[F. G. ENGLE, Commanding Steamer *Research;* WM. M. STEIRNAGLE, Commanding Steamer *Research.*]

SUMMARY OF RESULTS.—590 square miles of area covered, 9 stations selected for secondary scheme, 13 lines of intervisibility determined. Triangulation: 1,540 square miles of area covered, 24 signals and scaffolds erected, 16 stations occupied for horizontal measures, 47 geographic positions determined. Topography: 58 square miles of area surveyed, 155 miles of general coast line surveyed, 13 miles of rivers and creeks, 18 miles of roads, 4½ topographic sheets

finished. Hydrography: 1,308 square miles of area sounded, 5,086 miles run while sounding, 61,225 soundings, 7 tide stations established, 9¼ hydrographic sheets finished.

At the beginning of the fiscal year the party attached to this steamer was engaged in general surveys in the region about Masbate, Biliran, Maripipi, and Talajit Islands.. The triangulation covering this area was completed before the beginning of the year.

Topographic work was executed on the north coast of Biliran Island; over the entire areas of Generuan, Tagampul, Tomasa, Sambauan, Maripipi, Balanguingue, Bugton, and Basley Islands; and on the east coast of Masbate Island from Caduruan Point to Cataingan Bay.

Complete hydrographic surveys were made over practically the entire area, extending from a point about 2 miles east of Maria Island to Caduruan Point on Masbate Island, thence along the east coast of Masbate to the head of Cataingan Bay, thence southeasterly to Bugton Island, thence to a point about 1 mile northwest of Talajit Island, around this island at a distance of about 1 mile, and thence to Tomasa Island, thence due south to the north shore of Biliran Island, westerly along this shore to Tincansan Island, thence west for a distance of 6 miles south for 11 miles, and thence to the point of beginning.

An automatic tide gauge was kept in operation in Santo Nino Harbor, Santo Nino Island, until July 15, when it was moved to Cataingan Bay. Staff gauges were erected and read when required for the purpose of reducing soundings.

In December work was begun on the south coast of Masbate Island. An automatic gauge was established at Guion, and a traverse for locating hydrographic signals was run from Caduruan Point to Nanco Point on Masbate Island, a distance of about 16 miles.

In January the work of triangulation and hydrography was in progress on the south coast of Masbate. The hydrography was finished by March 6 and the triangulation by March 22, thus completing all necessary surveys in that region.

The triangulation consisted of one large quadrilateral and one small triangle, the longest line being about 42 miles. It furnishes a connection with previous surveys in that locality. The topography which covered one-half a sheet was for purposes of verification only.

The hydrography was carried over the region approximately from Caduruan Point to Buri Point on the south coast of Masbate and extending offshore to Tanguingui Island Lighthouse and connecting with previous surveys.

An automatic tide gauge was established at Guion and was kept in operation from December 21 to March 12.

One sea station for magnetic declination was occupied northwest of Guinauayan Island.

On March 24 work was begun in the area between Masbate and Samar, beginning on the coast of Samar. Triangulation was extended from Tagapula Island northward to southern Luzon and through San Bernardino Strait to San Bernardino Lighthouse. On May 14 final connection was made with the work of 1902 in San Bernardino Strait. Topography on the west coast of Samar was

completed from Malayoc Point to Balicuatro Point, connecting with previous surveys. The topographic work also included the entire areas of Dalupiri and Capul Islands.

The hydrography inshore was extended over the limits of the topography on the west coast of Samar and also around Dalupiri Island and along the east side of Capul Island. The offshore hydrography was extended to the limits of the topography on the Samar coast and for about 12 miles from the shore. Tide observations with an automatic gauge were made at Mano River, Samar, and staff readings were made at other points in the progress of the work.

[L. O. COLBERT, Commanding Steamer *Marinduque*.]

SUMMARY OF RESULTS.—Triangulation: 2,252 square miles of area covered, 40 signals and scaffolds erected, 28 stations occupied for horizontal measures, 83 geographic positions determined. Topography: 298 square miles of area surveyed, 162 miles of general coast line surveyed, 72 miles of rivers and creeks, 2 miles of roads, 10 topographic sheets finished. Hydrography: 1,857 square miles of area sounded, 2,631 miles run while sounding, 35,662 soundings, 1 tide station established, 15 hydrographic sheets finished.

The survey of Ragay Gulf, Luzon Island, by the party on the steamer *Marinduque* was continued from July 1 until July 30, when work for the season was temporarily suspended. During this time the hydrography of the area remaining unfinished in Ragay Gulf was completed. The topographic survey of the shore line of the Gulf was closed by an 18-mile traverse over the section between Pusgo and Lian Points. An automatic tide gauge was continued in operation until the close of the work.

In October work was begun on the east coast of Palawan and continued until November 6, when the steamer was stranded on a reef during a typhoon and was taken to Manila for repairs. In this region the triangulation was advanced in cooperation with the party on the steamer *Fathomer* from the line Cabulauan to Dalan on the islands of Cabulauan and Dalanganen. This line had previously been established by the party on the *Fathomer*. The resulting figure connected the points Cabulauan, Dalen, Pina, and Norte. From the line connecting the last two points the work was carried to the north, south, and west, connecting the island of Palawan with the general scheme of the triangulation of the Philippine Islands. Signals were erected to the southward as far as the line Pagdanan to Green. Five intersection stations were established and observations for the location of many prominent mountain peaks were obtained.

In January the *Marinduque* began work on the west coast of Mindoro. A main scheme of triangulation was carried up the coast from Apo Reef to Verde Island Passage, and subsidiary points were located for the control of the topography and hydrography. The topography was carried from the mouth of the Luminato River to Balto Point on the north coast of the island, joining with the work of 1906. The inshore hydrography was completed within the same limits as the topography. The offshore soundings were carried to the 1,000-fathom curve, a distance of about 15 miles from the west coast and 5 miles from the north coast. The hydrography included the development of Discovery Bank and Mamburao Reef. Tide staff readings were made in the progress of the work.

[R. F. LUCE, Commanding Steamer *Romblon*.]

SUMMARY OF RESULTS.—Triangulation: 1,433 square miles of area covered, 44 signals and scaffolds erected, 16 stations occupied for horizontal measures, 47 geographic positions determined. Topography: 171 square miles of area surveyed, 210 miles of general coast line surveyed, 6 topographic sheets finished. Hydrography: 1,335 square miles of area sounded, 4,114 miles run while sounding, 59,875 soundings, 6 tide stations established, 10 hydrographic sheets finished.

During the season from July 1 to September 19 the steamer *Romblon* was engaged in general surveys in the vicinity of Burias, Masbate, Sibuyan, and Romblon Islands.

All of the triangulation in the area covered by the instructions for this work had been completed prior to July 1 and the work after that date consisted entirely of topography and hydrography.

The topography done during the period mentioned was the mapping of the shore line of the following localities: North coast of Masbate Island, between Bugui and Colorada Point Lighthouses; Romblon Island, between Tongo and Apunan Points; and Alad and Cobrador Islands.

The hydrographic work done covers the following areas: North coast of Sibuyan Island, near the town of Magallanes; between Bugui and Colorada Point Lighthouses; northeast coast of Romblon Island and shores of Alad and Cobrador Islands; reefs near Cresta de Gallo Island; offshore work east of Sibuyan Island; northeast coast of Romblon Island and north coast of Romblon Island.

In general, in the entire work, lines were run radially to the coast to at least 1 mile from the shore, and beyond that usually parallel to the shore.

Inside the 25-fathom curve the lines were spaced about 100 meters apart and outside the 25-fathom curve from 250 to 275 meters apart except where the bottom was extremely irregular, when a smaller interval was used. Between the 65 and the 110 fathom curves the lines were spaced about two and one-half to the mile. Outside the 110-fathom curve soundings were taken about 3 miles apart.

Tidal observations with an automatic gauge and tide staff were made at Romblon, and a tide staff was also established at Magallanes on the north coast of Sibuyan Island, and continuous readings were taken there, day and night, for five days for the purpose of establishing a plane of reference.

In October, after completing a small piece of work on the northwest coast of Masbate Island, combined field operations were begun in the vicinity of the Lubang Islands.

A tertiary triangulation based upon points previously determined on the east coast of Ambil Island and west coast of Golo Island was carried to a point west of the town of Looc and another on Manog Point, Lubang Island. From the stations determined sufficient points were located to control the eastern section of the Lubang Islands.

Topographic work was done on the north, east, and south coasts of Lubang Island; on the east, south, and west coasts of Ambil Island; and the western half of the south coast of Golo Island. Small detached pieces of topography were also executed on the north and west coasts of Masbate Island.

For the completion of the survey of the Sibuyan Sea small detached pieces of hydrography were executed off the northwest coast of Masbate Island.

In the region about the Lubang Islands hydrographic work was done as follows: On the south coast of Lubang Island from Tapusan to Manog Point; southern part of Golo Passage from Manog Point on Lubang Island to a point on the south coast of Golo Island, about 2 miles east of Golo Passage; off the east coast of Lubang Island, from and including Golo Passage to the town of Looc in Looc Bay; on south and west coast of Ambil Island, extending about 1 mile offshore; Port Tilig; off northeast coast of Lubang Island from Balikias Bay nearly to Antipolo Point; along center of passage Ambil and Lubang Islands; over a strip 1 mile wide on the north coast of Lubang from Port Tilig to connect with work on the west coast of Ambil Island; south coasts of Lubang and Golo Islands from Tapusan Point on Lubang to a point south of the center of Golo Island; and over the area north of Golo Island and east of Lubang and Ambil Islands, extending nearly to the Luzon coast to a connection with the hydrography previously executed.

An automatic gauge was maintained at Port Tilig throughout the season and the staff readings were made at various places.

At the beginning of the calendar year the party attached to the steamer *Romblon* was engaged in combined field operations in the region about the Lubang Islands. That work was commenced on October 31 and completed on February 7, when hydrography was interrupted by the strength of the northward monsoon. The vessel next took up surveys in the vicinity of the Calamianes Islands, which were continued until May 14. Work was then resumed in the vicinity of the Lubang Islands, the weather conditions being again favorable. The survey of the Lubang Islands was completed on June 17 and the vessel was again transferred to the survey of the Calamianes Islands on June 23. The secondary triangulation in the Lubang Islands having been completed in the year 1906, only such additional triangulation was executed as was necessary for the location of points for carrying on the topography and hydrography. For work in the Calamianes the secondary scheme of triangulation was carried northward from points on Cabulauan Islands and Pinachiuyan Islands, Linapacan, Culion, and Galloc Islands to Basuanga Islands. From the points thus established and from those previously established on Culion and Calambagan Islands, a tertiary scheme of triangulation for the location of points for topographic and hydrographic surveys was carried over the region. The topographic work executed during the second half of the fiscal year consisted of the mapping of all those parts of the Lubang group that had not been completed previous to the last report, thus resulting in a complete topographic survey of those islands. The topographic work in the Calamianes included the shore line of the west coast of Culion Islands from Dicabaito to Galloc Islands and the shores of the eastern bay on the north coast of Linapacan. In the Lubang Islands the topography was carried over the entire surface of the islands, in the Calamianes it was carried a few miles inward. The hydrographic work in the Lubang Islands included the inshore and offshore work necessary to complete the survey of that region, extending to the westward to include the 100-fathom curve, to the northward and eastward junction of previous work, and to the southward to a junction of the work executed off the north coast of Mindoro. In the Calamianes, inshore

and offshore hydrographic work was executed within the limits of the topographic work extending from Dicabaito to Galloc Islands off the west coast of Culion and also the eastern bay on the north coast of Linapacan Islands. In connection with the work in the Lubang Islands an automatic tide gauge at Port Tilig was maintained in operation until February 13. Staff readings were taken at various stations throughout the locality of the work. All the staffs in the Lubang Islands were referred to the datum plane established at Port Tilig and those in the Calamianes were referred to the automatic gauge established at Port Uson by the party on the steamer *Fathomer.*

[EBERHARDT MUELLER, Commanding Steamer *Fathomer;* T. J. MAHER, Commanding Steamer *Fathomer.*]

SUMMARY OF RESULTS.—Triangulation: 5,378 square miles of area covered, 20 signals and scaffolds erected, 22 stations occupied for horizontal measures, 102 geographic positions determined. Magnetic work: 6 magnetic stations occupied. Topography: 76 square miles of area covered, 233 miles of general coast line surveyed, 10 miles of rivers and creeks, 15 miles of roads surveyed, 2¾ topographic sheets finished. Hydrography: 4,088 square miles of area sounded, 8,080 miles run while sounding, 56,592 soundings, 5 tide stations established, 2¾ hydrographic sheets finished.

During the period from July 1 to December 31 this party completed the secondary triangulation extending from the Island of Panay, across the northern part of the Sulu Sea over the Cuyo Islands to the island of Palawan, which had been begun in March of the previous year, and extended the survey along the west coast of Mindoro westward to Apo Reef. The topography and hydrography of Apo Reef was completed. Tertiary triangulation was executed in Coron Bay, through Coron Passage and along the east coast of Busuanga Island; the topography of part of the east coast of Culion Island and all of the smaller offlying islands was completed and the inshore hydrography in the same region was almost finished. The offshore hydrography included such soundings as it was possible to make while the triangulation was in progress and about 500 square miles of the comparatively shoal area lying east of Culion Island.

In the survey of Apo Reef the soundings were carried out to depths of 250 to 500 fathoms, with detailed work around the edge and over the reef. A channel running east and west through the middle of the reef was developed, and in this an anchorage affording good protection from the sea was found. The eastern edge of this channel contains many rocks with little depth of water over them, and although passage through is possible it is very dangerous except for small boats.

Numerous uncharted shoals were found and located throughout the region surveyed, many of which are dangerous to navigation.

Tidal observations were made with an automatic gauge on Bisucay Island and at Port Uson on Busuanga Island, and staff readings were taken on Apo Island.

Currents were observed at two stations, one on a shoal 15 miles east-northeast of Nangaloo Island, the other at the southern extremity of Apo Reef.

Magnetic declination was observed at six stations, four in the Calimianes, one on Apo Reef, and one on Dalanganem Island.

The *Fathomer* remained at Manila making repairs and obtaining supplies until March 8, when she returned to the working ground and resumed work on the surveys in the extensive region having the Quinilugan Islands as a central point and extending over the area bounded by Panay, Mindoro, Northern Palawan, the Calamianes, and Apo Reef. This work was continued without interruption until April 26, when the steamer returned to Manila for the purpose of making repairs and transfer of command. The command was transferred from Mr. Eberhardt Mueller to Mr. T. J. Maher on May 2. The field work was resumed on May 8. During the remainder of the fiscal year only a small amount of tertiary triangulation was done for the control of topography and inshore hydrography. The region of triangulation being sufficiently large to engage the hydrographic party for a considerable period. The topographic work was executed on the south shore of Busuanga Island and the north shore of Coron Island. Attention was chiefly confined to hydrography, on account of the vast unsurveyed water area assigned to the steamer. Ship hydrography was carried on in the waters of Cuyos, Cabulauan, and Calamianes Islands and the Apo Reef. This work was offshore from 15 to 40 miles, necessitating observations distant from 15 to 55 miles. Favorable weather conditions permitted the development of numerous offshore shoals. Depths varying from 200 to 1,500 fathoms made up and down casts necessary, and the very regular bottom required a closer development than is usual in such depths. The submarine sentry was used in localities where irregular bottom was found with excellent results in locating shoals. By this means shoal areas missed by the lead were found. Inshore hydrography was executed in Coron Passage and off the east coast of Culion Island. Observations of currents were made at 16 stations. A northwestward current varying from 1½ to 5 knots was found to set from the Sulu Sea to Mindoro Strait. The automatic tide gauge established in Port Uson on November 12, 1912, was still in operation at the close of the fiscal year. Readings for the reductions of soundings were taken from subsidiary staffs at various points. The vessel was in the field at the close of the year.

