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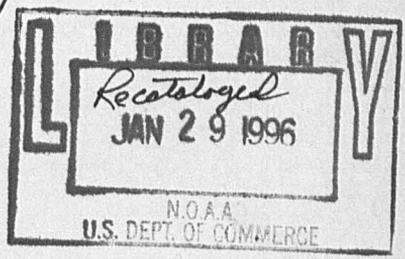
ANNUAL REPORT
OF THE
SUPERINTENDENT, UNITED STATES COAST
AND GEODETIC SURVEY

TO THE
SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1914

65



National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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CONTENTS.

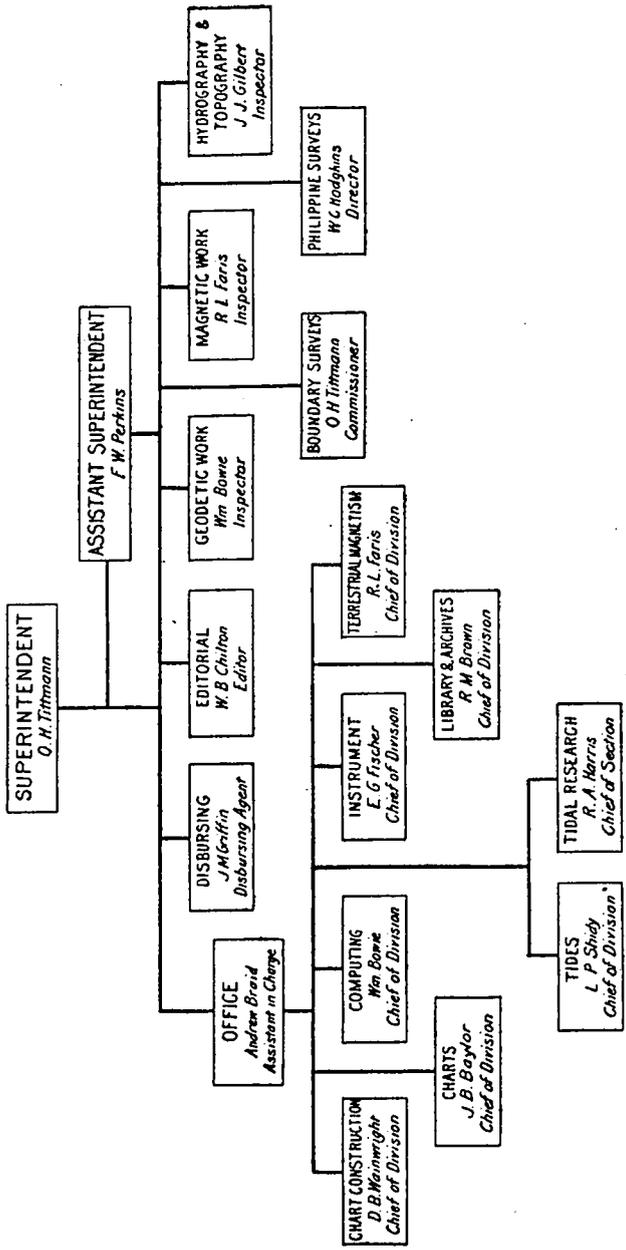
	Page.
General statements of progress:	
Hydrographic work.....	6
Geodetic, magnetic, and tidal work.....	7
International boundaries.....	8
Special surveys.....	10
Dangers to navigation.....	11
Office work.....	12
Office of Inspector of Hydrography and Topography.....	12
Office of Inspector of Geodetic Work.....	15
Office of Inspector of Magnetic Work.....	18
Appropriations and disbursements.....	23
Publications.....	23
Special duty.....	24
Details of field operations:	
Atlantic coast.....	25
Interior States.....	46
Pacific coast.....	53
Alaska.....	59
Outlying territory—	
Porto Rico.....	72
Philippine Islands.....	73
Hawaiian Islands.....	86
Special duty.....	91
International boundaries.....	100
Details of office operations.....	116

ILLUSTRATIONS.

Chart showing organization of the Coast and Geodetic Survey, 1914.....	4
1. Progress of reconnoissance and triangulation in the United States.....	52
2. Progress of topography in the United States.....	52
3. Progress of hydrography in the United States.....	52
4. Distribution of the principal astronomic stations occupied to June 30, 1914.....	52
5. Positions of telegraphic longitude stations from 1846 to June 30, 1913.....	52
6. Routes of geodetic spirit leveling and positions of gravity to June 30, 1914.....	52
7. Tide stations occupied to June 30, 1914.....	52
8. Positions of magnetic stations occupied to June 30, 1914.....	52
9. Positions of astronomic, gravity, and tide stations in Alaska to June 30, 1914.....	72
10. Progress of triangulation in Alaska to June 30, 1914.....	72
11. Progress of topography in Alaska to June 30, 1914.....	72
12. Progress of hydrography in Alaska to June 30, 1914.....	72
13. Positions of magnetic stations in Alaska occupied to June 30, 1914.....	72
14. General progress in Porto Rico to June 30, 1914.....	72
15. General progress in the Hawaiian Islands and Canal Zone to June 30, 1914.....	90
16. General progress in the Philippine Islands to June 30, 1914.....	86

CHART SHOWING ORGANIZATION OF THE COAST AND GEODETIC SURVEY

1914



REPORT
OF THE
SUPERINTENDENT, U. S. COAST AND GEODETIC SURVEY.

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, October 3, 1914.

SIR: There is respectfully submitted herewith the annual report of progress in the Coast and Geodetic Survey for the fiscal year ended June 30, 1914. It is accompanied by maps illustrating the general advance in the field work of the Survey up to that date.

For many years it was recognized by my predecessors as well as by myself that the buildings in which the Survey is housed are unsuited to the most economical performance of the duties with which it is charged. Its priceless records are endangered by the inflammable construction of the buildings, whose design prevents the proper coordination of the duties and interferes with proper supervision. The obvious need of suitable housing has not failed to receive the consideration of the Department and this Bureau, but since the creation of the Department of Commerce the avowed intention of Congress to provide a permanent building for it and some of its detached bureaus has compelled the Bureau to await the final action of Congress. Closely connected with this subject is the matter of installing a suitable and economical heating, power, and lighting plant. The modernization of the instrument and chart-printing shops to meet the increasing demands on the service has received your personal attention.

An estimate was submitted to Congress calling for three new vessels for the Alaska service to take the place of three antiquated ships and for three smaller vessels to be used in wire-drag work, but the appropriation for their construction was not granted. The urgent need of increased appropriations for hastening the surveys of Alaska in aid of commerce and of the development of that vast territory is apparent and in keeping with the policy which the Government has adopted by authorizing the construction of railways and roads. On both coasts the changing conditions in the size of ships has rendered it necessary to supplement the ordinary methods of hydrographic surveying by dragging submarine areas with the wire drag, the only known method of insuring the safety of ships; and plans have been submitted for a more extensive use of the drag in order to examine areas which are known to require it, within a reasonable period of time.

The time has also arrived to hasten the progress of the triangulation of the interior of our country. This is evidenced by the de-

mands made upon this Bureau by the various governmental organizations that need data for the extension and coordination of the surveys which they are making by order of Congress in aid of the economic development of this country. If sufficient means are not provided for this Bureau, the inevitable result will be expenditures at increased cost to the Government among the bureaus of the several departments needing the data.

GENERAL STATEMENT OF PROGRESS.

HYDROGRAPHIC WORK.

Wire-drag examinations were made on the coast of Maine, in vicinity of Matinicus Island in the outer approaches to Penobscot Bay; in Buzzards Bay, Mass., in vicinity of the entrance to the Cape Cod Ship Canal; in Duck Island Harbor of Refuge, Conn., between Menunketesuck Point and Hammonasset Point; and in the approaches to Key West, Fla.

The steamer *Hydrographer* was employed on coast-pilot examinations on the coasts of Connecticut, New York, and New Jersey, and in hydrographic surveys on the coast of North Carolina.

The steamer *Endeavor* was employed on the hydrography of the coasts of Rhode Island and of North and South Carolina.

The steamer *Bache* made hydrographic surveys at the entrance to Chesapeake Bay and of Sabine Bank, Gulf of Mexico, and was engaged in oceanographic examinations between the Capes of Virginia, Bermuda, and Habana, Cuba.

The schooner *Matchless* made hydrographic surveys in the East Branch of Elizabeth River, Va., and in the vicinity of Cape Charles, Va.

One party was engaged in a resurvey of Newark Bay and Passaic River, N. J., and another in revising the coast-pilot directions for the Potomac River.

With the cooperation of the Bureau of Lighthouses a series of current observations was made on light vessels along the Atlantic coast.

Several parties were engaged in chart revision on the Atlantic coast, and an officer with headquarters at New York has acted as inspector for the section of the coast between Narragansett Bay and Delaware Bay.

On the Pacific coast the steamer *Gedney* was employed during the winter on a revision of the survey of Bellingham Bay, Wash., and a party was employed in a resurvey of Suisun Bay. A revision was also made of the survey of the water front at Seattle, Wash.

An officer stationed at Seattle was engaged in inspection duty on the coasts of Washington and Oregon and another with headquarters at San Francisco performed similar duty for the coast of California.

The steamer *Explorer* was employed in the survey of the approaches to the Kuskokwim River, Alaska, and in the survey of Icy Strait.

The steamer *Yukon* cooperated with the *Explorer* in the survey of the approaches to the Kuskokwim River.

The steamer *Patterson* was engaged in surveys in the Shumagin Islands and the vicinity of Unimak Pass and search for the reported

Leonard and Anderson rocks, coast of Alaska, and during the winter season continued hydrographic surveys in the Hawaiian Islands.

The steamer *McArthur* was employed in surveys on the west shore of Cook Inlet, Alaska.

The steamer *Taku* was employed in surveys in Prince William Sound, Alaska, and made a special examination at the head of Passage Canal.

The steamer *Gedney* was employed on general surveys on the west coast of Prince of Wales Island, Alaska, including Bucarelli Bay, Klawak Inlet, Tonawek Bay, Sukwan Strait, and Mears Passage, Alaska.

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*, *Research*, *Romblon*, *Marinduque*, and *Fathomer* were 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 of the *Romblon* and *Marinduque*; are paid by the United States. The running expenses of the *Fathomer* and *Research* are paid by the Philippine government.

The steamer *Pathfinder* was employed on general surveys on the east coast of Mindanao and in the approaches to Manila Bay.

The steamer *Research* was employed in the region of the Samar Sea.

The steamer *Romblon* made surveys in the Calamianes and northern Palawan.

The steamer *Marinduque* was employed on the east coast of Palawan.

The steamer *Fathomer* was employed in the Sulu Sea and vicinity.

GEODETIC, MAGNETIC, AND TIDAL WORK.

Primary base lines were measured in Colorado, Wyoming, and Tennessee. Reconnaissance for triangulation was made in Washington, Oregon, California, Colorado, Utah, Wyoming, Montana, Arkansas, and Oklahoma. Primary triangulation was extended in Tennessee, Arkansas, and Mississippi. Astronomical latitude determinations were made in South Dakota, North Dakota, Colorado, Wyoming, Montana, and on the Texas-California arc of primary triangulation. Precise leveling was done in Washington, Montana, North Dakota, and Minnesota. Parties were engaged during the year in revising and supplementing the triangulation on the coasts of Maine, Massachusetts, Rhode Island, the District of Columbia, North Carolina, South Carolina, Washington, Oregon, California, Porto Rico, and in the Hawaiian Islands, and in determining the geographic positions of aids to navigation along the Atlantic and Pacific coasts and in Porto Rico.

Pendulum observations for determining the force of gravity were made in the District of Columbia.