[H. C. DENSON, Commanding Steamer *Pathfinder*.]

SUMMARY OF RESULTS.—Base lines: 1 base line measured. Reconnoissance: 428 square miles of area covered, 5 stations selected for secondary scheme, 20 lines of intervisibility determined. Triangulation: 2,311 square miles of area covered, 56 signals and scaffolds erected, 43 stations occupied for horizontal measures, 45 geographic positions determined. Azimuth: 1 station occupied for observations of azimuth. Topography: 320 square miles of area covered, 185 miles of general coast line surveyed, 52 miles of rivers and creeks surveyed, 96 miles of roads surveyed, 9 topographic sheets finished. Hydrography: 2,016 square miles of area sounded, 2,377 miles run while sounding, 26,514 soundings, 3 tide stations established, 10¾ hydrographic sheets finished.

At the beginning of the fiscal year the steamer *Pathfinder* was engaged in the survey of the southeast coast of the island of Mindanao in the vicinity of Mayo Bay, where operations were continued until July 27. The steamer then proceeded to Davao Gulf for the purpose of connecting the triangulation previously executed with a base line that had been measured in Pujada Bay on the east coast of the island. Stations Samal and Sigaboy of the previous work were

recovered and remarked and triangulation signals were erected over them. The triangulation connecting Davao Gulf with Pujada Bay was finished by August 15 and work was resumed on the southeast coast of Mindanao between Luban Island and Cape San Augustin. When this was completed the survey to the northward of Mayo Bay was again taken up. From September 7 to October 6 work was in progress between Manay and Baculin Point. Owing to a reported uprising among the mountain tribes back of Baganga it was regarded as unsafe to send parties into the interior and the season's work in this locality was then closed.

A severe typhoon was experienced on October 15 and 16 while in Cebu Harbor. Although many vessels were lost the *Pathfinder* suffered no serious damage. The two launches belonging to the vessel were sunk, but one of them was afterwards recovered.

During the storm the crew of the *Pathfinder* rendered valuable assistance in saving life and property at great personal risk.

On October 23 work was taken up on the unfinished portion of the west coast of Negros between Binalbagan and Sojoton Point. While engaged in this region the steamer encountered three typhoons, one of which made it necessary for the vessel to put to sea, as a harbor could not be reached. On December 5 the survey of the west coast of Negros was finished, and on December 19 the vessel sailed from Manila for Hongkong for necessary repairs.

At the beginning of the calendar year the steamer *Pathfinder* was at Hongkong and arrangements were in progress for making extensive repairs, a special appropriation of $20,000 having been made for the purpose. All the repairs were satisfactorily completed on April 2 and on April 8 the steamer left Hongkong for Manila arriving there on April 11. The steamer arrived at the working ground on May 18 and field operations were commenced the following day.

A base line of 4,450 meters in length was measured at the head of Bislig Bay on the east coast of Mindanao from which a triangulation was extended northward as far as Lamon Point.

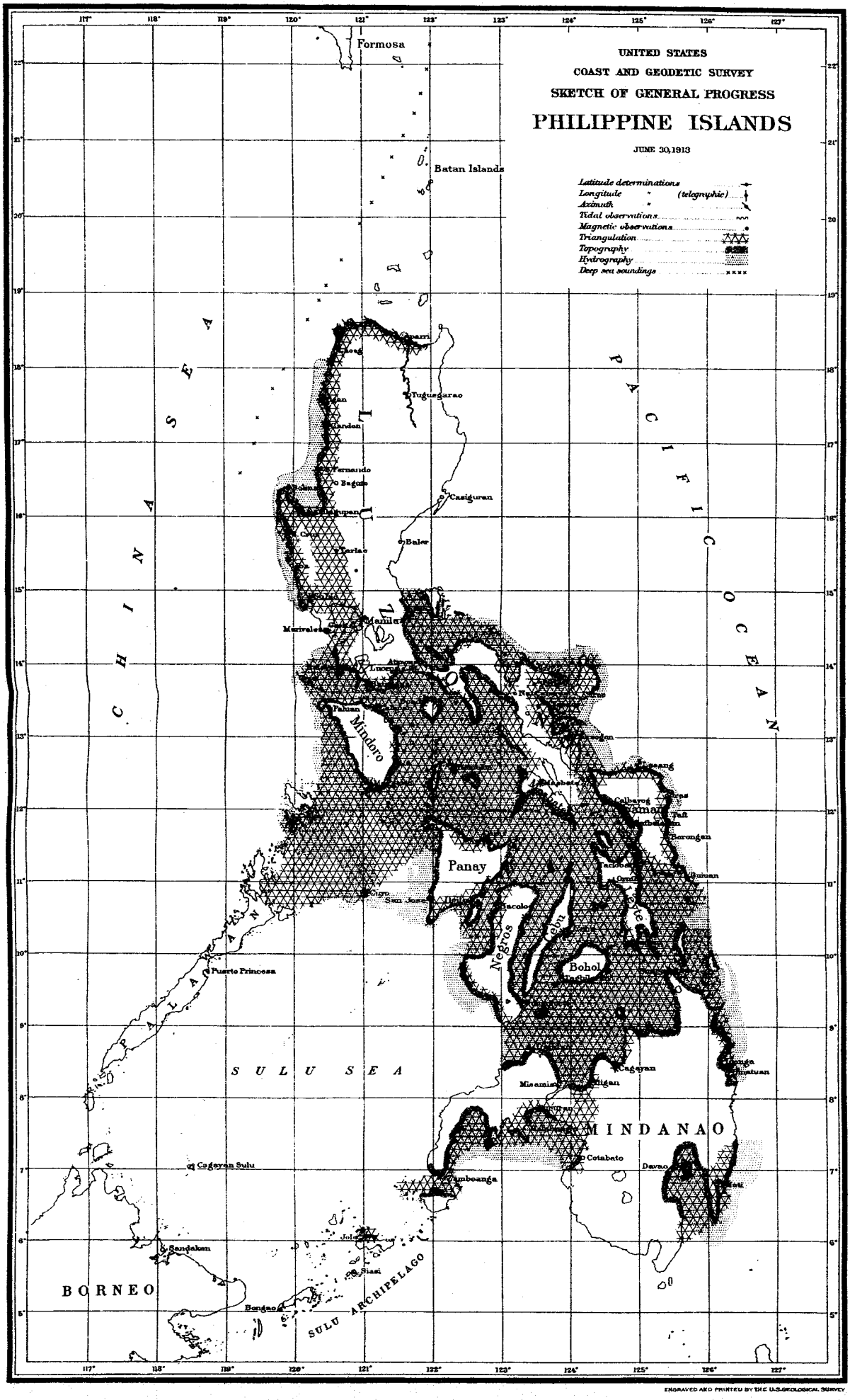
The topographic work was completed from Point Sanco to a point about 6 miles northward of the mouth of the Ninatuan River. The inshore hydrography was completed between Point Sanco and Lamon Point and the offshore work was carried from Point Sanco to the junction of the previous work in Lianga Bay and extending offshore approximately 20 miles. At the close of the year this work was still in progress.

[W. M. HILL.]

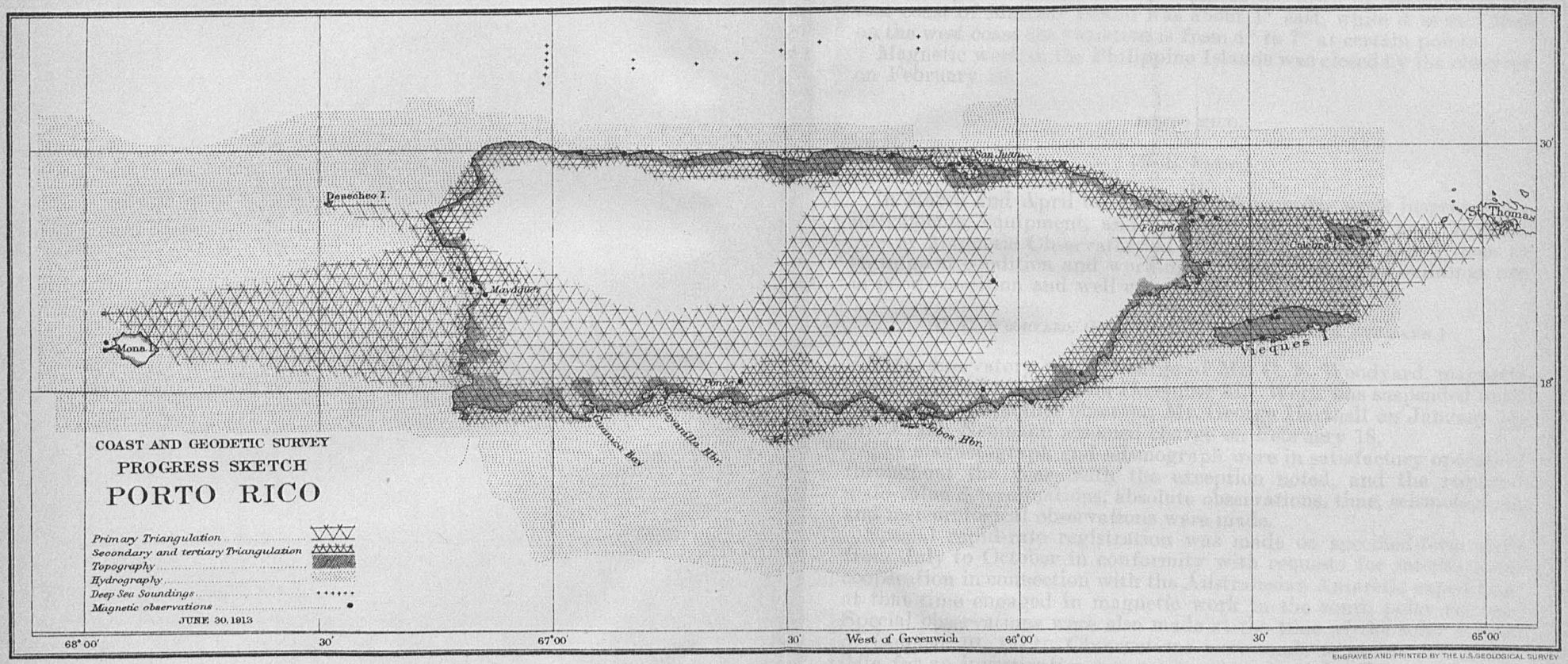
STATIONS OCCUPIED.—Atimonan, Antipolo, Boac, Butuan, Calapan, Calbayog, Catbalogan, Cebu, Cujo, Davao, Iligan, Lucena, Masbate, Misamis, Puerto Princesa, San Jose de Buenavista, Surigao, Tacloban, Vallehermosa.

The magnetic survey of the Philippine Islands begun during the last fiscal year was in progress on July 1.

In the execution of this work an attempt was made to relocate and reoccupy old stations that had been established many years previously. In many cases the marks could not be found and owing to the destruction of the reference points there was not sufficient data to relocate the exact spots where observations had been made. Whenever conditions were favorable, however, observations were made so



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY



ENGRAVED AND PRINTED BY THE U.S.GEOLOGICAL SURVEY

near to the old locations as not to practically affect the secular variation or change.

Observations, practically at the old locations, were made at San Jose de Buenavista, Vallehermosa, Cebu, Misamis, Suriagao, Iligan, Davao, Boac, Atimonan, Romblon, Calapan, Masbate, Calbayog, Tacloban, Catbalogan, Cujo, and Puerta Princesa.

In addition to the occupation of old stations, in cases where the locations were not suitable for future observations, new stations were established at Misamis, Iligan, and Calbayog. The stations Butuan and Lucena were established at places not before occupied.

The magnetic declination obtained at the town of Masbate on the east coast of Masbate Island was about 1° east, while it is said that on the west coast the variation is from 4° to 7° at certain points.

Magnetic work in the Philippine Islands was closed by the observer on February 20.

PORTO RICO.

[R. L. FARIS.]

In March and April the inspector of magnetic work inspected the instruments, equipment, and operation of the Coast and Geodetic Survey Magnetic Observatory at Vieques, P. R., and found them to be in good condition and working satisfactorily. The buildings are in good condition and well cared for.

[C. F. WOODYARD, GEORGE HARTNELL, and FRANK NEUMANN.]

This observatory was in charge of Mr. C. F. Woodyard, magnetic observer, until his death on December 31. Work was suspended until the arrival of another observer, Mr. George Hartnell on January 18. Mr. Frank Neumann assumed charge on February 18.

The magnetograph and seismograph were in satisfactory operation throughout the year, with the exception noted, and the required scale-value determinations, absolute observations, time, seismological, and meteorological observations were made.

Special rapid-rate registration was made on specified-term days from July to October in conformity with requests for international cooperation in connection with the Australasian Antarctic expedition, at that time engaged in magnetic work in the south polar regions. Special observations were also made at the time of the solar eclipse of October 10, 1912. Observations were made to secure additional data for an investigation concerning the cause of different values of Z-scale value resulting from deflections at different distances, and measurements were made for a further investigation of D-scale value.

About 30 earthquakes were recorded during the year.

HAWAIIAN ISLANDS.

[J. C. GAUGER.]

SUMMARY OF RESULTS.—Triangulation: 49 square miles of area covered, 10 stations occupied for horizontal measures, 10 stations occupied for vertical measures, 28 geographic positions determined, 12 elevations determined trigono-

metrically. Topography: 15 square miles of area surveyed, 28.4 miles of general coast line, 2 miles of shore line of creeks, 1 mile of shore line of ponds, 48.4 miles of roads, 3 topographic sheets finished.

The triangulation on the north coast of the island of Maui, completed during the season of 1912, measures 14 miles along its axis and covers an area of 49 square miles. The work is connected with four stations of the territorial survey. The original marks at many of these stations have been lost.

The unsurveyed shore line on the north coast of Maui from Huelo to Kahului was completed by August 28, together with the inshore topography needed for chart purposes. The work was done on scales of 1/20,000 and 1/10,000.

After closing work on the island of Maui preparations were begun for the survey of the island of Hawaii.

[E. R. HAND.]

SUMMARY OF RESULTS.—Triangulation: 75 square miles of area covered, 37 signal poles erected, 27 stations occupied for horizontal measures, 3 stations occupied for vertical measures, 50 geographic positions determined. Topography: 23.5 square miles of area surveyed, 99.3 miles of general coast line, 110 miles of roads and railroads, 7 topographic sheets finished.

The triangulation and topography of the island of Hawaii was taken up by this party in continuation of the work begun by Assistant J. C. Gauger. Operations were commenced in the vicinity of Hilo.

In the triangulation the lines of the old Hawaiian government survey were used in bases from which supplementary points were determined for topographic control, and from the old and new stations intersection stations were located with a view to future use as hydrographic signals. All of the old stations were re-marked and descriptions of them prepared. In the topography two sets of plane-table positions were determined with a view to their use by hydrographic parties. For this purpose were chosen conspicuous objects on cliffs, natural or artificial, and also points along the water line which can be identified in future and whitewashed or otherwise marked.

Points determined by the Coast and Geodetic Survey in 1900 which have been removed and rebuilt were relocated trigonometrically. Of these Alia Point Light was the most important. Improvements at Hilo Harbor were located on a topographical sheet.

By December 31 work was completed as far as the town of Laupahoehoe.

At the beginning of the year the party was engaged in extending the triangulation from a primary line of the old Hawaiian system into the Laupahoehoe Valley for the control of the survey of that valley and for the location of a new lighthouse to be constructed there, and for this purpose three triangulation stations were established.

Continuing westward along the coast secondary stations were established along the sea, based on the Hawaiian triangulation, for the topographic control and for use as checks.

In Kohala the primary line Puu o Nale to Kauhola was chosen and the scheme extended eastward as far as the islands of Honokea Gulch and westward so as to control the northwestern extremity of the island.

All prominent artificial objects useful as aids to navigation or for hydrographic signals were determined by triangulation. All old primary stations near the coast were re-marked where necessary. Photographs were made to aid in the identification of the higher and more conspicuous stations.

The shore line was completed a point east of Hilo westward to the town of Kawaihae. Prominent objects were located and signals erected for hydrographic work.

Progress westward from Waipio Valley was made difficult by the high cliffs. Working westward from the Waimanu Valley the way was barred by a point jutting out into deep water. This difficult stretch of cliff line was finally completed, however.

[J. B. MILLER, Commanding Steamer *Patterson*.]

SUMMARY OF RESULTS.—Hydrography: 991 square miles of area covered, 1,986 miles run while sounding, 14,266 soundings, 5,499 positions determined, 2 tide stations established, 8 hydrographic sheets finished. Physical hydrography: 15 current stations occupied, 433 readings of current pole, 543 surface temperatures observed.

Between November 27 and March 31 the Steamer *Patterson* was engaged upon surveys in the Hawaiian Islands, and during that period completed the hydrography of the windward side of Maui Island, and a portion of Penguin Bank, off the southwestern part of Molokai Island.

The topography of Maui Island having been recently revised, it was possible to begin the work of sounding at once, using the signals erected by the topographic party. Work was begun at the limit reached by the steamer *Pathfinder* in 1900 at Kaanapali Landing (Kekaa Point), west Maui, and from there the inshore sounding and also the offshore sounding to a distance of 6 to 11 miles from the shore, was completed along the northwest, north, northeast, east, and southeast coasts as far as Kaupo Landing on the southeast coast, a distance of 76 miles. Included in the survey, among other features, were the approaches to Kahului, the entrance and anchorage at Hana Cove, and several other landings of more or less importance or interest. For a distance of 21 miles on the south coast of Maui the hydrography is incomplete. This portion is uninhabited and has no ports or landings. Sounding work was done off the island of Molokai, on Penguin Bank, and an area of about 20 miles long and 7 miles wide was covered, lying directly in the track of interisland shipping.

In the offshore soundings the lines were spaced at the following intervals: 25 to 35 fathoms, one-sixth mile; 35 to 100 fathoms, one-third mile; 100 to 300 fathoms, 1 mile; 300 to 1,000 fathoms, 2½ miles. On doubtful spots and shoals special developments and detached soundings were made. Soundings were generally spaced at the same intervals along the lines except at critical places where they were spaced one-sixteenth mile and closer. For the inshore soundings the lines were spaced one-eighth mile apart on the average and generally not crossed; at critical or important places they were much closer and were crossed; in Hana Cove they were run one thirty-second mile apart in both directions.

Tides were observed with an automatic gauge at Kahalui Harbor on the north coast of Maui Island throughout the season, and a continuous series of one week was obtained at Hana Cove for comparison. The tides are very small and of little interest or importance except in Kahului Harbor, where the large ships have very scant depth for loading and sometimes load to within 1 or 2 feet of the bottom. The seiches and so-called tidal waves are of more importance. No tidal wave was registered on the gauge, but the seiches were registered continually, having a period of about one-third to one-half hour and a range of one-half to 1½ feet.

Current observations were made at 15 stations around Maui and Molokai Islands. The results showed a strong current from the south, setting against the prevailing wind; on the east and west extremity of Molokai Island this current has a strength of 1 to 2 knots, while along the northern and southern coasts it is weak and variable. The tide causes a slack in this current but does not reverse it, and the wind has little effect on it, but it seems to be affected by disturbances of the barometer.

[J. W. GREEN.]

The regular series of observations were continued at the Honolulu Magnetic Observatory during the year. The magnetographs recording declination, horizontal intensity, vertical intensity, and temperature were in continuous operation. Special rapid-rate registrations were made on specified days. Hourly scalings were made from the magnetograph traces for each of the elements as well as maximum and minimum values for each day.

Absolute observations for the purpose of base-line determination were made once each week. Scale values of the variometers were determined once each month.

The Milne seismograph was kept in continuous operation. The sensibility and period of the pendulum were determined at intervals.

Meteorological observations were made each day, and transits of stars were observed each week for chronometer corrections.

SPECIAL DUTY.

NEW YORK.

[E. G. FISCHER and G. W. CLARVOE.]

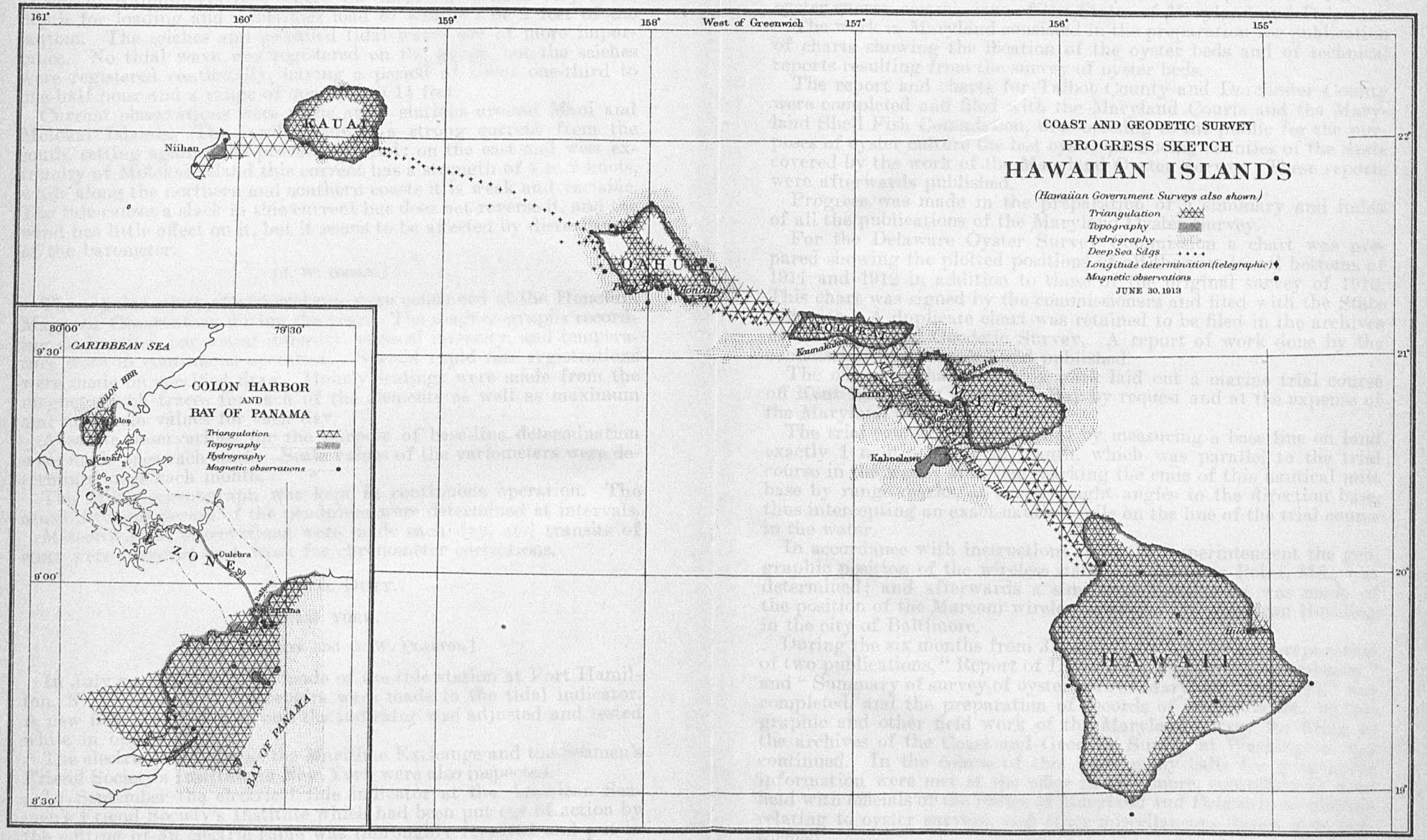
In July an inspection was made of the tide station at Fort Hamilton, N. Y., and necessary repairs were made to the tidal indicator. A new float was installed and the indicator was adjusted and tested while in operation.

The electric indicators at the Maritime Exchange and the Seamen's Friend Society's Institute in New York were also inspected.

In September the electrical tide indicator at the American Seamen's Friend Society's Institute which had been put out of action by the cutting of an electric cable was thoroughly repaired and put in working order.

The tide staff at the end of Pier 51, which had been destroyed, owing to its exposed situation, was not replaced. The electric cable was repaired and proper connections made.

This work was done between September 5 and 9.



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

MARYLAND.

[CHAS. C. YATES.]

Work was continued during the year in cooperation with the oyster survey commissions of the States of Maryland and Delaware.

The work in Maryland consisted in the preparation for publication of charts showing the location of the oyster beds and of technical reports resulting from the survey of oyster beds.

The report and charts for Talbot County and Dorchester County were completed and filed with the Maryland Courts and the Maryland Shell Fish Commission, thus opening to the public for the purposes of oyster culture the last oyster producing counties of the State covered by the work of the Maryland Oyster Survey. These reports were afterwards published.

Progress was made in the preparation of a summary and index of all the publications of the Maryland Oyster Survey.

For the Delaware Oyster Survey Commission a chart was prepared showing the plotted positions of all the new leased bottoms of 1911 and 1912 in addition to those of the original survey of 1910. This chart was signed by the commissioners and filed with the State librarian. A duplicate chart was retained to be filed in the archives of the Coast and Geodetic Survey. A report of work done by the commission was prepared and published.

The officer in charge of this work laid out a marine trial course off Kent Island in Chesapeake Bay by request and at the expense of the Maryland Steel Co.

The trial course was established by measuring a base line on land exactly 1 nautical mile in length, which was parallel to the trial course in the water, and then marking the ends of this nautical mile base by range marks, at exactly right angles to the direction base, thus intercepting an exact nautical mile on the line of the trial course in the water.

In accordance with instructions from the Superintendent the geographic position of the wireless station at Sparrow Point, Md., was determined; and afterwards a similar determination was made of the position of the Marconi wireless tower on the American Building in the city of Baltimore.

During the six months from January 1 to June 30 the preparation of two publications, "Report of Delaware oyster survey commission" and "Summary of survey of oyster bars of Maryland 1906–1912," was completed, and the preparation of records of triangulation, hydrographic and other field work of the Maryland survey for filing in the archives of the Coast and Geodetic Survey at Washington was continued. In the course of this work many calls for geographic information were met at the office in Baltimore, consultations were held with officials of the States of Maryland and Delaware on matters relating to oyster surveys, and other miscellaneous duties were performed.

At the end of the fiscal year the only work remaining to be done was a small amount of office work connected with the publications of the Maryland and Delaware surveys and the completion of the triangulation and hydrographic records for filing in the archives of the survey at Washington.

DISTRICT OF COLUMBIA.

[H. G. AVERS.]

Between February 21 and March 5 a line of levels was run to determine the elevation of a point near the new seismological observatory of Georgetown University. Two rodmen and a recorder, students of the university, were provided for this work without expense to the Government.

The elevation is based upon a bench mark of the District of Columbia topographical survey located near the university grounds and about one-half mile from the observatory. The line of levels was run forward and backward between the two points.

[GEORGE D. COWIE.]

SUMMARY OF RESULTS.—Topography: 5 square miles of area surveyed, 1 topographic sheet finished.

At the request of the Supervising Architect of the Treasury Department a topographic survey was made between November 25 and December 17 of the grounds of the Hygienic Laboratory, Washington, D. C., elevations being determined at intervals of 10 feet over the entire ground. This necessitated running a preliminary line of levels between established bench marks of the District of Columbia survey and a temporary bench mark on the laboratory grounds.

The extreme difference of elevation was about 70 feet. Levels were run in loops so that a check was obtained on each section of the work. A plat of the survey was completed giving elevations every 10 feet, 10-foot contours, boundaries, and bench marks.

[O. B. FRENCH.]

SUMMARY OF RESULTS.—Reconnoissance: 75 square miles of area covered, 35 lines of intervisibility determined, 11 points selected for scheme. Base lines: Secondary, length of 2½ kilometers. Triangulation: 75 square miles of area covered, 11 signal poles erected, 11 stations occupied for horizontal measures, 35 geographic positions determined. Leveling: 25 elevations determined by leveling, 7 miles of levels run.

In September work was begun on a triangulation undertaken at the request of the Department of Justice for the purpose of accurately locating and marking in a permanent manner the line of Florida Avenue. While the monuments were being placed under the direction of the surveyor of the District of Columbia, a reconnoissance was made and a comprehensive scheme of triangulation was executed covering the principal portion of the District of Columbia and connected with primary stations Hill, Capitol, and Theological Seminary. A number of intersection stations were observed and points located as near Florida Avenue as possible for the purpose of connecting the traverse along Florida Avenue with the triangulation.

By the time the triangulation was finished the stone monuments had been set and the measurements between them were proceeded with. These monuments were placed so that the adjacent stones are intervisible, 5 being on the north side of Florida Avenue and 15 on the south side. Most of them are set in the sidewalk and all are in

the space between the curb and the property line. The stones are of granite 8 by 8 inches and 4 feet long set in concrete with top 4 to 6 inches below the sidewalk or ground. Each is covered with a cast-iron box with a lid which is set in the ground so as to afford ready access to the top of the stone and to protect the mark from wear and possible disturbance. The center of each station is indicated by a regular triangulation station mark set in a drill hole in the top of the granite post. Each is a bench mark as well as a station mark. The distances between the monuments were measured with an invar tape.

Precise levels were run in both directions over the whole line and each end connected with bench marks of the Coast and Geodetic Survey. At the east end a complete circuit was run in both directions from the Capitol bench mark along North Capitol Street (connecting with the Printing Office bench mark) to Florida Avenue, to Fifteenth Street East and returning via Maryland Avenue to the Capitol bench mark.

After getting the connection between the measured line along Florida Avenue and the triangulation a small discrepancy in the measures was developed, making necessary the introduction of a base line into the scheme. A base was accordingly measured in Potomac Park just southeast of the railroad. It was measured with two invar tapes and satisfactorily connected with the triangulation. The final connection between the traverse and the triangulation is not yet entirely completed. A number of points used by the United States Engineers in their work around the harbor were determined in position by triangulation.

On June 16 work was begun on a revision of triangulation of the Potomac River between the Aqueduct Bridge and Little Falls and six stations were selected. This work was in progress at the end of the month.

VIRGINIA.

[Earl F. Church.]

In October, in accordance with the arrangement made with the Bureau of Lighthouses, the light vessels at Winter Quarter Shoal and Fenwick Island Shoal were visited; apparatus for making current observations was installed and instructions were given the masters of those vessels as to the method of making the observations desired. It was intended that the series of observations should continue for three months. Transportation was furnished the officer on this duty by the lighthouse steamer *Orchid*.