Observations of the three magnetic elements were recorded during the year at the magnetic observatories maintained by the Survey at

Cheltenham, Md.; Tucson, Ariz.; Vieques, Porto Rico; Sitka, Alaska; and Honolulu, Hawaii.

Seismograph records were continued at these observatories and daily meteorological observations were made in cooperation with the Weather Bureau. Special rapid-rate registration was maintained on certain term days in compliance with 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 Hawaiian Islands, and meridian lines were established where desired by local authorities. Observations were made at sea by vessels of the Survey in the course of surveying operations. Magnetic information has been supplied in reply to a large number of requests from engineers, surveyors, and others interested.

Tide observations were made in connection with hydrographic surveys in the United States and its outlying territory, and at regular tide stations at Portland, Me.; Fort Hamilton, N. Y.; Atlantic City, N. J.; Philadelphia, Pa.; Baltimore, Md.; Key West, Fernandina, and Cedar Keys, Fla.; Galveston, Tex.; San Diego and San Francisco, Cal.; Seattle, Wash.; and Juneau, Alaska. Tidal indicators exhibiting automatically the stage and height of the tide were maintained at Fort Hamilton, N. Y.; New York City; and 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.

A Canadian party to which an American surveyor was attached continued the survey and demarcation of the boundary from north-west angle of Lake of the Woods to the southward. Two schemes of triangulation were carried down the lake, one following the boundary and the other covering the main portion of the lake and connecting with the triangulation by an American party. A triangulation was carried 12 miles up Rainy River. Reference monuments were set in Lake of the Woods and in Rainy River, and soundings were made along the boundary in Lake of the Woods and up Rainy River to Baudette.

The party that had been engaged in the triangulation of the forty-ninth parallel and Lake of the Woods was transferred to the vicinity of Fort Frances, Ontario, to take up the triangulation of Rainy River. A base had been measured at Fort Frances and signals erected. Two schemes of triangulation were carried up Rainy River, the larger one with sides of 3 to 10 miles in length, for the purpose of bringing the work up from the Warroad base, and the smaller one following the banks of the stream. The main scheme was begun at Fort Frances and International Falls. Twenty-five stations were occupied in the main triangulation. An azimuth was determined and the base at Warroad was remeasured.

Another party, to which a Canadian surveyor was attached, engaged in triangulation, topography, monumenting, vista cutting, and

leveling on Lake of the Woods and Rainy Lake, continued work on Rainy Lake after the beginning of the fiscal year. During the season of 1913 the topography of Rainy Lake, including Black Bay, was completed from the outlet at Ranier eastward through Brule Narrows and reference marks were set on Rainy Lake; the large-scale mapping of Rainy River was completed from one-half mile below International Falls to the outlet of Rainy Lake at Ranier, and a small scheme of triangulation carried up the river; the large-scale topography of Four Mile Bay and the mouth of Rainy River was completed.

One thousand two hundred islands in the western part of Rainy Lake were mapped; a base line was measured at Fort Frances, Ontario; the reconnoissance for triangulation was extended through Rainy Lake and Lake Namakan, a distance of 60 miles along the boundary, and the occupation of stations in the triangulation was completed for 30 miles along the lake.

In the season of 1914 to June 30 the topography of Rainy Lake was completed between Brule Narrows and Deers Horn Point. The topography of Rainy River was completed from International Falls to the mouth of Little Fork. The reconnoissance and triangulation were continued on Rainy Lake and Lake Namakan, and a short line of levels was run.

Work on the portion of the boundary between the mouth of the Pigeon River and Lake of the Woods was continued after the beginning of the fiscal year. The survey was carried westward covering Carp, Birch, and Basswood Lakes and the river below to the east end of Crooked Lake. The topography was carried on with the triangulation. The elevations of triangulation stations were determined trigonometrically, and levels were run over the portages. Azimuth was observed at three stations, and a base was measured near Hoist Portage.

On the Maine-Quebec boundary, work was begun west of St. Pamphile, while at the same time a Canadian party took up the survey of the southwest branch of St. John River. A 30-foot lane was cut through the forest from west of English Lake to the intersection of the boundary with the southwest branch of the St. John River, and this portion of the boundary was measured, surveyed, and monumented. Observations were made for azimuth and six triangulation stations were occupied. A topographic survey was made of the country immediately adjacent to the boundary.

The party engaged in the survey of the boundary line between Maine and New Brunswick in the valley of the St. Croix River made a large-scale topographic survey from the large iron monument at the head of the river to the northern end of the survey made in 1913. This survey includes all characteristic features of the stream necessary for locating the boundary. Surveys were also made of the valley of Clendenning Brook, the principal affluent of Monument Brook, for a distance of about one-half mile above the junction of the two streams.

Afterwards the party removed to Eastport and, in conjunction with a Canadian party, located and established range marks in the sections of the international boundary included between the center of Grand Manan Channel and the mouth of the St. Croix River.

ALASKA BOUNDARY.

During the season of 1913 the monuments on the one hundred and forty-first meridian boundary between the Yukon River and Mount Natazhat were inspected and numbered, the positions of the monuments verified, and new monuments interpolated where necessary. This work was done by a joint American and Canadian party. During the season 210 miles of the boundary were covered, 35 stations were occupied, 84 monuments were inspected and numbered, 8 new monuments were interpolated, and 9 stations occupied for magnetic declination.

The topography of the Chitina Valley and along the one hundred and forty-first meridian between Mount Natazhat and Mount St. Elias was completed, excepting the portion between Mount Anderson and Mount Natazhat. Further progress toward Mount Natazhat was found impracticable at that time. About 305 square miles of topography were surveyed with the plane table and about 600 square miles by the photographic method. A plane-table sheet was completed covering parts of the Logan Glacier and Boundary Ridge in the vicinity of the one hundred and forty-first meridian.

The triangulation was carried up the Chitina River to and across the Chitina Glacier up the Logan Glacier to the one hundred and forty-first meridian; a base was measured near the foot of the Chitina Glacier and connected with the triangulation. The azimuth of a line in the triangulation was determined and observations were also made for astronomic azimuth. Mount St. Elias was connected with the triangulation. Three monuments were set during the season. Three stations near Mount St. Elias were occupied with the phototopographic camera. The party reached an elevation of 16,400 feet on the shoulder of Mount St. Elias, but farther ascent of the mountain was prevented by unfavorable weather. A Canadian party cooperated with the American party in this work.

The survey and marking of the boundary on Portland Canal and in Dixon Entrance was continued by a Canadian party, to which an American surveyor was attached. During the season of 1913 the triangulation of Pearse Canal was connected with the United States Coast and Geodetic Survey triangulation at the east end of Dixon Entrance. From this triangulation five reference marks were established on the Canadian side and the same number on the American side. Two stations were occupied in the primary triangulation of Dixon Entrance. A joint examination by the American and the Canadian surveyors was made of the islets off Cape Muzon and the passages between them for the purpose of locating the initial monument of the boundary. Photographs were obtained and soundings made. A monument was set on the south bank of the Stikine River, and the alignment of a monument on the ridge between Eagle Point monument and monument "D" was verified.

SPECIAL SURVEYS.

Requests were received for special surveys in the following localities: Vicinity of Rockland, Me.; Portland Harbor, Me.; Eel Pond Harbor, Woods Hole, Mass.; Bridgeport Harbor, Conn.; magnetic survey, vicinity of Potsdam, N. Y.; entrance to Delaware Bay, Del.;

triangulation to furnish points for hydrographic survey, special survey between Union Station Plaza and Pennsylvania Avenue, and precise leveling to connect various bench marks in Washington, D. C.; physical hydrographic work in Potomac River, D. C., Md., and Va.; exploration of the sea between Cape Lookout and Bermuda; definition of fishing limits and determination of geographic positions of aids to navigation on coast of North Carolina; line of precise levels in Georgia from Atlanta to the sea; survey of boundary line, Mississippi and Louisiana; oyster beds, Florida; wire-drag examination of channels at Key West, Fla.; survey of oyster beds, Texas; geodetic work for control of geological surveys near one hundred and sixteenth meridian; verification of speed trial course, Bellingham Bay, Wash., determination of aids to navigation, Puget Sound, Wash.; triangulation to furnish points for municipal survey, Portland, Oreg.; survey of fishing banks south and west of Yaquina Bay, Oreg.; survey of coast in vicinity of Trinidad, Cal.; survey of Yaquina Bar, Bay, and River, Oreg.; survey of Columbia River, Oreg.; surveys of channels and harbors in Alaska; wire-drag examination for hidden dangers and surveys on special localities; survey of Passage Canal, Alaska; location of rock on which steamer *State of California* struck in Gambier Bay, Alaska; survey of Agusan River, Mindanao, P. I.

DANGERS TO NAVIGATION.

Dangers to navigation were discovered, investigated, or reported by vessels or parties of the Coast and Geodetic Survey as follows: shoals in the approaches to Penobscot Bay, Me.; shoals and ridges in Portland Harbor, Me.; ledges in Matinicus Harbor and approaches, Me.; rocks in Piscataqua River, N. H.; rocks in Narragansett Bay, R. I.; rock near Great Point Light, R. I., struck by lighthouse tender *Anemone*; rock off wireless station, Harbor of Refuge, Point Judith, R. I.; rock near Stonington Point, Conn.; rock in Pine Island Channel, Conn.; breakwater off Sachems Head, Conn.; rocks at entrance to Mystic River, Conn.; rocks near Groton Long Point, Conn.; rocks eastward of Branford Harbor, Conn.; rocks near Duck Island, in Joshua Cove, Conn.; shoal spot off the Battery, Hudson River, N. Y.; shoal in New York upper bay and Buttermilk Channel, N. Y.; shoal spot in Kill Van Kull, N. Y.; uncharted rocks in Echo Bay, N. Y.; rocks in Block Island Sound, Gardners Bay, New York Bay, and Hudson River, N. Y.; obstruction near Holly Beach life-saving station, N. J.; rock off Easbys Point, Potomac River, D. C.; reported shoal spot off St. Augustine Inlet, Fla.; danger near Key West Harbor, Fla.; rocky reef above Warriors Point Light, Wash.; shoal off Eliza Island, Bellingham Bay, Wash.; rock on which steamer *Princess Maguina* struck in Yakutat Bay, Alaska; reported Leonard and Anderson Rocks, Alaska; shoal at entrance to Iniskin Bay, Alaska; shoal off Rocky Cove, Alaska; rock in Tonawek Bay, Alaska, on which the steamer *Curacao* was wrecked; rock at entrance to Tenakee Inlet, Alaska; shoal in San Alberto Bay, Alaska; rock on which steamer *State of California* struck in Gambier Bay, Alaska; submerged rock off Prince of Wales Island, Clarence Strait, Alaska; obstructions in Nichols Passage, Alaska; rock near Rocky Island Light, Alaska; rocks in Marble Passage, Alaska; rock on west coast of

Heceta Island, southeastern Alaska; rock in Bay of Pillars, Chatham Strait, Alaska; shoal spot near southeast end of Klawak Reef, Alaska; rock in Hidden Inlet, Pearse Channel, Alaska; rock in Rose Inlet, Alaska, on which steamer *Delhi* grounded; rock in Davidson Inlet, Alaska; rock in Excursion Inlet, Alaska; uncharted shoal in passage north of Bird Island Reef, entrance to Port Graham, Alaska; sunken rock in Kaigani Harbor, Alaska; rock off Bar Point, near Ketchikan, Alaska; Rock off South Inian Pass, Alaska; rocks in Chapin Bay, Frederick Sound, and Deep Bay, Peril Strait, Alaska; shoal at the entrance to Great Harbor, Porto Rico; shoals in Fajardo Harbor, P. R.; shoals in Mindoro Strait, P. I.; shoal on which steamship *Bustamente* was reported to have struck at Port Laguimanoc, 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 \$15,218.92, and miscellaneous receipts (work done for outside parties, sale of property, etc.), to \$5,732.55, making a total of \$20,951.47, which was duly covered into the Treasury.