[H. A. Seran.]

In March and April a number of objects on the north shore of Hampton Roads were determined in position for the use of ships anchoring in the naval anchorage grounds in Hampton Roads.

The objects determined are prominent chimneys, church spires, houses, and other objects readily identified.

The triangulation of the southern branch of Elizabeth River was connected with that of Hampton Roads.

The position of the Bayville chimney in the vicinity of Cape Henry was determined by triangulation. This work was closed on April 22.

MISSISSIPPI RIVER COMMISSION.

[H. P. RITTER.]

As authorized by law an officer of the Coast and Geodetic Survey continued to serve as a member of the Mississippi River Commission in addition to his other duties, and attended the meetings of the commission held at St. Louis, Mo., in July, August, and October.

INTERNATIONAL BOUNDARIES.

[O. H. TITTMANN, *Commissioner.*]

UNITED STATES AND CANADA BOUNDARY.

[C. H. SINCLAIR.]

SUMMARY OF RESULTS.—Base lines: 1 base line measured. Triangulation: 550 square miles of area covered, 3 signal poles erected, 12 observing tripods and scaffolds built, 24 stations occupied for horizontal measures. Line measure and monumenting: 15 miles of double measure with invar tapes, 19 monuments set on bounding (including 2 reference monuments).

Work on the forty-ninth parallel boundary between the United States and Canada east of the Rocky Mountains, between the Red River of the North and Lake of the Woods, was resumed in May, 1912.

Work was begun at the terminal line of the Canadian work of the preceding season about 1 mile west of the Red River, and by June 30, 10 stations in the main scheme of triangulation and 9 subordinate stations had been occupied, and 9 signal poles and 7 scaffold signals erected.

The banks of the Red River in this region are lined with tall cottonwood trees through which it was necessary to cut in order to clear the lines of sight. A central point, the cupola of the town hall at Emerson, saved the clearing of two diagonals in the quadrilateral. From a distance of 12 miles from Red River to the Lake of the Woods the country is covered with forest timber, necessitating the use of signals from 20 to 90 feet in height for the triangulation. The distance between the monuments east of No. 58 was measured with a 50-metar invar tape, and the monuments were occupied to carry along the azimuth. It was found impracticable to accurately determine the positions of monuments in the woods in any other way.

Between monuments 65 and 54 connection was made with the line States-Canada, the terminal of the ninety-eighth meridian triangulation by means of a 7-mile line Humboldt-Orleans, forming a quadrilateral to the south, and incorporating the line Furney-Joe, the south side of a quadrilateral in the regular scheme. This line, 11 miles long, was used as a base for the triangulation near Red River, and saved the measurement of a base and azimuth.

Transportation was difficult owing to the swampy nature of the ground traversed and the absence of good roads.

East of the Roseau River it was necessary to expand the scheme of triangulation and increase the height of the towers.

As a terminal base nearly 6 miles long had been measured along the Canadian railway running north out of Warroad across the boundary it was thought best to occupy the base points first. The

signals were first raised to a height of 70 feet, and later on South Base was carried up 90 feet in order to see over the tall trees to the west and reach points about 20 miles distant on the shores of Lake of the Woods and furnish a line for the Canadian triangulation that was being carried from the North West Point, along the Water boundary, to the mouth of Rainy River.

Eight towers from 65 to 90 feet in height were erected by a special signal building party. Sixteen signals from 30 to 55 feet high and one 22 feet high were put up by the members of the regular triangulation party. A signal pole 100 feet in height was erected over astronomical station Sprague. The latitude and longitude of Sprague, which is about 2 miles north of the boundary, were determined by the Canadian surveyors.

Monuments were taken to their final sites in the spring of 1912, together with sand for setting them, but the cement could not be left exposed so long and was taken in at the time that the monuments were set. This proved a laborious task where horses could not be used.

An azimuth was determined at South Base, Warroad, early in October, and referred to Buffalo Point, 6.5 miles distant, a station in the triangulation.

After the reconnoissance and signal building were completed to the west edge of the Lake of the Woods, it was found that two lines were obstructed by tall trees on a ridge about 3 miles west of the Warroad base, and owing to the lateness of the season the clearing of these lines was not attempted and work was closed early in November.

In March two members of the party were sent to Warroad to set monuments on the meridian boundary before the melting of the ice, and also to place monuments at right angles to the meridian for the purpose of marking the intersection of the north and south boundary and the boundary running southeastward. The position of this intersection point had been temporarily located by Mr. E. C. Barnard in 1912. On the ice there was very little difficulty in finding this point and locating it permanently by means of reference monuments in firm ground. These reference monuments are similar in every respect to the regular boundary monuments except that they have no lettering on them but the words "Reference Mark."

The meridian line from monument 1 to monument 7B was measured twice with an invar tape. Four monuments were set on the Parallel Boundary. Good foundations were found for all of these monuments by digging down to firm clay.

One observer had charge of the triangulation and tape measurement necessary to fix the position of the North West Angle, and another had charge of the reconnoissance, transportation, and signal building. At Fort Frances a base was laid out and a tower 80 feet high was erected at each end. Towers were built on Lake of the Woods at stations Gould, Long Point, and Big and poles were erected at Burton and Oak to furnish control for the topography as far as the mouth of Rainy River. The heights of the towers constructed ranged from 60 to 85 feet.

In order to complete the triangulation of the forty-ninth parallel west of the Warroad base a tower was erected and occupied at Guibo, and Sandy and Salol were reoccupied to strengthen the determination

of Sprague, the Canadian latitude and longitude station. The tower at West Base, which had been destroyed by a storm, was reerected; three towers were constructed in the vicinity of Rainy Lake, and a reconnoissance was made down Rainy River.

All of the observations at the stations on Lake of the Woods were completed by June 20.

On June 25 a base 8,062 meters in length was measured along the south rail of the Canadian Northern Railway west of Fort Frances, Ontario, using two invar tapes, the measurements being made in opposite directions.

Mr. I. Pounder, representing the British commissioner, assisted in the base measurement.

An inspection was made of the entire length of Rainy River to obtain information necessary for the extension of the triangulation.

[E. C. BARNARD.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 15 miles, 9 points selected for scheme. Triangulation: Primary, 9 stations selected, 2 signals erected, 6 primary and 12 secondary stations occupied for measurements of horizontal angles. Leveling: 155.5 miles of levels run, 74 permanent and 100 temporary bench marks established. Topography: 209.5 square miles of area surveyed, 95 miles of topographic belt along boundary, 100 square miles of plane-table triangulation. Boundary location: 102 miles of boundary located, 82.5 miles of vista cut, 76 monument sites recovered, 14 new monument sites located. These statistics include some work done in the spring of 1912.

The work of surveying and marking the boundary between the United States and Canada east of the summit of the Rocky Mountains was in progress at the beginning of the fiscal year. The work of this party included the topography, interpolation of monument sites, vista cutting, and leveling. During the season of 1912 these operations were completed from monument 70 on the west bank of Red River to monument 1 on the west shore of the Lake of the Woods and from the northwestern point of Lake of the Woods south to monument 7A. A part of this work has already been mentioned in the last annual report.

On June 30 the topographic work had advanced to monument 31, a distance of 39 miles along the boundary, 78 square miles having been mapped; the leveling to monument 25, a distance of 44 miles along the boundary, 88 miles of levels having been run; and the vista cutting to monument 28, 41 miles along the boundary. During the months of February and March preceding the iron monuments, weighing 400 pounds apiece with the necessary sand for the concrete foundation, nearly 1 ton in all to each monument, had been placed at the monument sites between Great Roseau Swamp and Lake of the Woods, the swamp being impassable for horses in the summer.

On July 17 the chief of party proceeded to Warroad, Minn., and had a conference with the Canadian surveyor, Mr. J. J. McArthur, and with him inspected the conditions at Northwest Angle, Lake of the Woods.

During the temporary disability of the levelman, Mr. J. L. Rannie, the Canadian surveyor, rendered valuable aid in the leveling work. Some triangulation stations were selected and signals were erected on the western shore of the Lake of the Woods. Assistance was ren-

dered to the American party engaged in measuring base lines along the boundary and also to the party engaged in signal building for the triangulation party.

All of the work on the forty-ninth parallel was completed on September 18 and the party proceeded to Warroad, Minn., on the Lake of the Woods, where power boats were hired for the transportation of the party and supplies. Instructions had been received to make a detailed map of the section of the Northwest Angle extending from the northwest point to monument 1. Diligent search was made for some mark in the vicinity of the northwest point, the location of which was determined by measuring from monument 1 the distance recorded in the report of the former commission, but nothing was found but a tripod 350 feet northwest of the point, erected in 1872 by the former commission, and which was still standing.

While camped on Harrison Creek, a base line 2732 feet in length, for control of the detailed map on scale of 400 feet to 1 inch, was measured with an invar tape, and a plane-table triangulation was expanded to the northwest point. A flag was set in the center of the channel on the extension of the north and south line from monument 1 to mark the most southerly intersection of the water boundary with the north and south boundary line, and a second flag was erected to mark the north and south boundary line near the northwest point. Toward the end of September a trip was made to the boundary line crossing on Stony Creek and the vista along the boundary cut in 1873 was found to be still clear of timber. On September 4 and 5 soundings were taken in the channel of Bear Creek, and the soundings were located on the plane-table sheet.

From monument 7 southward to the point where the north and south boundary line intersects the Lake of the Woods, a distance of 7 miles, the vista along the line had been cut, but apparently no permanent marks had been left and no record of any marks nor of distances on this section of the boundary is to be found in the report of the former commission. It was therefore necessary to extend the north and south boundary line and to locate additional monument sites to the south. For this purpose a 20-foot tower was erected over the site of monument 6 which stood on a high granite ledge. From the top of this tower monument 7 to the south as well as the signals erected over monuments 5, 4, 3, 2, and 1 were visible. The vista cutting was extended to the south across Stony Creek and the monument site for 7B was located by the extension of the line north of monument 6. The site for monument 7A, which was not visible from the tower at monument 6, was located by a line of sight from monument 7 to monument site 7B. The triangulation stations—New Rice, Old Rice, Pine, and New Loon, which had been established by the Canadian party in connection with the survey of the water boundary and monument 1, were occupied by the Canadian surveyor, Mr. J. L. Rannie, to connect the north and south boundary line with the system of triangulation through the lake as well as to determine the position of the flag marking the intersection of the water boundary with the north and south line. Observations of azimuth were made by the same officer at the triangulation station New Rice to determine the azimuth of the north and south boundary line. The distances between the monuments on the north and south line were measured with an invar tape.

On October 16 the levelman and one hand were sent westward along the boundary to determine and stamp all of the permanent bench marks that had been set in the monuments up to that date. Supplies of sand were placed at the point on Stony Creek selected for winter operations.

The main party was disbanded about the middle of October, but some field work of leveling and topography was done until December 1. During the winter the placing of monuments and of cement and sand for the concrete foundation was continued.

In January, 1913, the work was begun of transporting to the proper localities the cast-iron monuments and sand and cement for the foundations on the north and south boundary line from the northwest angle south to the Lake of the Woods, and the distances along the boundary between the monuments were measured in both directions with an invar tape under tension. After the completion of this work certain monuments were transported to their proper positions on the forty-ninth parallel boundary line and a 20-foot vista was opened along the north and south boundary from monument 7C south to the Lake of the Woods, a distance of 4½ miles. Bench marks were established at a distance of 5 miles apart for the entire length of Rainy Lake and Lake Namakin and a bench mark was established on Lake of the Woods near Zipple. The elevations of these bench marks above the water level of the lake were determined by leveling. Tide gauges at Warroad on Lake of the Woods, at Ranier on Rainy Lake, and near Kettle Falls on Lake Namakin were read during the operation of placing these bench marks. Some of the leveling was done at a temperature of 40° below zero, Fahrenheit.

A level line was also run from the tide gauge near Kettle Falls at the head of Rainy Lake to the tide gauge on Lake Namakin, a distance of 3 miles.

After the completion of the work mentioned and the location of the boundary from monument 7C to the shore of the Lake of the Woods the topography along the north and south boundary line and along the shore westward from Stony Point was taken up.

Work was completed to the Lake of the Woods on June 18 and was begun on Rainy Lake on June 24.

Triangulation was begun on Rainy Lake on June 1 and by the end of the month the reconnoissance had been completed as far as Brule Narrows about halfway up the lake.

A detailed survey on a scale of 1/5,000 was made of the portion of Rainy River extending below the dam at International Falls to above the railroad bridge at Ranier. For the control of this work a base line 4,000 feet in length was measured and the triangulation extended to locate the necessary boundary reference points along the river.

By the close of the year the topographic mapping was completed along the north and south boundary line from monument 7C to Lake Shore and from Stony Point along the west and south shore of Lake of the Woods to and including the mouth of Rainy River, scale 1/45,000, a distance of 70 miles along shore. A detailed topographic map of Four Mile Bay, mouth of Rainy River, Lake of the Woods, on a scale 1/20,000, were also completed.

Mr. I. R. Pounder, representing the British commissioner, joined the party on June 10 and assisted in the triangulation.

[O. B. FRENCH.]

SUMMARY OF RESULTS.—Base lines: 10 secondary, measured, aggregate length 29,391 meters. Triangulation: 27 square miles of area covered, 31 signal poles erected, 28 stations occupied for horizontal measures, 21 stations occupied for vertical measures, 13 geographic positions determined, 12 elevations determined trigonometrically. Leveling: 600 elevations determined by leveling, 18.02 miles of levels run.

The party engaged in measuring base lines on the boundary between the United States and Canada was on July 1 engaged in the final details connected with the measurement of a base at Souris, S. Dak. From this place the party went to Sherwood, N. Dak., where an extra base was measured and connected with the line Morse to Center about 10 miles west of Sherwood. This base was made necessary by failure to recover the stations selected before taking the field. The next base measured was at Portal, N. Dak., after which in turn were measured the Ross, Knute, Ogden, Green, Sowers, Kirk, St. Marys, and Warroad bases, the last being completed August 26. An officer was engaged in completing the levels along the Warroad base until the end of August.

All base lines were measured with invar tapes which were standardized before and after the field work. They were used with supports at 25-meter intervals on most of the bases. When the wind was strong two extra supports were inserted, making the intervals 12½ meters. Where the bases were measured along a railroad the tape rested along one of the rails for its whole length.

A double line of levels was run over each base line to give elevations for reduction to a horizontal line and also for reduction to sea level, vertical angles being also measured for this purpose when necessary.

All base lines were carefully marked with both surface and underground marks.

[F. D. GRANGER.]

SUMMARY OF RESULTS.—Hydrography: 27 square miles of area sounded, 264 miles run while sounding, 908 positions determined, 11,397 soundings, 2 permanent and 5 temporary tide stations established, 4 hydrographic sheets finished.

The party engaged in the survey of the boundary between the United States and Canada from the northwestern angle of Lake of the Woods and to the southward along that lake was in the field at the beginning of the fiscal year. This party was under the charge of Mr. J. J. McArthur of the Canadian boundary survey. Mr. F. D. Granger, who had been detailed to this party as the representative of the United States commissioner, remained on this duty until the close of the season in November.

On July 1 the survey of the boundary had been carried only a few miles down Northwest Angle Inlet from the starting point at Northwest Angle. Weather conditions were generally unfavorable to such a degree as to retard the progress of the work. The entire distance along the boundary covered by the triangulation and topography was 25 miles.