OFFICE OF INSPECTOR OF HYDROGRAPHY AND TOPOGRAPHY.

The Inspector of Hydrography and Topography has supervision over the work of parties on the surveying vessels and all other hydrographic and topographic work, including coast-pilot work in field and office, and is charged with various duties relating to the repair and equipment of the vessels of the Survey.

The field work done by the coast-pilot parties is referred to under another head in this report.

The office work done included the proof reading and indexing of Coast Pilot, Section D, Cape Henry to Key West; the compilation of Coast Pilot, Part IV, Point Judith to New York; the preparation of supplements for the present edition of Part IV and for Alaska Coast Pilot, Part I, and preparing corrections for other volumes.

Considerable time and attention have been given to a critical examination of the charts and of the original sheets from which they were prepared, with a view to planning future work and the preparation of instructions to hydrographic parties.

VESSELS AND PARTIES.

The steamer *Bache* made a detailed hydrographic survey at the entrance to Chesapeake Bay in conformity with a request of the

War Department, and afterwards was employed on oceanographic work in cooperation with the Bureau of Fisheries between the Capes of Virginia, Bermuda, and Cuba. Prior to this work a radio apparatus was installed on the vessel, and necessary repairs were made. After completing this work a resurvey was made of the channel east of Sabine Bank Lighthouse and a search was made for a reported 10-fathom bank in the Gulf of Mexico about 100 miles from Tampa. A depth of 14 fathoms was found in this locality and a wreck in 18 fathoms with mast protruding 3 feet above water was discovered in latitude $28^{\circ} 13'$, longitude $83^{\circ} 43'$. The next work undertaken was offshore hydrography on the coast of South Carolina in the vicinity of Cape Romain, which was in progress at the close of the year.

The steamer *Endeavor* continued the revision of hydrography of Narragansett Bay, R. I.; made an examination of Ricord and Cape May Channels, N. J.; a resurvey of St. Helena Bay, S. C., and at the mouth of the Cape Fear River, N. C.; and at the close of the year was engaged in surveying the shoals off Cape May, N. J.

The steamer *Hydrographer* was engaged in coast-pilot work between Point Judith and New York and made resurveys of Great Salt Pond and of Block Island north reef. Many uncharted rocks were located and an examination was made of a shoal off Whitestone Point. During the winter season the *Hydrographer* was employed in surveys in the sounds of North Carolina, and afterwards on supplementary hydrography in Long Island Sound, and in chart revision at Elizabeth, N. J., and in vicinity of New York, including search for a reported rock one-half mile south by east from Fort Hamilton.

The schooner *Matchless* completed the survey of Elizabeth River, Va., and has since been engaged in the revision of the inshore hydrography along the eastern shore of Chesapeake Bay from the vicinity of Fishermans Island to the northward.

A close hydrographic resurvey was made of the inner and outer harbors of Delaware Breakwater.

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

A revision was made in the field of the coast-pilot notes for the Potomac River, and from Cape Henlopen southward and up the west shore of Chesapeake Bay from Cape Charles. This work was completed to and including the Choptank River.

An investigation was made to determine the condition of the navigable inside waterways east of the Mississippi River, including an examination of water routes across Florida. An examination was also made at Eau Gallie, Fla.

Examinations with the wire drag were made in the vicinity of Matinicus, Me.; in the approaches to Portland Harbor, Me.; in the approaches to Rockland Harbor; in the approaches to the Cape Cod Canal in Buzzards Bay, Mass.; in Duck Island Harbor of Refuge, Conn., and its approaches; and in the vicinity of Key West, Fla.

Chart-revision work was done in Newark Bay and Hackensack and Passaic Rivers, N. J.; on the south shore of Long Island, N. Y., including a resurvey of Jamaica Bay; on Alligator River, N. C.; on Cohasset Bay, Mass.; and at St. Augustine Inlet, Fla.

Current observations and other physical hydrographic work in the Potomac River from the Chain Bridge, D. C., downstream was

undertaken at the request of the Public Health Service with special reference to determining the effect of the sewage of Washington on the fish and shellfish of the river.

During the first half of the fiscal year cooperation was continued with the Maryland Shell Fish Commission in the preparation of reports and maps for publication and the completion of records for the archives. This work was closed early in November.

Inspection duty for the region between Narragansett and Delaware Bays was continued by an officer of the Survey with headquarters in New York City.

FIELD WORK, PACIFIC COAST.

The steamer *Explorer* was employed in surveys of the approaches to the Kuskokwim River, Alaska; in Excursion Inlet and Icy Passage; location of rock in Inian Passage; and survey of Knik Arm, Alaska.

The steamer *Gedney* and launch *Cosmos* made surveys on the west side of Prince of Wales Island, Alaska, and determined the position of rocks in Gambier Bay, on one of which the steamer *State of California* had been wrecked. A channel was developed from Tuxican Bay to Sea Otter Sound. During the winter this vessel was engaged in revision work at Seattle and in Bellingham Bay, Wash.

The steamer *McArthur* made surveys on the west side of Cook Inlet, located a reported rock in Hidden Inlet, and began surveys in Nichols Passage, Alaska.

The steamer *Patterson* was employed on surveys in the vicinity of the Shumagin Islands, Alaska, and in hydrographic examinations in the region of the reported Leonard and Anderson rocks. It was concluded that these dangers do not exist. After the close of this work the *Patterson* was employed on the survey of the Hawaiian Islands, including the islands of Oahu, Maui, Lanai, and Hawaii. The survey of the Shumagin Islands was resumed in the spring of 1914.

The steamer *Taku* was engaged upon surveys in Simpson Bay, Prince William Sound, Alaska; Sheep Bay, Gravina Bay, Passage Canal, Chamberlain Bay, and Jackson Cove; and Landlocked Bay.

During the winter the triangulation of Lake Washington, Wash., was revised.

The steamer *Yukon*, in cooperation with the *Explorer*, continued the survey of the approaches to the Kuskokwim River, Alaska.

The hydrography of Carquinez Strait, Suisun Bay, and Sacramento River, Cal., was revised.

Chart-revision work was also done on the southern coast of California southward from Newport Bay.

A survey of Yaquina Bay, Oreg., was begun.

A wire-drag party was organized for work in Tongass Narrows, southeast Alaska.

The revision of the triangulation and topography of the island of Hawaii was continued.

An officer of the Survey continued on duty as inspector for the coast of California and in charge of the suboffice at San Francisco. Another officer with an office at Seattle has rendered efficient service as inspector for the coasts of Oregon, Washington, and Alaska.

PHILIPPINE ISLANDS.

All field work in the Philippine Islands is done under the immediate direction of an officer of the Survey assigned as director of coast surveys at Manila, P. I.

The steamer *Pathfinder* was at work on the east coast of Mindanao between Lianga and Caraga Bays and in the approaches to Manila Bay. A radio apparatus was installed on this vessel.

The steamer *Fathomer* was employed during the year on surveys on the east side of Busuanga in the general region between Mindoro, Busuanga, Calamianes, and the Cuyos Islands.

The steamer *Marinduque* was engaged in general surveys on the east and northeast coasts of Palawan Island.

The steamer *Romblon* was also at work on the east and northeast coasts of Palawan and in the region of the Calimianes Islands.

The steamer *Research* was engaged in surveys in the southern approaches to San Bernardino Strait, including Masbate, Ticao, and other islands.

OFFICE OF INSPECTOR OF GEODETIC WORK.

The duties of inspection are performed at the Coast and Geodetic Survey office and in the field. They consist mainly in planning field work, preparing the necessary instructions for field parties and correspondence relating to details of field operations, examination of records, computations and reports, scientific investigations based on the results of the field observations and computations in the computing division and preparation for publication of the results of field and office work done under his direction for the use of engineers and scientists.

The inspector has also assisted the international boundary commissioner by inspecting the records and computations of triangulation and the reports of field parties engaged in the survey of the boundaries between the United States and Canada. He attended the meeting at Atlanta, Ga., of the American Association for the Advancement of Science, as one of the representatives of the Department of Commerce.

The most important pieces of geodetic work done in the field during the fiscal year are the following:

The completion of 25 latitude stations on the one hundred and fourth meridian, by one party in about two and one-half months. The points occupied were stations of the arc of primary triangulation along that meridian, which had been established in previous years. The chief of this party used an automobile truck as a means of transportation, and it was due largely to this and to the good judgment shown by him, as well as to the fact that after the first few stations he was not required to make any computations on the field, that his party made such rapid progress. A series of latitude observations is now being made along the Texas-California arc of primary triangulation, from the vicinity of Barstow, Tex., westward.

The completion of the reconnoissance for an arc of primary triangulation which will extend from the vicinity of the Salt Lake base net northward to the Canadian boundary. This work is 555

miles in length, and provision has been made for connections with a number of monuments of previously conducted surveys and with several State boundary monuments. A connection has also been provided for with the triangulation along the forty-ninth parallel, done by the International Boundary Commissions. Some of the figures of this triangulation are rather large, but in order that the work may be of the greatest value to the topographers and others who will use the results of this triangulation the reconnoissance party interpolated a number of additional stations which will not be occupied. This reconnoissance was done in exactly two months, which is very rapid progress.

The reconnoissance for primary triangulation, which will extend from Little Rock, Ark., westward through Oklahoma, to a junction with the ninety-eighth meridian. This reconnoissance also provides for connections with the monuments of previous surveys and with those of the Oklahoma-Arkansas boundary.

Precise leveling by the two leveling parties, one working from Butte, Mont., northward to the Canadian border, and the other party working from Crookston, Minn., westward to Berthold, N. Dak. This work was done with remarkable rapidity, although the usual accuracy of the Coast and Geodetic Survey leveling was maintained. The average progress of a leveling party during a number of seasons in the past was about 70 miles per month. During September and October, 1913, one party completed 100 and 101 miles, respectively. During the same months the other party completed 99 and 105 miles, respectively. Each of these miles of progress was run twice by the leveling party, once in a forward and once in a backward direction. The use of the motor velocipede cars by these two parties had a great deal to do with the rapid progress, but much was due to the two officers who had charge of this work. The same two chiefs of party are now engaged on leveling, westward from Butte to Spokane, and from Berthold, N. Dak., to Devon, Mont.

Another important piece of work which was begun during the fiscal year was the triangulation between Grays Harbor and the Straits of Fuca along the coast of Washington. This portion of the State had never previously had any geodetic control. The reconnoissance and signal building for this work was completed and the observing at the northern end begun. At the approach of winter the work was suspended.

A difficult piece of work was the triangulation between the tertiary work in Oregon southwest to the junction with the tertiary triangulation along the coast in the vicinity of Redding Rock. The reconnoissance and signal building and most of the observing for horizontal directions in this work was completed during the summer of 1913. During the spring of 1914 all of the observations in this triangulation were completed. At the close of the fiscal year the triangulation was resumed on the western coast of Washington, which had been suspended in the fall of 1913.

The important work of determining difference of telegraphic longitude to connect the Naval Observatory, Washington, D. C., and the Cambridge, Mass., observatory, with a point near Far Rockaway, Long Island, N. Y., which latter place will be connected by

the observers of the Prussian Royal Geodetic Institute with Borkum, Germany, by cable, was begun before the close of the fiscal year.

It was found by observations made in this year that it would be possible to use the noon signals sent out by the United States Naval Observatory, over the wires of the Western Union Telegraph Co., in the determination of the periods of pendulums in gravity work. This method was given a severe test at this office by an officer of the Dominion Astronomical Observatory, Ottawa, Canada, who determined the periods of his pendulums at two different times at this office in connection with the relative determination of gravity at Ottawa. He used both his own time observations, made at a station near the Coast and Geodetic Survey office, and also the noon signals of the Naval Observatory. He found that the period of his pendulum was the same by the use of each time. This will greatly increase the rapidity of pendulum observations.