In addition to the triangulation above mentioned a larger scheme expanding from the smaller in the vicinity of American Point and Oak Island was planned, but little progress was made in its execution. One of the objects of the larger scheme was to cover the lower por-

tion of the lake and at the same time make connection with the boundary triangulation in the vicinity of Warroad, Minn., and Buffalo, Ontario, brought from the west along the forty-ninth meridian by one of the American boundary parties.

Following the small scheme of triangulation along the boundary reference marks for defining the exact position of the line were placed at various points between Northwest Angle and the easternmost point of Oak Island (Island No. 1).

As the precise location of the boundary from Island No. 1 to the north of the Rainy River depends upon the interpretation the commissioners may put upon the wording of the treaty defining it, no reference marks were set below the easternmost point of Island No. 1.

The reference marks used, all of which were connected with the triangulation, were bars of iron 2 inches square and 45 inches long, with sharp pyramidal top, and were each set in a bed of concrete 2 feet square by 3 feet deep.

While the other work was in progress a hydrographic survey of the lake along the boundary was made by the American surveyor.

Mr. Granger returned to Warroad on April 29 to make preliminary arrangements necessary for resuming field operations.

Field work was begun on May 27 at Bear Island, Ontario, and from that date to the close of the fiscal year the triangulation, topography, and hydrography were advanced as rapidly as possible.

[W. B. FAIRFIELD.]

SUMMARY OF RESULTS.—Reconnoissance: 50 points selected for scheme. Triangulation: 29.2 square miles of area covered, 282 stations occupied for horizontal measures, 107 stations occupied for vertical measures, 347 geographic positions determined, 196 elevations determined trigonometrically. Azimuth: 4 azimuth stations occupied, azimuth observed on 9 nights. Topography: 45 square miles of area surveyed, 41.5 miles of boundary surveyed, 81.15 miles of shore line of rivers and creeks, 12 topographic sheets finished.

The party engaged in the survey of the international boundary between the United States and Canada from Pigeon River and the Lake of the Woods was in the field at the beginning of the fiscal year. The work had been resumed on June 9 on Round Lake and was carried on continuously until October 29, when the party was disbanded at Prairie Portage on North Lake.

The triangulation was taken up at Round Lake and continued to the westward as far as the western end of Knife Lake, including all of the lakes, rivers, connecting streams, and divides along the boundary. Owing to the dense growth of timber it was necessary to reduce the size of the scheme in several places, and much cutting was necessary at nearly all of the stations.

Saganaga Lake is a large irregular-shaped body of water with large bays extending to the east into Canada and to the south into Minnesota. It is the largest lake along the boundary west of Lake Superior and contains many islands. The shores of the lake are steep and rocky with wooded bluffs from the water's edge. Several soundings were made in the main part of the lake, the greatest depth recorded being 104 feet.

Swamp Portage across the southern part of Hunters Island and connecting Swamp Lake with Cypress Lake leads over a rocky ridge

60 feet high at its highest point and heavily wooded; it is about 420 meters long. There is no water communication between Swamp and Cypress Lakes, the portage trail being the most direct route between the two lakes. From Swamp Lake the water flows easterly into another small lake, thence into Saganaga, but the flow of water is very small. The waters of Cypress Lake flow westerly into Knife Lake. Cypress Lake is a very long narrow body of water with high rock cliffs on either shore. These cliffs rise to height of from 100 to 200 feet.

Little and Big Knife Lakes are virtually one lake, the connecting stream being some 60 meters wide and 200 meters long with no perceptible current. There are several large bays or arms extending from Big Knife Lake both into Canada and Minnesota, one especially large on the Minnesota side extending 4 or 5 miles below the boundary.

A dam was built about four years ago by one of the Minnesota lumber firms at the west end of Big Knife Lake which has raised the water level of the lake 4 or 5 feet.

The topography, consisting of the shore line of all the lakes, islands, rivers, and connecting streams, together with the topography of the portages and divides, was carried on at the same time with the triangulation. The scale of the survey was 1/20,000, but all narrow places, lakes, connecting streams, portages, and divides were surveyed on a scale of 1/5,000.

Observations for azimuth were made at triangulation stations Care, Camp Dolores, and Engle.

The triangulation stations were marked in a permanent manner, 85 with brass plates set in the rock, and 197 with drill holes in the rock with a triangle cut around them.

Mr. John J. Phelan, assistant surveyor, executed all of the topography and assisted in the other work of the party.

Work was resumed near Winton, Minn., on May 21 and was in progress at the close of the fiscal year.

[J. B. BAYLOR.]

SUMMARY OF RESULTS.—Line measure along boundary with invar tape 31.5 miles. Leveling: 37 miles of levels run. Topography: 33.37 square miles of area surveyed, 22 miles of shore line of creeks, 10 miles of roads, 6 topographic sheets finished. These statistics include work done in the spring of 1912.

The party engaged in the survey and monumenting of the portion of the international boundary line separating the State of Maine from the Province of Quebec was at work during the season of 1912 in the section between Lake Pohenagamook and the northwest branch of the St. John River. At the same time a Canadian party was at work on different portions of this section of the international boundary, which runs in a straight line for .64 miles through an almost unbroken forest.

The region is remote and transportation difficult, as the boundary line can be reached along the greater part of its length only by means of trails which had to be cut through the forest, crossing bottomless bogs in many places. The use of drags was necessary for the transportation of outfit and supplies.

A 30-foot lane was cut through the woods along the boundary, the trees being cut off close to the ground and removed from this lane in order that the tape measurements might be made and the stakes necessary for the measures driven in position and their levels taken.

About every 800 or 1,000 feet along this straight line narrow lanes were cut through the forest at right angles to the boundary line for a distance of about 3,000 feet on each side of it in order to bring out the contours and other topographic features. During the progress of the work the American and the Canadian parties were in frequent communication.

The cast-iron monuments placed by the commission of 1842 were reset in cement with appropriate lettered cement bases, and additional cement monuments with similar bases were placed on the prominent hills, so as to be easily intervisible for the entire length of the line so far as completed. Forty-eight of the old cast-iron monuments were reset where necessary during the season. Field work was closed on November 18.

Work was resumed about the middle of May at a point west of the main branch of Black River. Topographic work, staking, and line measurement were begun May 26. By June 30, 9⅛ square miles of topography on a scale of 1/20,000 had been completed and 40 boundary monuments had been set. A 30-foot vista was cleared along the boundary as far as Quam River.

[J. E. McGRATH.]

SUMMARY OF RESULTS.—Reconnoissance: 18 square miles of area covered, 201 lines of intervisibility determined, 98 points selected for scheme. Base lines, secondary length of, 756 meters. Triangulation: 18 square miles of area covered, 83 signal poles erected, 82 stations occupied for horizontal measures, 134 geographic positions determined, 15 days occupied in marking and monumenting stations. Leveling: 619 meters of levels run. Topography: 2.5 square miles of area surveyed, 6 miles of general coast line, 16 miles of shore line of rivers, 2.4 miles of shore line of creeks, 1 mile of ponds, 4 topographic sheets finished.

The survey and marking of the boundary line between the United States and Canada in the valley of the St. Croix River was in progress at the beginning of the fiscal year near the mouth of Monument Stream.

Owing to the narrow water shed and densely wooded character of the country through which Monument Stream runs, it was impracticable to carry a scheme of triangulation more than 1½ miles up the stream. The last station for this class of work was Cropley, which is about 2,400 meters from North Lake. Between Cropley and Birch the distances depend upon a single triangle with a stadia-measured base. At Birch advantage was taken of the width of the valley to extend upward to Moose, another piece of triangulation, depending for lengths on a short base measured with a steel tape. From Moose a traverse line in which the distances were measured with a steel tape was extended to Poplar, a point located in 1891. The work was continued onward from Poplar by a traverse in which the distances were obtained by reciprocally measured stadia observations, checks being furnished by connection with Hornet determined by triangulation in 1891 and Poplar Mt. determined trigonometrically in 1912. These three stations divide the distance depending on traverse measure-

ments symmetrically. The work closed on Poplar Mt., and later in the season the Canadian party measured a traverse line from the Initial Boundary Monument at the head of the St. Croix River to Poplar Mt. triangulation station and to Avernus, the latter being the last traverse station determined by the American party in 1912. At all of the regular stations in the triangulation and traverse work done by the American party signals were set up, and angles were measured at each point.

Flags were set along Monument Stream at the estimated center of each point and bay, and from each of the regular marked stations stadia readings were made and angles measured so that all of these flag-marked points were located. At each of the regular instrument stations along the stream a permanent mark was left except at two points, where the ground is swampy. At both of these stations, however, permanently marked points are not more than 200 meters distant. At most of the stations above Hornet the station marks are bronze bolts set in rock ledges, in bowlders, or in granite posts embedded in cement.

On the return of the party after closing work at Poplar Mt. boundary marks were set at points shown on the topographic sheets at Duck Point, mouth of Scott Brook, near the Steep Banks, near Meeting House Rock, opposite old Keene farmstead, and at Cabin.

At Grand Falls the St. Croix Paper Co. has begun the construction of a new power dam which will impound the river at the foot of the upper pitch of Grand Falls. Because of uncertainty as to the level to be reached by the back water at Spednic and of the danger that seems to threaten Spednic South and Spednic North station marks, Cabin station, on top of a rocky ledge 5.8 feet above Spednic South was referred to Spednic South and Spednic North, and a bronze bolt was centered in the ledge as a station mark.

At Calais connection was made between Harrison triangulation station and the monuments of a recent survey of property lines in the vicinity of Eaton's and Murchies' saw mills.

Besides the work mentioned 8 stations were occupied between Milltown, Me., and Milltown, New Brunswick, for location of additional structural and topographic details; a trip was made to Woodland, Me., to examine the condition of signals erected along the river in 1911; arrangements were made for a supply of cement and sand and for setting reference marks; and reference marks were established at station No. 11 and at three other points. On October 5 a visit was made to the site of the new dam to ascertain how near the structure would approach the station marks established in that vicinity and to obtain other necessary information.

Work in the field was closed on October 6.

On June 25 work was begun with a reconnoissance for the recovery of the stations which had been marked at various times at the head of the St. Croix River. Several signals were erected and connection was made by vertical angle measurements between the elevation at Pole Hill and points near the Initial Monument.

A plane-table survey was begun at the Initial Monument, which is intended to show the features of Monument Stream in all detail practicable on a scale of 1/10,000. The work was in progress at the close of the fiscal year.

ALASKA BOUNDARY.

[THOMAS RIGGS, JR.]

SUMMARY OF RESULTS.—Triangulation: 16 signals erected in main scheme and 3 at line stations, 77 stations occupied for horizontal measures, 73.75 miles of triangulation belt completed. Magnetic work: 6 stations occupied for observations of magnetic declination. Line projection: 25.6 miles of boundary line run. Topography: 341 square miles of area covered, 239 miles of traverse run, 47 miles of topographic belt completed.

The party engaged in the survey and demarcation of the northern part of the boundary line between Alaska and Canada along the one hundred and forty-first meridian resumed work in the spring of 1912 so that a portion of this work was done in the last fiscal year. In order, however, to give a connected account of what was done it will be necessary to recount briefly the movements of the boundary party previous to July 1, 1912.

At the close of the surveying season in 1911, owing to an epidemic of smallpox among the natives, none of the field parties were allowed to come to the Rampart House, and in consequence practically all of the stores for the following winter were piled on the bank of the Porcupine River. Mr. W. B. Reaburn, surveyor, was left in charge at Rampart House with five other men charged with the duty of storing the outfit during the winter and to forward such supplies along the boundary as would be needed in the spring. He was also charged with the issuing of supplies to the Indians and with taking the launch *Midnight Sun* out on the ways and making the necessary repairs. With him were left Dr. G. T. Smith, surgeon, a foreman, an engineer for the launch, a pilot, and a cook. During the early part of the winter the launch was repaired, the outfit overhauled, wood cut for fuel, and an inventory made of all stores and equipment.

The Canadian Government had built a hospital on Edmonds Island for the Indians affected with the smallpox in order that no one except the doctor should come in contact with them. Instructions were given the American party, with a view to maintaining a quarantine and preventing the spread of the disease.

On February 2 two men were sent to Fort Yukon from Rampart House with mail and instructions to bring back supplies. In early April supplies were taken out along the boundary trail as far as Surprise Creek and when the ice in the Porcupine River broke up the launch was dispatched with 10 tons of supplies for the Old Crow River. On the high water the *Midnight Sun* was able to get up this river to the point where the trail leaves the river and heads across the flats for Ammerman Mountain.

The temperature was carefully recorded throughout the winter, which was of unprecedented mildness, the lowest recorded temperature being only −50°. A copy of the record of temperature and precipitation was furnished for transmission to the Weather Bureau.

Under instructions from the commissioner, the chief of the boundary party left Washington March 26 and proceeded to Ottawa for a final conference with the Canadian boundary surveyor. From Ottawa he proceeded to San Francisco, where arrangements were made with the Northern Navigation Co. for the transportation of men, supplies, and horses from Dawson to Rampart House on the Porcupine River.

The party, consisting of 18 men, sailed from Seattle on the steamer *Jefferson* on April 29. The 34 horses were taken on the same vessel. The party arrived at Skagway on May 4 and at White Horse on May 6.

To gain about three weeks over the usual opening of navigation through the lakes and the upper river the party left White Horse on foot on May 10 for Carmacks, 150 miles distant and well below the dangers of navigation, with such wagons as were necessary to transport the baggage and instruments. The chief of party and the Canadian surveyor left White Horse for Dawson the next day. A cache of 8 tons of grain and the saddles for the horses, which had been left at Coffee Creek at the close of the preceding season, were found to have been destroyed by a forest fire. Of the grain not more than 500 pounds were fit for use. At Dawson arrangements for transportation were completed and other details arranged.

The party arrived at Dawson May 22 and transferred to the steamer *St. Michael* the same afternoon, leaving that evening at 9 o'clock. At Circle City they met the steamer *Tanana* and the stock barge which was to take both the Canadian and the American party to Rampart House.

The launch *Midnight Sun* and the poling boat *Polaris* had already begun operations on the Old Crow. Depots of food and provisions had been established between Rampart House and the Old Crow, so that the parties could go through to the base camp on that stream without stopping to relay supplies.

On June 1 the first parties left for the field of operations, Messrs. Gilmore and Ryus leaving with their pack trains with instructions to make the Old Crow and thence to relay provisions as long as the Davidson Mountains remained impassable. On June 3 Messrs. Guerin and Reaburn started with the remainder of the stock and all the supplies which were to be taken from Rampart House during the season. On June 7 Mr. Craig dispatched two men with a pack train of dogs to Herschel Island, where they were to establish the heliotrope station, with which it was hoped that connection could be made some time during the summer.

A joint party headed by Mr. Riggs and Mr. Craig, the Canadian surveyor, was delayed at Rampart House until June 14. On June 19 they arrived at the Old Crow, remaining there one day to direct the movement of the launches and poling boats. Altogether, there were now about 60 tons of supplies inside the bar at the mouth of the Old Crow and at other points up the river.

The party crossed the Davidson Mountains and after a two days trip camped at the American cache on the north bank of the Firth River.

During the journey from the Porcupine River the monumenting and topography of the previous season were inspected and sites were selected for the interpolation of additional monuments where needed.

On June 30 the party moved to Joe Creek, a tributary of the Firth, there finding Mr. Lambart, the Canadian surveyor in charge of the stadia and monumenting, and accompanied him along the line, selecting monument sites between Joe Creek and the next large unnamed tributary to the north. Camp was made 12 miles east of the line. The British Mountains were crossed about 7 miles east of the bound-

ary. A party under Mr. Ryus made a dangerous crossing on the ice to Herschel Island, in the hope of obtaining medical assistance for Mr. Reaburn, who had been taken ill. The reconnoissance and line projection were afterwards continued by Mr. Riggs, in conjunction with the Canadian surveyor, Mr. Craig. In the meanwhile Mr. Gilmore was continuing the triangulation and occupied stations on the summit of the British Mountains. Mr. Guerin and Mr. Ryus were engaged in topographic work. On July 13 camp was moved to the Clarence River near station Z of the boundary, and on the 17th to a point 4 miles to the northward. On July 18 the party reached the shores of the Arctic Ocean.

After setting the boundary signal the reconnoissance and triangulation were continued. A signal was placed at Demarcation Point on a slight elevation near where a spit runs around Beaufort Bay.

On July 23 a reconnoissance and triangulation were begun to the eastward to connect with Herschel Island. After reaching the mouth of Malcomb River progress was interrupted by storms, and as the provisions were getting low the attempt to determine a point on Herschel Island was abandoned. On the return the stadia party was met at the boundary. One of the 5-foot aluminum bronze sectional monuments was in place. The topography was also completed to the coast. The topography of the ocean shore was extended eastward to Clarence Bay and westward to include Demarcation Point and Beaufort Bay. Some triangulation along the coast was done, but progress was retarded by unfavorable atmospheric conditions. While the party was at the shore camp observations were made with a staff gauge of the rise and fall of the tides. On the return journey, while at Joe Creek, the party met Mr. Copley Amory, jr., and one man who had come into the country to collect specimens for the Smithsonian Institution. Mr. Amory accompanied the party back as far as the Old Crow River. The parties arrived at Rampart House on August 16, at Skagway on October 7, and at Seattle on October 12. Here the party was disbanded.

Canadian parties.—The chief of party was Mr. J. D. Craig, D. L. S., who maintained general supervision of field work.

The line projection was carried on jointly with an American party, J. D. Craig observing for the Canadians and Thomas Riggs, jr., for the Americans. There were two Canadians and four Americans in the party.

Vista cutting, monumenting, and stadia work.—One party under Frederick Lambart, D. L. S., ran stadia and placed monuments from the point where the work had been dropped in 1911 to the Arctic Ocean. Another party under Douglas Nelles, D. L. S., connected the work south of the Porcupine. At the close of the season he inspected and numbered all of the monuments from the Porcupine to the Yukon and tied in those to the triangulation of which the positions were not sufficiently determined.

Geology.—Mr. A. G. Madden, of the United States Geological Survey, with his two assistants, J. M. Jessup, of the Smithsonian Institution, and J. S. Harrington, took advantage of the facilities offered by the boundary survey to conduct a geological reconnoissance north from the point where they had closed their work in 1911. South of the Porcupine River Dr. D. D. Cairnes, of the Geological Survey of

Canada, conducted a geological reconnoissance along the boundary covering the ground between the Yukon and the Porcupine not gone over by him in 1911.

Both geological parties were furnished with photographs of the previous season's work of the boundary party and also with tracings of the topography as it was plotted in the field.

Character of country.—North from "X" of the boundary through the coast range of the British Mountains the hills are steep and rugged, absolutely devoid of all vegetation. The streams are swift and scattered over bars of gravel and sand. In a few spots sufficient willows may be found for camp purposes, but for all side camps either wood has to be packed or oil burned. There is sufficient natural grass to furnish subsistence for the horses if a moderate amount of oats is provided. In the main the traveling is excellent, as there are few swamps and these only of small extent. Station "Y" of the boundary is on a high rocky ridge at about an elevation of 5,200 feet. From "Y" the country gradually rolls off to the lower foothills, which extend to within 12 miles of the ocean. From these foothills to the Arctic Ocean, a distance of about 12 miles, is the flat coastal plain dotted with a few lakes and permanent ice fields. A peculiarity of this plain is that it has a foundation of ice over which the rivers have carried deposits of gravel and sand. In places there has been a subsidence, caused by the melting of the ice and huge ice mushrooms appear, the tops of which carry about 3 feet of moss and dirt. Fine examples of the alluvial fan are shown where the rivers break through the foothills onto the tundra. The shore of the ocean consists of mud banks which drop, on an average, about 15 feet to a narrow pebble beach not more than 50 feet wide. The action of the ice seems to be gradually driving the beach line farther south. A peculiarity of the coast are the long sandy spits extending into the ocean, such as Demarcation Point and Icy Reef. At the highest point these spits can not be more than 10 feet above mean sea level. Plenty of wood for camp purposes is to be found scattered along the beach.

Inland waters.—North of the Old Crow River there are no navigable waters. The first river to be crossed on the journey north is the Firth, which runs through the valley in numerous channels, except where it narrows into what is known as the Canyon, well to the east of the line. The Canyon is always blocked with ice, and large portions of the valley have a perpetual covering of ice of about 8 feet in thickness. This river can not be crossed after heavy rains, as the rise is very sudden. The next rivers to be encountered are the Backhouse and the Malcolm Rivers, which are the same in character but much smaller. The Clarence River flows into Clarence Bay.

Horses.—Seventy-seven horses were shipped to Coffee Creek at the close of the field season of 1911 and from there driven to the head of White River for wintering. Of these only 21 survived. Thirty-four additional horses were purchased and three had been left at Rampart House during the winter. At the end of the season of 1912 thirty-four horses were sent to Champagne Landing to be kept during the winter and the rest were either sold or shot. Never during the years when the boundary survey was in progress have the horses come out in such good condition.

Dogs.—Of the 10 dogs which were left at Rampart House 1 was shot and 1 given away, on account of a troublesome disposition. The others were sold.

Line projection.—The line was produced from " Y " of the boundary to the Arctic Ocean, a distance of 25.6 miles, by the method employed in previous years.

The party was the same as found under the heading " Canadian parties," with the party as reorganized. Thomas Riggs, jr., represented the United States commissioner. J. D. Craig represented the British commissioner.

The final point was set on the shore of the Arctic Ocean on July 18. The reconnoissance was begun by Mr. Reaburn and continued by Mr. Riggs in conjunction with the line projection. Signals were also erected by Mr. Craig and Mr. Guerin. Reconnoissance was carried eastward for two quadrilaterals, but all stations were not occupied, as one observer was not available, and it was on this account that it became impossible to make connection with Herschel Island. In all, 18 signals were erected on main-scheme stations.

Triangulation.—Triangulation was conducted in accordance with the rules for tertiary triangulation of the Coast and Geodetic Survey, with additional instructions to fit local conditions.

The instruments used were the 6½-inch and 7-inch Berger repeating theodolites on the main-scheme stations and at main-line points. The monument sites were tied into the main scheme with 4-inch and 6½-inch theodolites.

The first stations occupied were Tub and Reaburn, using the line Siwash-Turner as the going forward line.

Mr. Wm. B. Gilmore was in charge of triangulation on the main scheme, additional triangulation being done by Thomas Riggs, jr., J. D. Craig, Frederick Lambart, and Douglas Nelles.

Magnetic observations.—In addition to the work of triangulation Mr. Gilmore occupied six stations with the Coast and Geodetic Survey compass declinometer No. 744 for magnetic declination. The results have been transmitted to the commissioner. In all, six new stations were occupied.

Mr. Guerin and Mr. Ryus obtained a very close declination at Demarcation station and various points adjacent by scaling with a protractor from their plane-table sheets the true azimuth from the magnetic bearing.

Topography.—Owing to the small amount of topography to be done only one topographic party was put in the field. This consisted of the chiefs of last year's two parties with one assistant topographer. The party picked up the work where it had been abandoned in 1911 and carried it to completion on the shores of the Arctic, then extending east and west so as to take in natural objects to which the boundary could be referred. After the coast was reached Mr. Guerin and Mr. Ryus separated, Mr. Guerin working west while Mr. Ryus with only three men worked to the east.

On the coast 20-foot contours were put in so as to show such small eminences as would otherwise be lost in the 100-foot contours.

The method employed was the same as in previous seasons. Horizontal and vertical control furnished by field computations of triangulation and supplemented by plane-table triangulation from in-

tersections with elevations computed from vertical angles. Rivers and streams and coast lines were traversed by stadia.

The instruments used were the Johnson head-plane table with 18 by 24 board and Bausch & Lomb special alidades. The field scale is 1/45,000; contour interval 100 feet, except as stated above; datum mean sea level carried from the coast and adjusted through two sheets, whence a correction is added to the elevations along the remainder of the boundary line.

In June preparations were made for a joint inspection of the boundary by the American and the Canadian surveyor. The party left Seattle on June 9, but owing to various delays work was not begun until June 27.

[ASA C. BALDWIN.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 90 statute miles, 38 points selected for main scheme, and 7 for secondary scheme. Base lines: 2 (one 2,552.2697 meters in length). Triangulation: Length of scheme 90 miles, 38 signals erected in main scheme and 7 in secondary scheme, 44 stations occupied for horizontal measures, 38 stations occupied for vertical measures. These statistics include work done in the spring of 1912.

After the initial points on the one hundred and forty-first meridian on the south bank of the Yukon River had been determined in 1907, the projection and survey of this dividing line between Alaska and Canada were carried southward until a high range of mountains beyond the White River was reached. Mount Natazhat of this range, 13,435 feet in height, was found to stand nearly on the line, and presented so formidable a barrier that it was impracticable to pass over it. The following year, therefore, operations were begun north of the Yukon River and continued toward the Arctic Ocean. The section south of Mount Natazhat was left unsurveyed and the demarcation of the boundary line in this direction temporarily suspended.

This unsurveyed line south of Mount Natazhat was known to extend about 80 miles and to end near Mount St. Elias, but very little was known of the intervening region. In 1909 Mr. Riggs had carried the triangulation up the White River and about 30 miles west of the line. It was now proposed to extend this work and to establish and mark the boundary between Mount Natazhat and Mount St. Elias.

The plan of work adopted involved carrying the triangulation to the west of Mount Natazhat until a passable route should be found leading to the boundary south of the mountain range; to establish some one point on the boundary there; or, if that should be impracticable in one season, to determine whether or not the region is accessible and whether it would be possible to trace the meridian on the surface at some future time.

The chief of party left Washington on February 23 for Seattle, where a party was organized. Leaving Seattle on March 19 the party arrived at Cordova, Alaska, on March 23 and at McCarthy station, the nearest point on the railroad to the locality of field work, on the 25th.

McCarthy station is over 60 miles from the boundary on the White River and to connect with the previous survey work there the Skolai Pass had to be crossed. It is a 5,000-foot divide filled with a glacier

and is the one pass from the Nizina drainage to the White River. Horses and sleds were used for transporting supplies, and by April 5 the entire outfit had been moved across the Nizina River and a main cache had been established at the mouth of Chititu Creek. From the information now available it was concluded that the one practicable route for carrying forward the work was the drainage route. The plan adopted was, after joining the work on the White River, to extend it over Skolai Pass and follow the Skolai Creek and the Nizina River as far as Chititu Creek and then to cross the low foothills to the Chitina River where a turn could be made toward the one hundred and forty-first meridian.

From the amount of snow on the ground it was evident that some time would be required to break a trail to the pass, and it was decided to utilize this time by building the triangulation stations up the Nizina as the party proceeded. Initial positions were taken from the United States geological map of the Nizina district, plotted on the plane-table sheet and used for orientation.

On April 7 the ascent was made of East Sourdough Peak (6,670 feet) and later a cairn signal was built. During the following week signals Young Creek, May Creek, Geological, and Boulder were built. In addition a base site was selected on the Nizina River and its ends marked with concrete piers.

Two men were sent up the Nizina to build signals while the chief of party was measuring the azimuth of the base and observing for latitude, time, and azimuth.

A party sent to break a trail across Skolai Pass returned on May 1, having accomplished their object with much difficulty. The foot of the Nizina glacier had not been reached, but a cache had been built at timber line 15 miles from the glacier. One of the horses had been killed by falling over a bluff.

In this locality it was necessary to build an additional signal before turning at right angles toward Skolai Creek. This signal was placed on what is called Goat Island, which rises 8,500 feet above a sea of glaciers.

Up to this time 12 signals had been built, which formed a scheme of triangulation spanning the Nizina River from Chititu Creek to Skolai Creek. It was now decided to recover the old stations on the White River as soon as possible. Leaving the valley of the Nizina the party followed the trail which had been broken to Skolai Creek. Skolai Pass was crossed on May 23 and on the 24th the White River was reached.

At White River stations Bend, End, Solo, and Skolai were recovered and a reconnoissance was begun to connect with the stations on the Nizina River.

On June 6 and 7 the consequences of the eruption of Mount Katmai volcano were noticed by the frequent falling of large masses of ice from the mountain peaks accompanied by a rumbling sound resembling thunder.

Observations were finished and the pass recrossed on June 12.

On Skolai Creek additional signals were built so as to form a continuous scheme of triangulation from White River to Chititu Creek. The occupation of these stations was finished by July 10, by which date 50 miles of reconnoissance and 30 miles of triangulation had

been completed. To reach the boundary at the head of the Chitina River would have required about 100 miles of triangulation, an amount too great to be accomplished in the time remaining available for work. It was imperative, however, that the Chitina should be reached, in order to control the work of the topographic party and to gain the required information concerning the country along the one hundred and forty-first meridian.

Camp was therefore moved to Chititu Creek, the reconnoissance taken up where it had been begun in the spring, and the work of signal building in the direction of the Chitina advanced as rapidly as possible. On the 24th the valley of this river was reached and a turn made in the scheme toward the one hundred and forty-first meridian. The reconnoissance was continued 20 miles farther to include the initial signals of the topographical party and command the mountains up the valley in the vicinity of the boundary.

After the completion of the reconnoissance the remainder of the season was devoted to observing angles. Sixty miles of triangulation remained to be done after August 1. An observer was detailed from the topographic party to aid in the triangulation, and by September 1 all but 10 miles of the work was finished.

The combined parties then met at the Nizina River base line and measured it on September 10.

After another week devoted to observing angles the party returned to McCarthy station, and thence via Cordova to Seattle, where the hands were discharged on October 10.

In May, 1913, a base line was measured and arrangements were made to extend the triangulation up the Logan Glacier. By June 1 the reconnoissance was completed to a point within 8 miles of the boundary, when progress was delayed by a heavy snowfall.

[D. W. EATON.]

SUMMARY OF RESULTS.—Topography: 500 square miles of area covered by plane table, 200 square miles covered by phototopographic method.

The topographic survey of the international boundary line and region adjacent in the vicinity of the Chitina River and along the one hundred and forty-first meridian between Mount St. Elias and Mount Natazhat, Alaska, was in progress at the beginning of the fiscal year. This work was based upon triangulation done by a separate party working in cooperation with the topographic party. The region to be surveyed being comparatively unknown much of the season's work was necessarily of an exploratory nature.

Transportation of the party and supplies was by rail from Cordova to Chitina and thence by horses and sleds to within about 12 miles of the Chitina Glacier.

Signals were erected and a small scheme of triangulation was carried up from the surveyed topography at Canyon Creek to the Chitina Glacier. To begin the plane-table work a traverse line was run up the valley of the Chitina for a distance of 12 miles to a connection with the triangulation scheme. From this point a plane-table triangulation was continued to the boundary and up the Anderson Glacier.