The erection of signals and the observations for primary triangulation on the arc of triangulation which will extend between Memphis, Tenn., and Huntsville, Ala., are in progress. When this scheme has been completed, it will be possible to place all of the triangulation of the Mississippi River on the North American Datum, as connections between the triangulation of this river and the primary triangulation of the United States will then have been made at New Orleans, La.; Memphis, Tenn.; St. Louis, Mo.; Dubuque, Iowa; and Royalton, Minn. The triangulation along the Mississippi River is of a high grade of tertiary triangulation, almost approaching secondary, and will be of great geographic value as soon as it has been recomputed and adjusted.

Other work done under the inspector of geodetic work was the following:

Triangulation in Porto Rico for the determination of geographic positions of aids to navigation on Culebra Island.

Revision of triangulation and re-marking of stations on Lake Washington, Wash.

Determination of geographic positions at the mouth of the North Edisto River, S. C.

The triangulation of the Columbia River. A number of connections with triangulation stations of the United States engineers were made during this work. This triangulation was done at the request of the Bureau of Lighthouses that the geographic positions of all aids to navigation on the river be determined.

Measurement of the Cheyenne base, in Wyoming, and the re-measurement of the El Paso base, Colo. The primary triangulation, including only four stations, which was done to connect the Cheyenne base with the main scheme of the one hundred and fourth meridian.

The revision of triangulation and the re-marking of old stations along the coast of Maine south of Passamaquoddy Bay.

The location of an exact line between the Union Station and the Peace Monument, Washington, D. C.

The revision of triangulation and the re-marking of old stations in Narragansett Bay, R. I., and in the vicinity of Portland, Me.

The revision of triangulation, which practically amounted to a new triangulation, in Alligator River and North River, S. C. It was necessary to do some triangulation in Albemarle Sound to provide bases from which to start this work.

The revision of triangulation, which also amounted to a new triangulation, on the coast of North Carolina, between Bogue Sound and Cape Fear River. It was found by each of these parties in North Carolina that practically all of the old triangulation stations had been destroyed and that new work was necessary.

The determination of the geographic position of the wireless tower in the vicinity of Tuckerton, N. J.

Precise leveling between the Capitol bench mark and the Aqueduct Bridge in the District of Columbia. This work was done at the request of the District Engineer, Corps of Engineers, United States Army.

The geodetic work is being extended as rapidly as possible and, wherever practicable, new work is done in those areas where it will be of greatest value to other Government organizations needing the results obtained therefrom. While every means is used to increase the output and lower the unit costs of the several branches of geodetic work, at the same time the usual high standard of accuracy has been constantly maintained.

The publications on geodetic subjects which were issued during the fiscal year are listed under the head of "Publications," in another part of this report.

The manuscript has been prepared for the following two publications:

The Results of Triangulation on the One Hundred and Fourth Meridian and the Thirty-ninth Parallel in Colorado, Utah, and Nevada. This has been sent to the printer and will appear as Special Publication No. 19.

The Results of Precise Leveling Between Brigham, Utah, and San Francisco, Cal. This publication also contains a discussion of the errors of precise leveling. It will appear as Special Publication No. 22.

OFFICE OF INSPECTOR OF MAGNETIC WORK.

The duties of this office are to plan magnetic work to be done in the United States and outlying territory under the jurisdiction of the United States; to inspect magnetic field work on land and at sea and at the magnetic observatories; to recommend the construction or purchase of new magnetic instruments, or alteration of old ones when required, or the designing of new ones; to recommend changes in the design of magnetic instruments, or methods of observing, to secure improved results or to save time; to supervise the planning and construction of magnetic observatory buildings, etc.

In November the Cheltenham Observatory was visited and inspected. All other inspection work during the year was performed at the office through current examination of the records when received from the field, and reports from chiefs of parties and others engaged in magnetic work. The magnetic parties transmit their records to the office about twice a month, and the observatory records are transmitted monthly.

The magnetic work accomplished during the year may be summarized as follows:

At Cheltenham Observatory the magnetographs and seismograph were kept in operation without appreciable interruption, and all of the required observations and records secured. The usual meteorological observations were made. The number of magnetic storms remained small though the sun-spot minimum period is now well past. Less than 20 earthquakes were recorded by the Cheltenham seismographs, nearly all of which were of small amplitude and distant origin. This was seismically the quietest year at Cheltenham since the installation of the instruments.

Harold W. Pease, magnetic observer, was given instruction in observatory work and the duties of a chief of party.

All of the instruments used in the field work during the year were standardized at the Cheltenham Observatory, and an indirect comparison made with the Porto Rico Magnetic Observatory. The standard earth inductor and standard magnetometer of the department of terrestrial magnetism of the Carnegie Institution, of Washington, were compared with the Cheltenham standards. The agreement of the Cheltenham standards with the now adopted international standard of the Carnegie Institution is quite satisfactory for declination and horizontal intensity, but there remains a difference of about one minute in the dip which is not yet satisfactorily accounted for. More evidence on this point will be had when a new earth inductor, now ordered, is received and compared at Cheltenham after previous comparisons at Potsdam, Germany.

The necessary repairs to buildings, fences, repainting, etc., were made. The instrument equipment is in good condition and giving satisfactory results.

At Tucson Magnetic Observatory, the magnetic and seismograph instruments were in successful operation and all required observations were secured. Daily meteorological observations were made during the entire year and reported daily by telephone to Tucson, to be telegraphed to the local weather office at Phoenix, Ariz.

Less than 25 earthquakes were recorded during the year, which shows, like Cheltenham, a year of less seismic disturbance than in the past.

The observatory buildings were kept painted and in good condition, and the instruments in good working order.

Some special azimuth observations were made; also comparison of one set of field instruments. The chronometer corrections were usually obtained about once a week from the Mare Island time signals transmitted to the observatory by telephone from the Tucson Western Union telegraph office.

At the Honolulu Magnetic Observatory, the Eschenhagen magnetograph and seismograph were in operation all the year without material interruption, and the necessary absolute observations, scale-value determinations, and daily meteorological observations were made and sent to the local section of the Weather Bureau at Honolulu. Exchange of meteorological reports were made with the Ewa Plantation Co. as heretofore.

Two sets of field instruments were compared during the year, used in the magnetic resurvey in the Hawaiian Islands, including special

work at Kilauea, and the other was that belonging to the Coast and Geodetic Survey steamer *Patterson*, at that time engaged on survey work in the Hawaiian Islands.

Earthquake data were furnished to the director of the Hawaii Volcano Observatory, as requested last year.

The necessary repairs to the observatory buildings to keep them in good condition were made. The road from the observatory to the post office, however, remains in poor condition.

At the Sitka magnetic observatory, the magnetograph and seismograph were in continuous operation throughout the year. The required absolute observations, scale-value determinations, and time observations were secured. About 25 earthquakes were recorded during the year; a less number than in previous years.

One set of field magnetic instruments were compared, namely, those that had been used in the field work in the Southwest and Pacific Coast States. At the beginning of the season this set of instruments was compared at Cheltenham, and during the season at Tucson, thus obtaining control of the correction to these instruments through three observatories.

The observatory buildings have been kept in good condition, and the instrumental equipment is in good working order and giving satisfactory results.

At the Porto Rico Magnetic Observatory the magnetograph and seismograph were kept in operation throughout the year, and all of the required observations were made. One field magnetometer was compared at this observatory for the purpose of an intercomparison of the absolute instruments with those at Cheltenham.

An unusually small number of earthquakes were recorded. The necessary painting, minor repairs, and improvements to the buildings for their proper upkeep were made. The instrumental outfit is in good order and satisfactory results are being obtained.

MAGNETIC WORK ON LAND.

The magnetic elements (declination, dip, and horizontal intensity) were determined at about 308 stations. The stations were distributed, in accordance with what seemed the most urgent needs, over 37 States and Territories and outlying territory under the jurisdiction of the United States. Fifty-nine "repeat" stations were occupied during the year for the purpose of getting observational data for maintaining the necessary knowledge of the secular change of the magnetic elements, especially the declination. The field work in Hawaii last summer, with the exception of the special magnetic survey of Kilauea Volcano, was exclusively repeat work for secular-change data:

The following table shows how the stations were distributed throughout the country:

SUMMARY OF RESULTS ON LAND.

State.	Localities.	Stations.	Old localities re-occupied.	Declination results.	Dip results.	Intensity results.
Alabama.....	5	5	1	5	5	5
Alaska.....	18	18	2	19	5	5
Arizona.....	2	3	2	3	3	3
Arkansas.....	9	9	1	9	9	9
California.....	8	10	6	10	10	10
Colorado.....	17	17	3	17	17	17
Connecticut.....	5	5	1	5	5	5
Delaware.....	19	22	1	22	22	22
Florida.....	19	22	4	22	22	22
Georgia.....	14	15	2	15	15	15
Hawaii.....	14	41	9	37	36	36
Idaho.....	1	1	0	1	1	1
Iowa.....	4	17	0	17	19	17
Louisiana.....	2	2	2	2	2	2
Maryland.....	1	1	1	6	6	6
Massachusetts.....	2	2	1	2	2	2
Michigan.....	7	9	1	9	7	7
Minnesota.....	4	4	0	4	4	4
Mississippi.....	2	2	1	2	2	2
Missouri.....	1	2	1	2	2	2
Montana.....	2	2	1	2	2	2
Nebraska.....	1	1	1	1	1	1
New Hampshire.....	7	7	0	7	7	7
New Jersey.....	10	11	0	11	11	11
New Mexico.....	2	2	2	2	2	2
New York.....	17	19	3	19	19	19
North Carolina.....	1	1	0	1	1	1
Oregon.....	8	11	2	11	10	11
Pennsylvania.....	2	2	0	2	2	2
Philippines.....	5	5	0	5	0	0
Tennessee.....	2	2	2	2	2	2
Texas.....	4	5	3	5	5	5
Utah.....	8	8	2	8	8	8
Vermont.....	3	3	0	3	3	3
Virginia.....	1	1	1	1	1	1
Washington.....	1	1	1	1	1	1
Wisconsin.....	10	20	2	20	19	19
Total.....	247	308	59	310	288	289

MAGNETIC WORK AT SEA.

The magnetic work carried out at sea by vessels of the Survey was, as heretofore, incidental to the regular surveying work, and the magnetic observations were made when the vessels were en route to or from their working grounds, or when opportunity occurred on the working grounds. The ship's routes have covered little new territory in the last year or so and the ship's results are not so numerous as during some past years. The table below gives, approximately, the magnetic results secured aboard ship during the year, so far reported to the office:

SUMMARY OF RESULTS AT SEA.

Vessel.	General region.	Results from swings.			Declination from course observations.
		Declination.	Dip.	Intensity.	
Hydrographer.....	Atlantic Ocean.....	22			
Bache.....	do.....	8			
Patterson.....	Pacific Ocean.....	10	6	0	1
Explorer.....	do.....	1	1	1	
McArthur.....	do.....	7			
Total.....		48	7	7	1

^a Seven for 1912 not previously reported.

Each vessel of the service suitable for magnetic work is instructed each season to make magnetic observations, especially for magnetic declination, whenever the conditions of weather and of the regular duties will permit. The *Patterson* and the *Explorer*, on the Pacific coast, are supplied with sea-dip circles for observations of dip and relative total intensity, and are equipped with field magnetometers for observations on land.