The topography was carried up the Chitina Valley to and along the one hundred and forty-first meridian northward toward Mount Natazhat as far up the Anderson Glacier as practicable. The photo-topography covers the same area as the plane-table work, the valley being covered by both methods.

In the latter part of the season the topographic party cooperated with the triangulation party in measuring a base line and completing the triangulation.

The Chitina River ("Chitni"=copper and "na"=river) valley was at one time occupied by a great valley glacier, the traces of which are shown by lateral moraines far up on the mountain sides. The glaciers at the head of the Chitina Valley are the remnants of this once great glacier, and they have their sources in the elevated region between Mount Natazhat on the north side and Mount Logan and Mount St. Elias on the south. Across this elevated region runs the boundary line along the one hundred and forty-first meridian to a point near and to the northwestward of Mount St. Elias. The region to the westward of Mount Logan appears to be the source of numerous glaciers extending to the northward and joining the Logan Glacier.

PORTLAND CANAL.

[FREMONT MORSE.]

On July 19, in accordance with instructions, Mr. Fremont Morse joined Mr. Clinton Dennis on Portland Canal, as representative of the American commissioner in placing or identifying reference marks or monuments for the turning points of the boundary line. The Canadian party had been in the field since the latter part of May, and had erected monuments opposite the turning points of the line down the canal from No. 20 to No. 15.

The main triangulation was extended during the season through a chain of nine quadrilaterals from the base Twel-Thur to the line Thirty-Thirty-one, a distance of about 64 miles. The last two stations were not occupied.

Photographs were taken at all the main stations and at some subsidiary topographic stations from which the topography of region adjacent to the canal can be plotted.

Monuments were erected opposite the following turning points of the boundary line, viz: Nos. 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, and 5. There are two monuments for each turning point except that on the Alaska side of the canal near Camp Point, one monument, called U. S. 16 and 17, was used to mark both the 16 and 17 turning points.

A change was found necessary in the form of the reference monuments and the method of setting them, in order to prevent damage from winter high tides and storms. The height of the monuments was decreased to 18 inches and the area of the base considerably increased. Three iron rods, instead of one, were embedded in each of the monuments with a view to increasing their stability. Work was closed for the season on October 12. Work in the field was resumed on May 23, and was in progress at the close of the fiscal year.

DETAILS OF OFFICE OPERATIONS.

The Assistant in Charge of the Coast and Geodetic Survey office has direct supervision of the work of the office. The Miscellaneous Section and the Tidal Research Section are under his immediate direction.

COMPUTING DIVISION.

The greater part of the time of this division was given to the reduction of field operations and the preparation of results for publication and the preparation of data for field parties of the Survey and for departments of the Government, civil engineers, and others interested in the work.

The computation and reduction of the triangulation along the coasts and in the interior of the United States and along the international boundaries has made satisfactory progress. Much work was done on the computation and adjustment of the precise level net in the United States and the preparation of results for the printer.

The use of the photostat for copying, formerly done on the typewriter, has increased the output of the division and effected a great saving in time and labor. The division has thus been enabled to furnish information more promptly and to change the system of book registers for a vertical filing system.

Five publications relating to geodetic work were received from the printer during the year and the text of another was submitted for publication. Proof of a number of publications was read in the division and progress made in the preparation of others which were nearly completed by the close of the fiscal year.

The computations made at the office by many of the field officers of the Survey and of officers engaged on the international boundary work were supervised in the Computing Division. Several computers employed on the boundary work were attached to the division. A number of field officers have aided in the work of the division when not employed in the reduction of their own field observations.

DIVISION OF TERRESTRIAL MAGNETISM.

Besides supervising the work of the computers engaged in the reduction of the magnetic results and the preparation of these results for publication, the chief of this division represented the Department of Commerce at the first meeting of the National Association of Port Authorities, which met at New York City on December 9, 1912.

The statistics of correspondence during the year show a steady demand for information concerning terrestrial magnetism and particularly the magnetic declination.

The revision of field observations on land and sea was kept up to date, including the compass declinometer work on the one hundred and forty-first meridian boundary in Alaska.

The results of field magnetic observations on land and at sea for the period from July 1, 1911, to December 31, 1912, were prepared and submitted for publication as Special Publication No. 15.

Four publications relating to the work of the magnetic observatories were prepared and submitted for publication during the year,

the proof of four publications was read, and progress was made in the preparation of one other publication.

Magnetic and seismological data were furnished for the use of the International Commission of Terrestrial Magnetism, the International Seismological Association, the Seismological Committee of the British Association, the Kew Observatory, and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Investigations were made of the scale values and constants of magnetic instruments.

Several papers containing results of magnetic observations were prepared for publication in the Journal of Terrestrial Magnetism.

TIDAL DIVISION.

During the year the Tide Tables for 1914 were completed and published, harmonic analyses were completed for 4 stations, each one year in length, and some of the summations were made for analysis of one other station for one year. Nonharmonic reductions were made for 145 stations, with a combined length of 60 years, 2 months, and 11 days; mean sea level was computed for 38 stations, with a combined length of 68 years, 9 months, and 20 days; high and low waters and hourly heights of the sea were tabulated for 251 stations, with a combined length of 61 years; 264 volumes of soundings were reduced, involving the computation of the plane of reference for 233 stations and the entering of many thousand tide reducers.

There were received, examined, registered, and indexed tidal records for 48 stations in the eastern division, 4 stations in the middle division, 9 stations in the western division, 25 stations in the Alaska division, and 18 stations from the Philippine Islands and Hawaii.

Additional observations of tides have been received from the Corps of Engineers, United States Army, the Ordnance Department, United States Army, the Hawaiian government survey, the Hydrographic Office of the Navy Department, the Government of Cuba, and from Tientsin, China.

Tidal data were exchanged with the Imperial Hydrographic Office at Wilhelmshaven, Germany, and copies of tidal predictions for Wellington and Auckland were furnished to the secretary of the Marine Department at Wellington, New Zealand.

CHART CONSTRUCTION DIVISION.

On account of the character of the work of this division ample well-diffused daylight is an essential in order to properly deal with the fine details of the charts. The present quarters are inadequate for the growing demands on this department of the work, not only in the respect mentioned but also as regards heat, ventilation, and proper supervision. An increase in the personnel and equipment will also be necessary to meet the necessity for an increased output of charts. The demand during the year 1913 was more than 9 per cent greater than for the previous fiscal year.

In the drawing section the present practice of making chart drawings on vellum has been found subject to certain disadvantages, to

avoid which it is proposed to return to paper as the best medium for the drawing and it is expected that by using celluloid transfers the compilation can be copied almost as rapidly as in the case of vellum.

Besides the new charts constructed good progress was made in replacing the old diagonal and double unit charts with those of the new scheme.

The work of the engraving section with a slight exception is more nearly up to date than ever before.

The facilities of the printing section have been taxed by the increased demand for charts as well as by a delay caused by the necessity of installing a new electric-power cable. The surface printing from aluminum plates of an increased number of charts, including some of the old engraved charts for which there is a large demand, is expected to relieve the situation to some extent. The surface printing of charts from aluminum plates, among other desirable features, enables corrections to be made with great facility in the aids to navigation shown on the charts. Additional presses are needed in the lithographic section.

The electrotype section, owing to the extensive corrections to plates, has become overcrowded with work, and the purchase of two additional vats is recommended.

The photograph section, besides the usual work, has turned out a large amount of copying with the photostat for the different divisions of the office, taking up a large part of the time of one of the photographers. Additional help is needed in this section.

The statistics of work during the year are as follows:

CHART PREPARATION.

Schemes approved for new charts	15
Approved schemes on hand, charts not started	5
Drawings for new charts finished	15
Drawings for new charts in hand	13
New drawings for new editions finished	5
New drawings for new editions in hand	2
Extensive corrections finished	121
Extensive corrections in hand	5
Chart drawings from Manila for new charts finished	12
Chart drawings from Manila for new editions finished	1

Various miscellaneous drawings and tracings.

ENGRAVING.

New plates for new charts finished	9
New plates for new charts in hand	10
New engraved plates for former lithograph charts finished	4
New etched plates for former lithograph charts finished	3
New bassos for new editions finished	15
New bassos for new editions in hand	14
New bassos for reissues finished	7
New bassos for reissues in hand	20
New editions using current plate finished	21
New editions using current plate in hand	2
Extensive corrections applied to plates	258
Extensive corrections in hand	13
Miscellaneous plates engraved or corrected	8
Minor corrections applied to plates	1,315
Charts in engraving section, engraving not started	2

PRINTING.

New subjects printed from aluminum plates	116
Reprints printed from aluminum plates	77
Reprints printed from stones	3
Total number of different lithograph charts printed	196
Different engraved charts printed	803
Miscellaneous lithographic publications	19
Miscellaneous engraved publications	2
Copies of lithograph charts printed and delivered	61,939
Copies of engraved charts printed and delivered	79,595
Miscellaneous lithographic prints	61,875
Miscellaneous engraved prints	37
Total	203,446
Lithographic impressions (all work)	244,578
Engraved impressions (all work)	88,187
Total	332,765

ELECTROTYPING.

Altos completed	56
Bassos completed	56
Total	112

PHOTOGRAPHING.

Glass negatives made	992
Paper negatives made	32
Velox prints made	1,215
Vandyke prints made	135
Bromide prints made	340
Blue prints made	2,123
Photostat prints made	11,240
Lantern slides made	1
Matrices made	74
Prints mounted	23
Negatives developed	6
Photolithographic negatives, number of charts	76

CHART DIVISION.

The regular work of this division has been continued during the year, and by details of employees from other divisions from time to time it has been possible to keep up with the increasing demand for charts.

There are now 149 sales agencies for Charts, Coast Pilots, and Tide Tables, not including the subagencies of the office at Manila.

The total issue of charts for the year was 143,694, an increase of 12,357 over the previous year. The issue of Coast Pilots was 5,555 copies, and of Tide Tables, Atlantic coast, 1,729; Pacific coast, 10,380; complete, 936.

In addition to the Charts, Coast Pilots, and Tide Tables, the following publications were received during the year for sale:

Catalogue of Charts, Coast Pilots, and Tide Tables, 1912; Notes on Inland Waterways; Supplements to Coast Pilots, as follows: Parts I, II, III, IV, V, VIII, California, Oregon, and Washington; and Alaska, Part I.

There were issued of the Chart Catalogues 1,695 copies, of the Maryland Oyster Charts 6,954 copies, and of the United States and Canada Boundary maps, 1906, one set.

There were delivered to the division 34 new charts and 75 new editions of charts, and 26 charts and 5 plans were canceled.

Charts were issued as follows:

Sales agents	55,257	Suboffice, Manila, P. I.	6,282
Sales by Office and Chart Division	2,760	Executive departments	6,212
Congressional account	5,512	Foreign governments	1,290
Hydrographic Office	52,955	Miscellaneous	1,887
Bureau of Lighthouses	4,823	Total	143,694
Coast and Geodetic Survey Office	6,716		

The following Coast Pilots were distributed and sold during the year:

Part I–II	343	Inside Route Pilot	1,753
Part III	459	Porto Rico	47
Part IV	571	California, Oregon, and Washington	510
Part V	451	Alaska	577
Part VI	466	Total	5,555
Part VII	105		
Part VIII	273		

The following Tide Tables were distributed and sold during the year:

Atlantic coast:		Pacific coast:		Complete:	
1867	1	1867	1	1896	1
1885–1894	10	1886–1895	10	1897	1
1895	2	1901–1903	3	1898	2
1901	2	1907	1	1899	2
1902	2	1909	1	1900	1
1903	2	1910	1	1902	1
1904–1906	3	1911	1	1903	1
1907	2	1912	475	1908	2
1908	1	1913	9,887	1909	1
1909	2			1910	2
1910	4			1911	3
1911	4			1912	78
1912	217			1913	840
1913	1,477			1914	1
Total	1,729	Total	10,380	Total	936

Charts were issued at the suboffice, Manila, P. I., as follows:

Sales agents	1,081	Executive departments, Philippine Islands	802
Sales at suboffice	1,855	Miscellaneous	107
Army	469	Total	5,329
Hydrographic Office (Navy)	482		
Coast and Geodetic Survey	250		
Suboffice, Manila, and vessels of the Survey	283		

INSTRUMENT DIVISION.

The report of the Chief of the Instrument Division contains the usual detailed statistics of the work of the employees during the year. The work of repairing instruments used in the Survey, and of design-

ing and constructing special new instruments and apparatus, including, incidentally, experimental researches, adaptations and improvements to meet new requirements, was satisfactorily performed.

The selection and purchase of new instruments and material when required was also attended to by this division. The making and repairing of furniture and repairs to office buildings; packing and unpacking instruments and general property issued from and received at the Coast and Geodetic Survey Office; and special technical woodworking, have been given careful attention.

The duty of accounting for all instruments and general property, including furniture, and of preparing the correspondence incidental thereto, was continued as heretofore.

The work of finishing the new tide-predicting machine No. 2 was completed. Various scientific instruments were tested for foreign governments. The tide gauges and indicators in New York City and at Fort Hamilton, N. Y., were inspected and repaired during the year.

LIBRARY AND ARCHIVES.

The report of the Chief of Division of Library and Archives gives the usual details concerning the collection of books, periodicals, maps, and charts, and the receipt of original topographic and hydrographic sheets, photographs, and field records of every kind.

Ten thousand books and pamphlets of no further use to the Survey were taken from the shelves and listed for transfer to the Library of Congress or bureaus of this Department. Three thousand books and pamphlets selected from some 7,000 items no longer needed were transferred to the Library of Congress. Seven thousand books and pamphlets of no further use to the Survey and not desired by other bureaus are recommended for condemnation and sale.

A compilation of Coast and Geodetic Survey work in the Philippine Islands was prepared.

The number of field records received during the year was 25 per cent greater than that for any previous year. No less than 272 original hydrographic and topographic sheets were received and registered.

The revision of the map catalogue and the elimination of useless maps was continued.

ACCESSIONS.

Classification.	Purchased.	Donated.	Exchanged.	Total.
Books and pamphlets	85	.....	568	653
Maps, charts, and blue prints	.....	.....	1,528	1,528

STATISTICS OF ACCESSIONS—ARCHIVES ACCESSIONS.

Subjects.	Volumes.	Cahiers.	Sheets.	Miscellaneous.
Astronomy:				
Observations, original	9	13		14
Computations—				
Field		11		
Office		2		
Geodesy:				
Observations, original	150	21		
Computations—				
Field	1	83		
Office		31		
Hypsometry:				
Observations, original	80	41		
Computations—				
Field		7		
Office		4		
Magnetics: Observations, original		270		
Soundings	549			
Sheets:				
Hydrographic			139	
Topographic			133	
Boundary reports		4		
Tides:				
Original observations	138	4		
Marigrams				165
Meteorology	2			
Currents	3			
Levels	2			
Topographic miscellany	17	4		2
Hydrographic miscellany	5	1		
Photographic material (negatives and prints)				220
Total	965	496	272	401

TIDAL RESEARCH SECTION.

Current observations taken during the summer season on board certain light vessels in the fifth and sixth lighthouse districts of the direction and velocity of the wind were tabulated and reduced.

Short series of current observations made in connection with the work of field parties were plotted and reduced.