A new earth inductor was ordered, but not yet received, which is intended to be used especially for intercomparison observations between the Cheltenham standard dip instrument and the dip instruments at the other four observatories of the Coast and Geodetic Survey. This instrument can also be used as a relief instrument in case any of the observatory earth inductors should need to come to the office for repairs. A new India survey pattern magnetometer has been ordered (but not yet delivered), which is intended primarily to be used for periodic comparison with the Cheltenham standards in order to keep ourselves informed as to the stability of those standards. The instrument division is still considering the question of making dip needles and it is expected that it will soon succeed in turning out needles that will meet present-day requirements. A new form of magnetogram reading scale (on plate glass) has been made in the instrument division, after design of this division, by the use of which it is intended, at the beginning of 1915, to read the mean ordinate of the magnetic curves, instead of the ordinate at the beginning of each hour. With this scale it is believed that the mean ordinates can be read as quickly as the ordinates at the hour are now read, and with the advantage that the mean ordinates more nearly represent the actual magnetic conditions that ought to be dealt with in the discussion of the results.

During the year a field party reoccupied a number of old magnetic stations in the Hawaiian Islands for secular change data. In connection with this work it was also convenient to undertake a special magnetic survey of Kilauea Volcano requested by the director of the Hawaiian Volcano Observatory.

During the year the standard absolute instruments of the department of terrestrial magnetism of the Carnegie Institution of Washington were compared with the Cheltenham standards. The magnetic declination and horizontal intensity results were found to hold the same relations as heretofore, but there was a disagreement in the determination of dip of about one minute, which yet remains unexplained. Several indirect comparisons of the Cheltenham earth inductor with the Potsdam, Germany, standard in past years supported the view that the Cheltenham instrument had remained stable. However, the observer in charge at Cheltenham has overhauled the adjustments of the earth inductor, supplied new brushes, and tested their adjustment in accordance with the theory of the subject. Further opportunity to test the stability of this instrument will be afforded upon the receipt of a new earth inductor, now ordered, which will have been compared at the Potsdam Magnetic Observatory. Other indirect comparisons of observatory instruments with Cheltenham have been made at magnetic observatories at Vieques, Tucson, Sitka, and Honolulu.

Only about 20 true meridian lines were established during the year. These lines were all established at the request of the local authorities.

APPROPRIATIONS AND DISBURSEMENTS.

The total appropriations made by Congress in the sundry civil act for the fiscal year ended June 30, 1914, for the Coast and Geodetic Survey was \$1,021,920, divided as follows:

Field expenses.....	\$320, 400
Repairs and maintenance of vessels.....	40, 000
Officers and men, vessels.....	252, 200
Pay of field officers.....	160, 200
Pay of office force.....	199, 120
Office expenses.....	50, 000
Total.....	<u>1, 021, 920</u>

New freight elevator in Richards Building (\$4,200 transferred by authority of legislative act of March 4, 1913, for expenditure for this service under title "Contingent expenses, Department of Commerce, 1914").....	2, 500
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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 remaining 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 1914:

Annual report of Superintendent, 1913. 102 p. 15 maps. [Printed also as H. doc. 400, 63d Cong. 2d sess.] 8vo.

Tide tables, [calendar] year 1913 [with list of references]. 542 p. 1l. [Reprint.] large 8vo.

Same, 1914. 542 p. large 8vo.

General tide tables, [calendar] year 1915 [with list of references]. 542 p. 1l. large 8vo.

Tide tables for Atlantic coast of United States, including Canada and West Indies; from Tide tables, [calendar year] 1913. 181 p. 1l. [Reprint.] large 8vo.

Same, 1914. 181 p. large 8vo.

Atlantic coast tide tables for eastern North America, [calendar] year 1915; from General tide tables [calendar year 1915]. 183 p. 1l. large 8vo.

Tide tables for Pacific coast of United States, with foreign ports in Pacific Ocean; from Tide tables, [calendar year] 1913. 165 p. [Reprint.] large 8vo.

Same, 1914. 165 p. large 8vo.

Pacific coast tide tables for western North America, eastern Asia, and many island groups, [calendar] year 1915; from General tide tables [calendar year 1915]. 167 p. large 8vo.

Results of magnetic observations made by Survey, July 1, 1911-Dec. 31, 1912; by R. L. Faria. 1 text fig. (Special publication 15.) 102 p. large 8vo.

Results of observations made at magnetic observatory at Cheltenham, Md., 1911-12; by Daniel L. Hazard. 98 p. 8 charts. 4to.

Same, Honolulu, Hawaii, 1911-12; by Daniel L. Hazard. 99 p. 6 charts. 4to.

Same, Vieques, P. R., 1911-12; by Daniel L. Hazard. 102 p. 7 charts. 4to.

Same, Sitka, Alaska, 1911-12; by Daniel L. Hazard. 100 p. 15 charts. 4to.

United States coast pilot, Atlantic coast: sec. D, Cape Henry to Key West; [compiled by Herbert C. Graves, assisted by E. Vance Miller and J. T. Watkins]. map. [This volume covers same territory formerly included in pt. 7, Chesapeake Bay entrance to Key West.] 231 p. 8vo.

Same: pt. 4, Point Judith to New York [supplement to 5th edition]. May 15, 1914. 10 leaves. large 8vo.

Inside route pilot, New York to Key West, 1913; [by Herbert C. Graves and W. E. Parker]. 66 p. 2d edition. 8 maps in pocket. large 8vo.

Determination of time, longitude, latitude, and azimuth: by William Bowle, 5th edition. 8 pl. 18 p. of pl. (Special publication 14.) [Reprint.] 177 p. 4to.

Triangulation along west coast of Florida; by Clarence H. Swick. 1 pl. 28 maps. (Special publication 16.) 147 p. 4to.

Triangulation on coast of Texas, from Sabine Pass to Corpus Christi Bay; by Charles A. Mourhess. 1 pl. 18 maps. (Special publication 17.) 89 p. 4to.

Fourth general adjustment of precise level net in United States and resulting standard elevations: by William Bowle and H. G. Avers. 4 pl. map. (Special publication 18.) 328 p. 4to.

Table of depths for channels and harbors, coasts of United States, including Porto Rico, Hawaiian Islands, and Philippine Islands. 175 p. 4to.

Summary of survey of oyster bars of Maryland, 1906-12 [carried on by Coast and Geodetic Survey in cooperation with Fisheries Bureau and Maryland Shell Fish Commission]; by C. C. Yates. 81 p. 1 pl. 2 maps in pocket. large 8vo.

Principal facts of the earth's magnetism and methods of determining true meridian and magnetic declination: [by L. A. Bauer]. 7 pl. 5 maps. [From United States magnetic declination tables and isogonic charts, 1902, with certain changes.] [Reprint.] 99 p. large 8vo.

Statement of expenditures in Coast and Geodetic Survey, fiscal year 1913. Jan. 13, 1914. 22 p. 8vo. [H. doc. 580, 63d Cong. 2d sess.]

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 allotment to the Department of Commerce for printing and binding was \$28,837.49.

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.

Board on life-saving appliances.—The Superintendent of the Survey 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.—The officer detailed for duty with the Maryland Shell Fish Commission completed the preparation of maps, reports, and publications in connection with that work.

Oceanographic work.—The steamer *Bache*, in cooperation with the Bureau of Fisheries, made a cruise for oceanographic work between the Atlantic coast, Bermuda, and Cuba, and made current observations in the Gulf Stream at a station between Cuba and the Florida coast.

Triangulation, District of Columbia.—Some additional triangulation was done in the District of Columbia to furnish points for a survey of the Potomac River.

Precise leveling, District of Columbia.—At the request of the District engineer, Corps of Engineers, United States Army, Washing-

ton, D. C., a line of precise levels was run connecting various bench marks in the District of Columbia.

Topographic survey of grounds of Bureau of Standards.—A topographic survey was made of the grounds of the Bureau to supplement a former survey and to furnish data for laying out sites for new buildings.

Proposed avenue in Washington, D. C.—At the request of the Attorney General a survey was made from the junction of Pennsylvania Avenue and First Street NW., and the Union Station Plaza, to determine whether a proposed avenue would overlap a portion of square 633.

Physical hydrography, Potomac River.—In cooperation with the Public Health Service an extensive series of current and tidal observations was made in the Potomac River to determine to what extent the tides affect and currents carry the sewage from the vicinity of Washington, D. C., toward the oyster beds in the lower Potomac, the amount of dilution of the river water from fresh water streams or influx of salt water from the Chesapeake, etc.

North Carolina Fisheries.—At the request of the North Carolina Fish Commission buoys were replaced marking the limits of fishing grounds in Albermarle, Croatan, and Pamlico Sounds.

American Association for Advancement of Science.—In December the inspector of geodetic work, as a representative of the Department of Commerce, attended the meeting of the American Association for the Advancement of Science, held at Atlanta, Ga.

DETAILS OF FIELD OPERATIONS.

ATLANTIC COAST.

MAINE, MASSACHUSETTS, AND CONNECTICUT.

[N. H. HECK.]

SUMMARY OF RESULTS.—Triangulation: 293 square miles of area covered, 8 signal poles erected, 25 stations in supplemental schemes occupied for horizontal measures, 41 geographic positions determined. Leveling: 10 permanent bench marks established, 8 miles of levels run. Hydrography: 169 square miles dragged, 16,365 angles measured, 469 soundings made, 3 tide stations established, 7 hydrographic sheets finished, 1 hydrographic sheet begun.

At the beginning of the fiscal year the wire-drag party was at work on the coast of Maine in the vicinity of Matinicus Island in the outer approaches to Penobscot Bay. Progress in this work prior to July 1 is mentioned in the last annual report.

In order to expedite the work and to insure the removal of the lobster pots from the area to be dragged, charts were prepared dividing this area into sections containing about 5 square miles each. These charts were posted in the post offices and other public buildings, and notices were attached from time to time indicating the time for the removal of the lobster pots and the areas completed.

As the areas were sufficient to make possible a full day's work with an 8,000-foot drag where no shoals were found, the work progressed rapidly.

An area of 114 square miles was dragged, and a number of new shoals were found. The principal result of the work was to show

that a large area of bottom is free from obstructions, and that the shoal areas are more extensive and generally of less depth than had been shown on the charts.

Investigations were made in Matinicus Harbor and its approaches as the result of local information and a number of shoals were located, the most important of which are a ledge known as White Rock in the north approach and several rocks off Wheatons Island.

It was necessary to make a complete revision of the triangulation. As a number of old stations were recovered only a simple scheme was required in addition to the intersection stations.

On September 2 wire-drag work was taken up in Buzzards Bay and was steadily continued until November 19. Long drag work was carried on until all of the open area was completed. A shorter drag was afterwards used, and later two drags were operated to cover small areas not previously gone over. The total area dragged was about 60 square miles. A portion of the area was left unfinished at the close of the season.

The special characteristic of Buzzards Bay is the frequent occurrence of detached boulders and of well determined ridges of boulders. Many of the isolated boulders are of small extent and difficult to locate.

Areas which previous surveys had indicated as perfectly clear were found to contain boulders at certain intervals. The discovery of all the obstructions in the bay is of importance to shipping destined for the Cape Cod Canal.

It was necessary to extend the triangulation of 1910, by the party on the steamer *Endeavor*, to the mouth of the bay to furnish points for the Survey.

On September 30 a subparty was detailed to make an examination of Duck Island Harbor of Refuge between Menunketesuck Point and Hammonasset Point. The area covered, about 6 square miles in extent, is badly broken by shoals, islands, etc., and subject to strong tidal currents. Here some supplemental triangulation was also necessary. This work was completed by October 23.

On the coast of Maine and on Buzzards Bay search was made for tidal bench marks previously established, and so far as practicable new bench marks were established where necessary and connected by leveling.

Improvements made in methods and equipment for wire-drag work are fully treated in a new edition of the paper descriptive of the long wire drag.