Current predictions for Seymour Narrows, British Columbia, and Sergius Narrows, Alaska, were furnished for use in the Tide Tables for 1914, and rules were deduced by which it can be ascertained when the currents in these passages will be least violent.

Some work was done upon the compilation of tidal and related matter from published French and German sources.

Tides observed at Gauss station, Antarctic continent, by Prof. Dr. Erich von Drygalski in 1902 have been plotted and are being reduced, and tidal data obtained at other stations in the southern hemisphere are being compiled and examined.

Temperature observations of air and water between Cape Flattery and the Hawaiian Islands made by the Coast and Geodetic Survey steamer *Patterson* in 1912 and 1913 were tabulated and plotted.

Brief consideration was given to questions connected with cotidal lines and also to matters relating to sea-level determination.

Information has been furnished in reply to requests from outside parties on a wide range of scientific subjects often requiring considerable study and investigation.

MISCELLANEOUS SECTION.

This section attends to the purchase and distribution of supplies and keeping of the accounts relating thereto; makes requisitions for printing and binding; issues stationery to field parties and office divisions; audits accounts payable from the appropriation for "Office expenses;" conducts the correspondence relating thereto; and performs various other miscellaneous duties.

A contract for rewiring the Coast and Geodetic Survey buildings under an appropriation made by Congress was awarded on May 21, and this necessary work was in progress at the close of the fiscal year.

On January 1, 1913, the chief of this section was appointed by the Secretary of Commerce to serve as a member of the General Supply Committee, and since then about half of his time has been spent on duties in connection with that work.

Respectfully submitted.

O. H. TITTMANN,
Superintendent.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

INDEX.

Page.

Adams, F. L., magnetic observer--- 48
Aids to navigation located-------- 26, 27, 28, 29, 30, 31, 32, 37, 38, 39, 47, 48, 71
Alabama magnetic observation------ 38
Alaska, boundary ----------- 9, 82
  base measurement ----------- 87
  hydrography------- 48, 49, 50, 51, 52, 54
  magnetic observations ---------- 48, 51, 53, 54, 55, 82
  reconnoissance ----------- 87
  tide observations ---------- 7, 48, 49, 50, 51, 52, 54, 55
  topography---------- 82, 89, 90
  triangulation- 49, 50, 51, 52, 54, 82, 87, 90
Amory, Copley, jr---------- 84
Appropriations and disbursements-- 18
Arkansas, magnetic observations--- 36
Arizona, magnetic observations------ 36, 38
Avers, H. G., computer---------- 70
Azimuth observations---------- 41, 42, 63

Bache, steamer---------- 11, 33
Baldwin, Asa C., surveyor--------- 87
Barnard, E. C., Chief Topographer- 72, 74
Base measurement---------- 41, 63, 87
Baylor, J. B., assistant---------- 79
Beal, A. F., magnetic observer------ 45
Benton, J. R., magnetic observer---- 32
Bilby, J. S., signalman---------- 43
Bond, O. J., jr---------- 47
Boutelle, J. B., assistant---------- 29
Bowie, William, assistant---------- 44
Bureau of Lighthouses------ 7, 25, 37, 71

Cade, C. M., assistant---------- 37
Cairnes, D. D---------- 84
California, tide observations------- 7, 47
  triangulation ---------- 47
Canada and United States boundary- 8
Chart agencies inspected---------- 26, 27
Chart Construction Division------- 92
Chart Division---------- 94
Chart revision- 12, 13, 21, 22, 23, 24, 28, 46
Church, Earl F., assistant--------- 71
Coast pilot work, North Carolina--- 36
  Virginia ---------- 36
Colbert, L. O., assistant---------- 59
Colorado, longitude---------- 41
  magnetic observations---------- 44
  reconnoissance ---------- 43
  triangulation ---------- 41
Computing Division---------- 91
Corps of engineers, U. S. A-------- 23, 26
Cosmos, launch---------- 20
Cowie, G. D., assistant--------- 41, 43, 70

Page.

Clarvoe, G. W., carpenter---------- 68
Condor, steamer---------- 37
Craig, J. D---------- 83, 86
Curacao, steamer---------- 20, 54
Current observations--- 7, 35, 53, 55, 67, 71

Dangers to navigation---------- 10
Delaware, hydrography---------- 33
  magnetic observations---------- 32
  Oyster Survey Commission------ 12, 69
  tide observations---------- 33
  triangulation- ---------- 32
Dennis, Clinton---------- 90
Denson, H. C., assistant---------- 68
Derrickson, R. B., assistant-------- 45, 52
Details of field operations, Atlantic coast ---------- 21
  interior States ---------- 40
  outlying territory---------- 55
  Pacific coast---------- 45
Details of office operations--------- 91
Details of operations, special duty-- 68
Director of Navigation, P. I-------- 21
District of Columbia, leveling------ 70
  reconnoissance ---------- 70
  topography ---------- 70
  triangulation ---------- 70

Eaton, D. W., surveyor---------- 89
Economy and efficiency ---------- 19
Endeavor, steamer ---------- 12, 25, 29
Engle, F. G., assistant---------- 57
Explorer, steamer---------- 13, 48

Fairfield, W. B., assistant--------- 78
Faris, R. L., assistant---------- 65
Fathomer, steamer ---------- 14, 62
Ferguson, O. W., assistant-------- 35
Fischer, E. G., Chief Mechanician-- 68
Florida hydrography---------- 22, 34
  tide observations---------- 7
  triangulation ---------- 32, 38
  wire drag work---------- 22
Forney, Stehman, assistant--------- 33
French, O. B., assistant---------- 70, 77

Gaarden, O. H., magnetic observer- 38, 45
Gauger, J. C., assistant---------- 65
Gedney, steamer---------- 13, 20, 45, 52
General statement of progress------ 5
Geodetic work---------- 14
Georgia hydrography---------- 33, 34
  magnetic observations---------- 38
  tide observations---------- 34
  triangulation ---------- 26, 32, 37, 38

	Page.
Granger, F. D., assistant	77
Green, J. W., magnetic observer	68
Gilmore, W. B	83, 86
Guerin	83
Hand, E. R., assistant	66
Hardy, F. H., assistant	46, 49
Harrington, J. S	84
Hartnell, George, magnetic observer	34, 65
Hawaiian Islands, current observations	67
hydrography	67
magnetic observations	68
tide observations	67
topography	66
triangulation	65, 66
Heck, N. H., assistant	21
Hill, W. M., magnetic observer	64
Hodgkins, W. C., assistant	33
Hodgson, C. V., assistant	41
Hydrographer, steamer	12, 20, 24
Hydrographic Office, United States Navy	24
Hydrography	11
Alaska	48, 49, 50, 51, 52, 54
Delaware	33
Florida	22, 34
Georgia	33, 34
Hawaiian Islands	67
Massachusetts	22, 24, 28
Maryland	29, 34
New York	28
North Carolina	25, 30, 36
Philippine Islands	58, 59, 60, 62, 63
Rhode Island	22, 29, 30, 31
South Carolina	33
United States and Canada boundary	77
Virginia	35
Washington	45
Inside route pilot	12, 32
Inspection duty	12, 13, 65
Inspector of hydrography and topography	11
Inspector of geodetic work	14
Inspector of magnetic work	16
Instrument Division	95
International boundaries	8, 9, 72
Iowa, magnetic observations	44
Jessup, J. M	84
Julia Luckenbach, steamer	25
Juniata, steamer	25
Kansas, magnetic observations	44
Kentucky, magnetic observations	36
Kershaw, steamer	24
Lambert, Frederick	83
Latham, E. B., assistant	47
Leveling, District of Columbia	70
Maine	21
Nevada	40, 44
Library and Archives Division	96
Longitude, Colorado	41
Montana	41
Nebraska	41
North Dakota	41
South Dakota	41
Texas	43
Wyoming	41
Louisiana, triangulation	39
Louisiana, U. S. S	31
Luce, R. F., assistant	60
Lugano, steamer	34
Lukens, R. R., assistant	37
McArthur, J. J	74, 77
McArthur, steamer	13, 50
McGrath, J. E., assistant	80
Madden, A. G	84
Magnetic observations, Alaska	48, 51, 53, 54, 55, 82
Arkansas	36
Colorado	44
Delaware	32
Georgia	38
Hawaiian Islands	68
Iowa	44
Kansas	44
Kentucky	36
Maryland	34
Missouri	40, 44
Nebraska	44
New Jersey	32
North Carolina	32
Oklahoma	40
Pennsylvania	32
Philippine Islands	62, 64
Porto Rico	65
South Dakota	44
Tennessee	36
Texas	40
Virginia	32, 36
Magnetic work, at sea	16, 17
on land	16
Maher, T. J., assistant	62
Maine, chart revision	21
hydrography	21
leveling	21
tide observations	7
topography	21
triangulation	21
wire drag work	23
Marinduque, steamer	14, 59
Maryland, hydrography	29, 34
magnetic observations	34
oyster survey	69
Shell Fish Commission	12, 69
tide observations	7
triangulation	32
Massachusetts, chart revision	24
hydrography	22, 24, 28
tide observations	23
triangulation	22, 23, 26
wire drag work	22
Matchless, schooner	12, 35
Midnight Sun, launch	83
Miller, J. B., assistant	55, 67

Page.

Miscellaneous Section 98
Mississippi, magnetic observations 38
Mississippi River Commission 72
Missouri, magnetic observations 40, 44
Montana, longitude 41
triangulation 40
Morse, Fremont 47, 90
Mueller, Eberhardt 62

Nebraska, U. S. S 22
Nebraska, longitude 41
magnetic observations 44
Nelles, Douglas 86
Neumann, Frank, magnetic observer 65
Nevada, leveling 40, 44
Newburyport, Mass 23
New Jersey, magnetic observations 32
tide observations 7
topography 33
triangulation 31, 32, 33
New York, chart revision 28
hydrography 28
tide observations 7, 28
triangulation 28, 31, 32
North Dakota, longitude 41
reconnoissance 43
triangulation 40
North Carolina, coast pilot work 36
hydrography 25, 30, 36
magnetic observations 32
topography 25, 30, 36
triangulation 30, 37

Office work 11
Oklahoma, magnetic observations 40
Orchid, lighthouse tender 71
Oregon, triangulation 46, 47

Pagenhart, E. H., assistant 39, 46
Pathfinder, steamer 14, 20, 63
Patterson, steamer 13, 54, 55, 67
Patton, R. M., assistant 48
Pennsylvania, magnetic observations 32
tide observations 7
topography 33
triangulation 31, 32, 33
Peters, J. H., assistant 39, 44
Philippine Islands 14
azimuth observations 63
base measurement 63
general statement of work 55
hydrography 58, 59, 60, 62, 63
magnetic work 62, 64
reconnoissance 57, 63
tide observations 58, 59, 60, 62, 63
topography 57, 59, 60, 62, 63
triangulation 57, 59, 60, 62, 63
Porto Rico, magnetic observations 65
Pounder, J. R 76
Publications 18

Quillian, C. G., assistant 50

Rannie, J. L 74
Reaburn, W. B., surveyor 82, 83

Page.

Reconnoissance, Alaska 87
California 47
Colorado 43
District of Columbia 70
North Dakota 43
Philippine Islands 63
South Dakota 43
Texas 43
United States and Canada boundary 74, 78, 80
Washington 46
Wyoming 43
Research, steamer 14, 21, 57
Resurveys 12
Rhode Island, chart revision 22
hydrography 22, 29, 30, 31
tide observations 22, 29, 30, 31
triangulation 22, 26, 29, 30
wire drag work 22
Ritter, H. P., assistant 28, 72, 82, 86
Romblon, steamer 14, 60
Rude, G. T., assistant 51
Ryus, F. S 83

Sallie Purnell Beswick, schooner 20, 25
San Francisco, suboffice 47
Seran, H. A., assistant 29, 37, 41, 46, 71
Sinclair, C. H., assistant 72
Smith, E. E., assistant 46
Smith, G. T., surgeon 82
Scuth Carolina, hydrography 33
triangulation 26
South Dakota, longitude 41
magnetic observations 44
reconnoissance 43
triangulation 40, 41, 43
Sowers, Don C., magnetic observer 36
Special duty 20
Special surveys 10
Steirnagle, Wm. M., assistant 57
Stiles, W. E. I 24
Suboffice, San Francisco 47

T'aku, steamer 13, 51
Tennessee, magnetic observations 36
Terrestrial Magnetism Division 91
Texas, inspection of work in 44
longitude 43
magnetic observation 40
reconnoissance 43
tide observations 7
triangulation 39, 41
Tidal Division 92
Tidal Research Section 97
Tide gauge inspection 32
Tide indicators 7, 68
Tide observations, Alaska 7, 48, 49, 50, 51, 52, 54, 55
California 7, 47
Delaware 33
Florida 7
Georgia 34
Hawaiian Islands 67
Maine 7

	Page.
Tide observations, Maryland	7
Massachusetts	23
New Jersey	7
New York	7, 28
Pennsylvania	7
Philippine Islands	58, 59, 60, 62, 63
Rhode Island	22, 29, 30, 31
Texas	7
United States and Canada boundary	77
Virginia	35
Washington	7
Tittmann, O. H., Superintendent	72
Topography	12
Alaska	82, 89, 90
District of Columbia	70
Hawaiian Islands	66
Maine	21
New Jersey	33
North Carolina	25, 30, 36
Philippine Islands	57, 59, 60, 62, 63
Rhode Island	22, 30, 31
United States and Canada, boundary	74, 78, 79, 80
Virginia	35
Washington	45
Townsend, S. G., magnetic observer	34
Triangulation, Alaska	49, 50, 51, 52, 54, 82, 87, 90
California	47
Colorado	41
Delaware	32
District of Columbia	70
Florida	32, 38
Georgia	26, 32, 37, 38
Hawaiian Islands	65, 66
Louisiana	39
Maine	21
Maryland	32
Massachusetts	22, 23, 28
Montana	40
New Jersey	31, 32, 33
New York	28, 31, 32
North Carolina	30, 37
North Dakota	40
Oregon	46
Pennsylvania	31, 32, 33
Philippine Islands	57, 59, 60, 62, 63
Rhode Island	22, 26, 29, 30
South Carolina	26
South Dakota	40, 41, 43
Texas	39, 41
Triangulation, United States and Canada, boundary	72, 74, 77, 78, 80
Virginia	32, 35
Washington	46
Wyoming	40, 41
United States and Canada boundary	8, 72
azimuth observations	78
base measurement	72, 77, 80
hydrography	77
leveling	76, 77, 79, 80
reconnoissance	74, 78, 80
tide observations	77
topography	74, 78, 79, 80
triangulation	72, 74, 77, 78, 80
Virginia, coast-pilot work	36
hydrography	35
magnetic observations	32, 36
tide observations	35
topography	35
triangulation	32, 35
Warner, T. L., assistant	28
Washington, chart revision	46
hydrography	45
reconnoissance	46
tide observations	7
topography	45
triangulation	46
Weed, L. W., magnetic observer	45
Welker, P. A., assistant	55
Westdahl, Ferdinand, assistant	47, 54
Whitehead, Z. W	37
Whitney, Paul C., assistant	24
Winston, Isaac, assistant	26
Wire drag work	12, 21
Connecticut	21
Florida	21
Maine	21
Massachusetts	21
New York	21
Rhode Island	21
Wireless-telegraph stations located	28, 29, 31, 32, 46, 48
Woodyard, C. F., magnetic observer	65
Wyoming, longitude	41
reconnoissance	43
triangulation	40, 41
Yates, C. C	69
Yukon, steamer	49, 69