On April 20 preparations were begun for wire drag work in the approaches to Portland Harbor, Me. Dragging was begun on April 7. It was found that a considerable portion of the area to be dragged was exceptionally rocky. Several ridges extending nearly across the entrance with depths of 6 fathoms or less were developed. All of these ridges are in the general direction of the islands of Casco Bay. By June 30 an area of 22 square miles had been covered, but a portion of this required further examination. A small amount of triangulation was done to locate points needed in the survey.

A number of young officers were trained in wire drag work so as to be available for such work in other localities. Improvements have been made in the apparatus used, including an automatic winder for guiding the wire to the reel and an arrangement for controlling

the reel lever from a point near the bow of the launch, and experiments have been made in wireless signalling. Another improvement has been the adoption of compressed air for controlling the signalling system.

MAINE.

[GEO. D. COWIE.]

SUMMARY OF RESULTS.—Reconnoissance: 67 points revisited.

The revision of the triangulation on the coast of Maine southwestward from Passamaquoddy Bay was begun on July 14. Between that date and August 8, 67 points were visited and of these 60 were recovered, 3 were found to have been destroyed, and 4 were not located. In most cases the old stations were found without difficulty.

Aids to navigation were determined at Eastport, North Lubec, Pleasant Point, and Deer Island.

[O. B. FRENCH.]

SUMMARY OF RESULTS.—Reconnoissance: 15 square miles of area covered, 140 lines of intervisibility determined, 23 points selected for scheme. Triangulation: 15 square miles of area covered, 11 signal poles erected, 23 stations in main scheme occupied for horizontal measures, 43 geographic positions determined.

The revision of the triangulation of the coast of Maine in the vicinity of Eastport begun by G. D. Cowie was continued after August 11.

The work included the recovery of old triangulation stations, re-marking them where necessary, and such triangulation as was necessary to locate aids to navigation not previously determined.

All of the triangulation stations from the St. Croix River to Gouldsborough Bay were visited by Mr. French or Mr. Cowie, excepting a few near Calais which had recently been used in the triangulation along the boundary and had already been reported upon in connection with that work.

During the season of two months and three days 180 stations were visited, 123 of them recovered, and most of them re-marked. Six stations can not be located without additional triangulation. Only three stations were not found where marks in rock ledges were described. Forty-four stations were not found and are undoubtedly lost, of these 28 were simply marks on trees. Out of the remaining 16 only 2 had been marked in a permanent manner, the others being chimneys, church spires or stations where no marks were mentioned in the descriptions.

Twenty-three triangulation stations were occupied for the purpose of locating beacons or other objects, and the geographic positions of 43 points were determined.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Topography: 5 square miles of area revised, 3 miles of general coast line revised, 5 topographic sheets partly finished.

In the latter part of November the field revision of topographic work on the coast of Maine in the vicinity of Portland, which had been temporarily suspended in April owing to the necessity for work in another locality, was completed. The work done is included on topographic sheets 312, 414, 1188, 1224, and 1225.

MAINE, MASSACHUSETTS, AND RHODE ISLAND.

[ISAAC WINSTON.]

SUMMARY OF RESULTS.—Triangulation: 7 square miles of area covered, 73 stations recovered and re-marked, 7 stations in main scheme occupied for horizontal measures, 4 geographic positions determined.

During the autumn of 1913 a revision was made of the triangulation in the State of Maine along the Kennebec River from Augusta to a point about 8 miles south of Bath. A small sloop with auxiliary power was used for transportation.

All of the old stations in the vicinity of the river were searched for and nearly all of them were recovered. All recovered stations, 26 in number, were re-marked with standard station and reference marks. Three stations were found to have been destroyed.

Several tidal bench marks were recovered and levels were run between them. Several were found to have been destroyed.

Notes were made of numerous changes affecting the charts of the river and the necessary corrections were noted on copies of the charts.

The geographic positions of Ames Ledge Light and Abagadassit, Trout, and Rear Range Lights were determined.

Work was closed on November 14.

A revision of the triangulation in Narragansett Bay, Sakonnet River, Mount Hope Bay, R. I., and Taunton River to Taunton, Mass., was made between July 22 and September 16. A search was also made for tidal bench marks at Sakonnet Point, Warren, Bristol, Bristol Ferry, and Babbits Wharf, Mount Hope Ferry, R. I.

Twenty-six stations were recovered and re-marked where necessary; 18 stations were found to have been destroyed and 3 stations not found are probably lost. Two tidal bench marks were recovered and re-marked, 1 was found of which the stability is doubtful, and 2 were found to have been destroyed.

Wharves were located at Tiverton, R. I., on both sides of the Sakonnet River and also the reservoir dam back of Easton's Beach near Newport.

Between July 21 and August 13 the work of recovering and re-marking triangulation stations in Rhode Island between Narragansett Bay and Fishers Island Sound was in progress. Twelve stations established by the Coast and Geodetic Survey and 36 stations established by the United States Engineers were recovered. The Coast and Geodetic Survey stations were marked with the standard station and reference markers and the United States Engineers stations with the authorized Engineers station markers and with the standard reference markers. The United States Engineers stations Cedars and Middle Bridge E were found to have been destroyed.

The geographic position of Green Hill Life-Saving Station was determined.

MAINE AND NEW HAMPSHIRE.

[ROSCOE P. STROUGH.]

SUMMARY OF RESULTS.—Hydrography: 10 square miles of area covered, 210.2 miles run while sounding, 10,959 soundings made, 1 hydrographic sheet finished.

Work was begun in June 1913 on a hydrographic survey of Piscataqua River, Great Bay and the affluent streams.

The work was carried from the northwestern limit of the survey made by the Coast and Geodetic Survey in the Piscataqua River in 1903, $3\frac{1}{4}$ miles east-southeast of Dover Point, up the Piscataqua River to the junction of the Salmon Falls and Cochecho Rivers, and up the Salmon River to a distance of $1\frac{1}{2}$ miles above the highway and electric car bridge at South Berwick Junction. From the limits of the survey of 1903 the work was carried through Little Bay, up the Bellamy River to a junction with the hydrographic survey of that river made by the United States Army Engineers in 1909, up the Oyster River to the head of navigation, through Great Bay and up the Exeter River to about one-tenth mile north of the Stratham highway bridge, joining with the United States Engineers survey of 1909. The Cochecho and Lamprey Rivers were also surveyed by the United States Engineers in 1909.

The control of this work was obtained largely from the triangulation. Some of the topographic signals from the surveys of 1900, 1908, and 1909 were recovered and used, and some new signals were located with the plane table and sextant.

Lines of soundings were run generally in the direction of the channel at intervals of from 30 to 60 meters, according to depth, except on shoals where closer development was required. The soundings were referred to a tide staff at Dover Point.

MASSACHUSETTS.

[C. H. SINCLAIR.]

In the latter part of June a field revision was made of the chart of the vicinity of Cohasset, Mass., in order that recent changes, improvements, new structures, etc., might be put upon a new edition of the chart.

The positions of the aids to navigation were determined by theodolite or sextant angles. Four stations were occupied with the theodolite. This work was completed on June 24.

An inspection was made of the small observatory at Cambridge, Mass., with reference to its use in longitude determinations.

[J. H. HAWLEY.]

SUMMARY OF RESULTS.—Triangulation: 54 square miles of area covered, 1 signal pole erected, 3 geographic positions determined. Hydrography (wire drag): 4 square miles of area covered, 12.3 miles run while dragging, 89 angles measured, 7 soundings made, 1 tide station established, 1 hydrographic sheet begun.

In the latter part of May a wire-drag party was organized to continue work begun during the previous season in the approaches to the Cape Cod Canal in Buzzards Bay, Mass. The expected early opening of this important waterway made it desirable that all dangers in the channels leading to it should be accurately located.

Wire-drag work was begun on June 25. A drag about 2,400 feet in length was used. A tide staff was established at the mouth of Westport River and tide observations were begun on June 26. Several natural objects were located by triangulation to furnish control for the work.

MASSACHUSETTS, RHODE ISLAND, AND CONNECTICUT.

[W. E. PARKER.]

In September, in accordance with an arrangement with the Bureau of Lighthouses, apparatus for the observation of currents was installed on light vessels *No. 42*, Hen and Chickens; *No. 90*, Vineyard Sound; *No. 85*, Nantucket Shoals; *No. 41*, Hedge Fence; *No. 5*, Cross Rip; *No. 3*, Shovelful Shoal; relief *No. 66*, Boston; *No. 48*, Cornfield Point; *No. 13*, Bartlett Reef; *No. 23*, Ram Island Reef; *No. 39*, Brenton Reef; and *No. 74*, Cape Elizabeth.

The light vessels were visited in the order named, as the tenders were available for transportation. The lighthouse inspectors and officers of the vessels afforded every facility to the officer assigned to this duty.

On each light vessel where possible the instruments were adjusted and one observation made with the assistance of an officer of the vessel, and full instructions were given in regard to the observations required.

MASSACHUSETTS, NEW YORK, NEW HAMPSHIRE, AND VERMONT.

[FRANK NEUMANN.]

STATIONS OCCUPIED: *Massachusetts*: Becket and Pittsfield. *New Hampshire*: Winchester. *New York*: Alexandria Bay, Cape Vincent, Clayton, Camden, Morristown, Potsdam, Pulaski, and Rome. *Vermont*: Ludlow, South Londonberry, and Vergennes.

Magnetic observations were made at the above-named stations during the season from May 28 to June 30.

The stations on the St. Lawrence River were established as nearly as possible in the localities where observations had been made by the United States Lake survey observers in 1913. Stone or concrete posts and magnetic station markers were used to mark most of the stations.

A meridian line was established at Ludlow, Vt.

The stations at Camden, Clayton, and Morristown were not marked.

RHODE ISLAND, NEW YORK, AND DELAWARE.

[E. F. DICKINS.]

Inspection duty for the region included between Narragansett and Delaware Bays has been continued by an officer of the Survey with headquarters at the Customhouse, New York City.

The duties of the inspector are to obtain information for the correction of charts, reported dangers, notices to mariners, etc.; to furnish information in regard to charts, sailing directions, and tides; to supervise the construction and shipment of material needed for the repair or outfit of the vessels and boats of the survey, and to receive and forward instruments or material for the use of field parties and vessels; and to keep in touch with the maritime public and navigators and to find out their needs.

RHODE ISLAND AND NEW JERSEY.

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

SUMMARY OF RESULTS.—Triangulation: 118 square miles of area covered, 35 signal poles erected, 29 stations occupied for horizontal measures, 100 geographic positions determined. Leveling: 6 elevations of tidal bench marks determined by leveling, 5 miles of levels run. Topography: Plane table triangulation for determination of hydrographic signals, new wharves, etc., only. Hydrography: 67.5 square miles of area sounded, 1,279.5 miles run while sounding, 6,102 positions determined, 59,734 soundings made, 4 tide stations established, 3 hydrographic sheets completed.

On July 1 the steamer *Endeavor* proceeded from New York to Narragansett Bay and began work on a sheet extending from Hope Island to the head of Greenwich Bay. On July 15 this work was temporarily interrupted in order to determine the position of buoys and of a reported rock off Great Point. This rock was located and also one in Sakonnet River, and the positions of the buoys were determined, and on July 24 the resurvey of Narragansett Bay was resumed.

Signals were erected over the area covered by three hydrographic sheets and determined by triangulation and by plane table and sounding was continued until November 1. The three sheets completed comprise the area on the west of Prudence Island from Hope Island northward to Bullock Point Lighthouse and including Greenwich Bay, and thence on the east side of Prudence Island and including Bristol Island to as far south as Dyer Island. Few changes were noticed from the general depths indicated on the charts. A number of uncharted rocks were located particularly off the north end of Patience Island.

On November 1 the vessel proceeded to Lewes, Del., and was engaged in examining the changes in Ricord and Cape May Channels. On November 21 the vessel proceeded to Baltimore for repairs.

From June 9 to 30 the steamer *Endeavor* was engaged in hydrographic work in the vicinity of Cape May, N. J. Signals were erected and determined in position by triangulation. Sounding was commenced on June 18 and was in progress at the end of the month.

NEW YORK.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Topography: 14 square miles of area surveyed, 53.5 miles of shore line surveyed, 2.5 miles of rail and electric roads surveyed, 4.75 miles of roads surveyed, 1 topographic sheet begun, scale 1/10,000.

A topographic resurvey of Jamaica Bay, south shore of Long Island, N. Y., on a scale of 1/10,000, was begun on May 15 and was in progress at the close of the fiscal year. By the end of June, 14 square miles of area had been covered and 53.5 miles of shore line run.

CONNECTICUT, NEW YORK, AND NEW JERSEY.

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

SUMMARY OF RESULTS.—Hydrography: 1.5 square miles of area covered, 30 miles run while sounding, 1,501 soundings made, 1 hydrographic sheet finished, 23 uncharted rocks located, 6 other objects for correction of charts located.

Under instructions dated July 1 the steamer *Hydrographer* left Baltimore on July 21 and proceeded by way of the Chesapeake and

Delaware Canal to Cold Spring Inlet at Cape May, N. J., arriving there on July 22.

At Cape May an examination was made, changes in channels and shoals were reported, and information was obtained in regard to the inland waterways on the coast of New Jersey. On July 24 the vessel proceeded to Jersey City.

From July 24 until October 23 the party on the *Hydrographer* was employed on the field of work covering all navigable waters and tributaries in the vicinity of Block Island Sound, Gardiner's Bay, Hudson River to Troy, and New York Bay. The navigable waters and inside route on the south coast of Long Island from Peconic Bays to Far Rockaway Inlet were examined.

Twenty-three uncharted rocks were located, and six other chart corrections were reported, and hydrographic surveys were made of Great Salt Pond, Block Island North Reef, and for a reported shoal at Whitestone Point, East River.

Twenty swings of the ship, each on 32 headings, were made to determine compass variation.

NEW YORK.

[H. C. DENSON.]

SUMMARY OF RESULTS.—Triangulation: 70 square miles of area covered, 9 signal poles erected, 8 stations in main scheme occupied for horizontal measures, 40 geographic positions determined. Leveling: 3 permanent bench marks established, 2 miles of levels run. Topography: 18½ square miles of area surveyed.

Chart revision work on the south shore of Long Island in the vicinity of Great South Bay was begun in May. The object of this work was to bring the charts of this region up to date to meet the requirements of the numerous motor boats and other small craft navigating these waters. No considerable changes were found to have taken place in the natural features of the shore line, but the great number of improvements that have been made, such as bulkheads, yacht basins, navigable canals, and numerous new roadways leading to the shore necessitates what is almost an entirely new survey of the area shown on the old charts.

By June 30 the topography had progressed from the western edge of the town of Babylon to Great River, a distance of 11 miles, in a direct line to the eastward and extending back from the shore as far as the main highway running east and west on Long Island. The work completed on the outer beach includes Muncie Island, Oak Island Beach, Point of Woods, and Ocean Beach.

The triangulation was begun at the base Nichol to Island and was carried as far as Howell's Point, a distance of 13 miles.

In the execution of this work permanent objects such as standpipes, watertanks, cupolas of buildings, and factory chimneys were carefully determined for use in hydrography.

A reconnoissance of the area to be surveyed indicates few changes in depths from those shown on the chart, except in the vicinity of Fire Island Inlet, and where dredging has been done in the channels leading from the main shore to the resorts on the outer beach.

NEW JERSEY.

[STEHMAN FORNEY.]

SUMMARY OF RESULTS.—Reconnaissance: 9 square miles of area covered, 225 lines of intervisibility determined as per sketch submitted, 54 points selected for scheme. Base lines: 7 tertiary. Triangulation (tertiary): 14.5 square miles of area covered, 68 signal poles erected, 104 stations in main scheme occupied for horizontal measures, 204 geographic positions determined. Topography: 32.85 square miles of area covered, 50.95 miles of shore line of rivers surveyed, 24.5 miles of shore line of creeks, 91 miles of shore line of ponds surveyed, 3½ miles of shore line of canals, 96 miles of railroads, 4 topographic sheets finished. Hydrography: 1 square mile of area sounded, 11 miles run while sounding, 130 positions determined, 215 soundings, 2 tide stations occupied, 1 hydrographic sheet finished.

From July 1 to September 30 work was continued on the triangulation of Newark Bay up to the mouths of the Hackensack and Passaic Rivers and the topography and shore line of Newark Bay into the mouths of the same rivers.

At Bergen Point, where the refining plant of the Texas Oil Co. is located, there is a dredged channel which was made by that company in order to permit their large seagoing tank steamers to come to the wharves. This channel was thoroughly sounded out and developed. No other hydrographic work was done on Newark Bay or the Hackensack and Passaic Rivers, as the depths in these localities do not appear to have changed to any extent since the dredging in 1906-1913 and the surveys by the United States Army Engineers in 1906.

The triangulation was extended up Newark Bay from the line Bergen Point Lighthouse to Summerville Methodist Church spire, stations in the triangulation of the United States Army Engineers. All church spires, factory chimney stacks, and other prominent objects visible from the bay and rivers were determined in position.

In October the triangulation was completed up the Hackensack River to Smoke Hill and up the Passaic River to the Erie bridge in Passaic City. The topographic sheet on a scale of 1/10,000 of Newark Bay, up the Passaic River to the Plank Road Bridge in Newark, and up the Hackensack River to the Jersey City end of the same bridge was also completed.

An entirely new scheme of triangulation was necessary for Newark Bay and its tributaries. None of the original stations were recovered, many of them having been obliterated by the erection of buildings and others by the erosion of the shores. In the triangulation of the Passaic River stations were established on the tops of flat-roofed buildings and marked with the usual bronze disks set in cement blocks. The lines are short and the stations numerous, but an unbroken scheme of quadrilaterals was developed from Smoke Hill on the Hackensack and up the Passaic River to the first dam above Passaic River.

The shores of Newark Bay and its tributaries have undergone marked changes in the way of improvements along the water front; many new buildings, wharves, and structures have been built, and many of the old structures have been removed or destroyed.

An extensive sewer system is under construction at Newark, which when completed will greatly improve the sanitary conditions along

the Passaic River. The solid portion of the sewage will go to a disposal plant on the Newark flats and the purified liquid residue will flow into Newark Bay.

Between January 1 and March 22 the party was engaged in the tertiary triangulation of the Passaic River northward from the Erie Railway bridge at Arlington, N. J., and the topographic survey of the Hackensack River from its mouth northward to the West Public Service Building, and of the Passaic River from the Plank Road Bridge to the Pennsylvania Railway passenger bridge, including a great deal of detail in the way of docks, bridges, streets, trolley and railway tracks. In this work local and railroad maps were utilized for details.

Between March 23 and May 3 the party was temporarily under charge of E. B. Latham. During this period 7 tertiary base lines were measured on the county and railroad bridges crossing the Passaic River, and two plane-table sheets were partly completed, and tracing made from local surveys.

From May 4 to the close of the fiscal year the triangulation and topographic resurvey of the Passaic northward from the Erie Railway bridge at Arlington, N. J., was continued. The triangulation was completed to the first dam above Passaic, and the topography to triangulation stations Coal and Brush.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Base lines: 6 tertiary, total length 2,100 meters. Topography: 7.5 square miles of area surveyed, 13 miles of rivers surveyed, 26.5 miles of roads surveyed, 2 topographic sheets partly finished.

Between March 27 and May 4 the resurvey of the Passaic River was temporarily in charge of E. B. Latham. The plane-table work was continued. Streets near the water front were plotted from published maps and controlled by points determined in the field. Six lines in the triangulation of the Passaic River from 108 to 1,200 meters in length were measured with a tape and base apparatus. One topographic sheet of Passaic River, south of the Erie Railroad bridge, on a scale of 1:5,000, was practically completed and another sheet north of the Erie bridge was one-quarter completed.

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

SUMMARY OF RESULTS.—Hydrography: 6 square miles of area covered, 32.25 miles run while sounding, 262 angles measured, 651 soundings made, 1 tide station established, 1 hydrographic sheet finished.

In the early part of June the following work was done:

Topographic examination of a section of the water front of Elizabethport, N. J., to locate an error in a previous survey; location of buoys in the lower anchorage, New York Bay; location of life-saving stations along the coast of New Jersey; search for shoal spot reported 1 mile southeast of Fort Hamilton, N. Y. This report was found to be erroneous.

On June 22 the *Hydrographer* began operations in Long Island Sound, in vicinity of Stamford. This work consists of what is practically a resurvey of the water areas of the Sound from Execution Rocks eastward to the Norwalk Islands.

DELAWARE.

[PAUL C. WHITNEY.]

SUMMARY OF RESULTS.—Leveling: 2.6 miles of levels run to connect tidal bench marks. Hydrography: 9 square miles of area covered, 117.8 miles run while sounding, 3,889 soundings made, 1 tide station established, 1 hydrographic sheet finished.

Between July 31 and August 14 a hydrographic survey on a scale of 1:10,000 was made of the inner and outer harbors of Delaware Breakwater. Natural objects previously determined were used for signals. All existing tidal bench marks in the vicinity were connected by leveling and a tide staff used in this survey was referred to these bench marks. The nonexistence of the back range for compass deviation work was reported on.

NEW JERSEY, DELAWARE, MARYLAND, AND VIRGINIA.

[L. A. POTTER.]

Field revision of the region included in Coast Pilot, Section "C," which includes the coast from Sandy Hook to Cape Henry, with Delaware and Chesapeake Bays and their chief tributaries, was begun March 16. The navigable waters were visited by using the regular steamer lines or by hired launches. The work on the Potomac River and tributaries was completed on March 30.

On May 11, revision work was taken up at Milton, Del. From this date until May 23 an examination was made of the interior channels and inlets on the coast between Cape Henlopen and Cape Charles. On May 16, $2\frac{1}{2}$ miles of shore line was relocated at Assateague anchorage, where extensive changes have occurred. On May 19 and 20, $2\frac{1}{2}$ miles of shore line was relocated at Wachapreague and Great Machipongo Inlets.

Between May 23 and June 23 the navigable waters on the eastern shore of Chesapeake Bay from Cape Charles northward, to and including the Choptank River, were examined.

Throughout the progress of the work opportunity was taken wherever possible to take sextant angles for the location of aids to navigation.

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

[J. R. BENTON.]

STATIONS OCCUPIED.—*New Jersey*: Beverly, Bordentown, Haddonfield, Hightstown, Lambertville, Merchantville, and Trenton. *Delaware*: Bellevue, Felton, and Wilmington. *Virginia*: Cape Charles. *North Carolina*: Scotland Neck.

The stations in the foregoing list were occupied for magnetic observations by the observer named between July 1 and August 16. Of these Cape Charles was an old station which was reoccupied and the others were new stations. The new stations were permanently marked usually with a terra cotta drainpipe set in cement and capped with a bronze station mark.

In the region around Bellevue, Del., the magnetic declination was found to be more than 12 degrees west of north, the normal variation for that locality being only about $7\frac{1}{2}$ degrees; and to determine the extent of this irregularity observations were made at 26 additional places in Delaware and Pennsylvania for a distance of about 22 miles east and west and about 13 miles north and south of Bellevue.

It was found that the declination varied in the region covered between extremes of 3 degrees and 21 minutes west at Montchanin, Del., and 12 degrees and 12 minutes west at Bellevue, Del. The dip varied between 71 degrees at Talleys Corner, Del., and 73 degrees and 30 minutes at Concord, Del. The horizontal intensity also varied between .1770 Gauss at Concord, Del., and .2014 Gauss at Hockessin, Del.

The distribution of the magnetic disturbance in this region appears to be quite irregular although the westerly declination seems to increase at points on the eastern side of the disturbed area and to decrease at points on the westward side. The irregularity appears to extend beyond the area over which observations were made, but is greater on the west side of the Delaware River where the country is hilly and rocky.

Between June 20 and June 30 magnetic observations were made at Wilmington, Del.; Bordentown, Hightstown, Lambertville, and Trenton, N. J. At all of these places, except Wilmington, the old stations were reoccupied. At Wilmington observations were made as nearly as possible in the position of the original station, but no mark was left as the ground was being regraded. The other stations were permanently re-marked.

MARYLAND.

[GEORGE HARTNELL.]

The regular work of the magnetic observatory at Cheltenham, Md., has been continued during the year. All of the observatory instruments have been in satisfactory adjustment.

Comparisons were made with the standard observatory instruments of a magnetometer and earth inductor belonging to the Carnegie Institution.

In the latter part of the year a number of adjustments to the magnetographs were found necessary, but this did not prevent obtaining complete records of the magnetic elements.

A new azimuth mark was placed and satisfactory observations for azimuth were made.

The observatory buildings are in good condition.

VIRGINIA.

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

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 45 miles. Base lines: 1 secondary, 429 meters in length. Triangulation: 107 square miles of area covered, 175 signal poles erected, 27 observing tripods and scaffolds built (average height 25 feet), 32 stations in main scheme occupied for horizontal measures, 12 stations in supplemental scheme occupied for horizontal measures, 22 geographic positions determined. Leveling: 13 permanent bench marks established, 8 miles of levels run. Topography: 2.3 square miles of area surveyed, 80 miles of general coast line surveyed, 3 miles of creeks surveyed, 7 miles of roads surveyed, 3 topographic sheets finished. Hydrography: 165 square miles of area covered, 1,376.7 miles run while sounding, 6,291 angles measured, 47,810 soundings made, 6 tide stations established, 2 current stations occupied, 5 hydrographic sheets finished.

At the beginning of the fiscal year the schooner *Matchless*, which had previously been engaged on the survey of the eastern branch of Elizabeth River, Va., was at Baltimore undergoing repairs.

The survey of the eastern branch of Elizabeth River was resumed on September 12, and continued to completion on September 21. The triangulation started from stations Berkley and Power. In this work six station marks established by the United States Engineers were utilized and another was determined. Other triangulation points occupied and reference points were marked in the usual manner. In September the line between Broad and Park triangulation stations was remeasured twice with a steel tape and satisfactory results were obtained.

The topographic work executed on a scale of 1:5,600 was all in the vicinity of Norfolk. The details were mapped for a distance of 200 to 300 meters from the river, joining with the survey of the southern branch.

The hydrography was continued to the head waters of the branches. Sounding lines were run only in the direction of the stream. The western limit of the hydrography is Campostella Bridge, the area to the westward having been covered by the United States Engineers.

Current observations were made on two days in the channel below the Norfolk & Western Railroad bridge.

Observations of high and low waters, night and day, were made during the progress of the work at a gauge established at Berkley.

Between September 12 and 15 lines of level were run in Richmond, Va., connecting two tidal bench marks with permanent bench marks.

On September 20 the work in Elizabeth River was finished and surveys were begun on the eastern shore of Virginia in the vicinity of Cape Charles. The inshore hydrography from 3 miles below Fishermans Island at the entrance to the Chesapeake Bay to 25 miles above, with a usual width of hydrography of 3 miles, was in progress during the period from September 23 to December 31.

Twelve old triangulation stations were recovered from which a supplemental scheme of triangulation was extended to furnish points for the control of the hydrography. The line Old Plantation Flats Lighthouse to Cherrystone Lighthouse was used as a base.

The positions of lightship *No. 35* on the Middle Ground and of other aids to navigation were determined.

Tide observations were made at Cape Charles City during the progress of the hydrography in that vicinity and a comparison was made of the results with those obtained at the quarantine station at Fishermans Island.

The work done by this party from January 1 to June 30 begins 3 miles below Fishermans Island, covers 45 miles of the eastern shore of Chesapeake Bay, and includes many creeks.

This area is covered by three large sheets on a scale of 1:20,000. The more detailed work is shown on a hydrographic sheet and a topographic sheet for the entrance to Cape Charles City and for Cape Charles City itself on a scale of 1:5,000.

For the control of the topography and hydrography 25 old triangulation stations were recovered, and a sufficient number of additional points were located either by triangulation, with the plane-table, or by traverse lines.

All old stations recovered were permanently marked.

The shore line of Nassawadox Creek was rerun, and such other topographic work was done as was required to show changes in the shore line.

The principal work done was the hydrography of the creeks and from the shore to a depth of 6 or 7 fathoms, with lines sufficiently close to develop all of the shoal area, bars, and channels.

Tide gauges were established at the quarantine station on Fishermans Island, at Old Plantation Flats Lighthouse, at Cape Charles City, and on Nassawaddox Creek and Nandua Creek.

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

SUMMARY OF RESULTS.—Triangulation: 3 stations occupied for horizontal measures. Magnetic work: Ship swung at 1 station for magnetic deviation. Hydrography: 66 square miles of area covered, 644 miles run while sounding, 14,619 soundings made, 1 tide station established.

After completing repairs at Boston the steamer *Bache* sailed from that port on August 5 and arrived in Chesapeake Bay on August 8. From that date a careful development was begun of a comparatively shoal bank northward of the main ship channel close to Cape Henry at the entrance to Chesapeake Bay for the purpose of ascertaining the deepest draft that can be safely taken over the bank.

A tide gauge was established at the wharf of the Cape Charles quarantine station on Fishermans Island. The tide staff was connected by leveling with the bench marks at that station and with several additional bench marks established for the purpose.

On account of the difficulty of fixing positions, due to the width of the entrance and to the frequently hazy condition of the air, a water signal was built on the Middle Ground shoal. Bad weather and rough water retarded the erection of this signal.

On August 3 the vessel was visited by the Assistant Secretary of Commerce and the Superintendent of the Coast and Geodetic Survey who came on board at Hampton Roads to inspect the work at the entrance to the bay.

The hydrography of the entrance was advanced as rapidly as conditions would permit. The water signal which had been built with considerable trouble and expense was destroyed by a severe storm in the latter part of September and was not reerected.

By the latter part of October the area included between the parallels $36^{\circ} 57'$ and $37^{\circ} 03'$ and by the meridians $75^{\circ} 49'$ and $76^{\circ} 00'$, had been sufficiently examined, and work was closed for the season on October 28.

After closing this work an examination was made of a rock in the Georgetown Channel, Potomac River, opposite Easbys point, which had been reported as a danger to navigation.

NORTH CAROLINA.

[R. P. STROUGH.]

SUMMARY OF RESULTS: Base lines: 3 secondary, 852, 539, and 1,025 meters in length. Triangulation: 670 square miles of area covered, 108 signal poles erected, 3 observing tripods and scaffolds built, average height 40 feet, 104 stations in main scheme occupied for horizontal measures, 115 geographic positions determined. Azimuth: 1 azimuth station occupied.

Work was begun January 14 on the triangulation of the coast of North Carolina in the vicinity of Swansboro. Four triangulation stations established in 1909, just east of Bogue Inlet, were recovered and a base line about one-half mile in length was measured between

two of them. The geographic positions throughout the scheme depend upon that of station Bell at the southwest extremity of the base. After the measurement of the base signal building and observing were carried on when the weather permitted until about the middle of February, by which time work was completed as far as Freemans Landing, about 10 miles southwest of White Oak River. From here nearly to New River the sound is about one-third mile in width and it was necessary to narrow the scheme to this width. Along the shore of the mainland the high trees come down nearly to the beach and a broadening of the scheme by the use of high poles and scaffolds was impracticable. Many stations were necessary. A base was measured in this narrow portion of the work about 3 miles northeast of New River. The measurement of this base agreed with the computed length within about 1 part in 15,000. From this base toward New River the scheme is narrow for about 2 miles and then broadens considerably at the mouth of New River and continues with a width of over a mile from New River to the southwest for about 12 miles where it narrows slightly and then broadens out to $1\frac{1}{2}$ or 2 miles in width at Topsail Sound.

Connection was made with six triangulation stations established in 1855, and the lengths of the lines between them were found to agree satisfactorily with the new work. Three stations of the United States Army Engineers at the mouth of New River were recovered and connected with the triangulation. Two of these stations were re-marked.

About April 1 work was begun in Stump Sound and continued through Stump and Topsail Sounds to Bald Eagle Point abreast of Rich Inlet. Many of the old stations along this portion of the coast were searched for but none were found. All the new stations were marked with the standard disc station and reference marks. On May 20 the charge of the work was transferred to C. L. Garner.

[C. L. GARNER.]

SUMMARY OF RESULTS.—10 square miles of area covered, 9 signal poles erected, 13 stations in main scheme occupied for horizontal measures, 19 geographic positions.

The triangulation done by R. P. Strough between Beaufort and Rich Inlet was extended to Wrightsville, N. C., by C. L. Garner between May 23 and June 12, when work was closed for the season.

Work was begun on the line Eden to Rich, of which station Rich had not been occupied, and carried to about 1 mile east of Wrightsville Beach, finishing with a completed quadrilateral. Stations of the former triangulation were searched for but none were found.

SUMMARY OF RESULTS.—Base line: 1, 2,238 meters in length. Triangulation: 210 square miles of area covered, 44 signal poles erected, 7 observing tripods and scaffolds built, heights from 10 to 45 feet, 40 stations in main scheme occupied for horizontal measures, 75 geographic positions determined. Leveling: 1.3 miles of levels run. Topography: 14 square miles of area surveyed, 83 miles of shore line of rivers surveyed, 1.7 miles of creeks surveyed, 2.7 miles of roads surveyed, 2 topographic sheets finished.

Between December 30 and May 18 work of triangulation and topography was done in Albemarle Sound and vicinity.

After building the necessary signals observations in the triangulation across Albemarle Sound were begun on January 16 and con-

tinued until February 9, when on account of unfavorable weather observations were suspended on the sound and work begun on Alligator River, where the weather conditions had less effect on progress.

The triangulation was carried up the river to above Deep Point, where the stream narrows to about one-half mile in width, and was closed on March 8. The triangulation on Albemarle Sound was then resumed and afterwards that on the Pasquotank River.

During the observations across Albemarle Sound large signal lamps were used and observations were made at night.

The topography in the Alligator River, begun March 27, was carried up the river to the end of the triangulation and finished by April 21. The shore line was found to have receded along practically the entire river, in several places as much as 200 meters.

On April 22 the triangulation in North River was taken up and continued to beacon No. 10, south of Buck Island. Here it joins with the triangulation by the United States Army Engineers, which extends to the mouth of the Albemarle and Chesapeake Canal.

A base 2,200 meters in length was measured just to the southward of Buck Island.

Permanent reference marks were established at each station in the triangulation consisting of a brass plate set in concrete, and distinctive marks were also cut in trees. The marks were often placed at a considerable distance from the shore, in order that some mark may be recovered even if the station, which is usually close to the shore, should be lost.

NORTH CAROLINA AND SOUTH CAROLINA.

[ISAAC WINSTON.]

SUMMARY OF RESULTS.—Triangulation: 11 square miles of area covered. 2 observing tripods and scaffolds built 25 feet in height, 8 stations occupied for horizontal measures, 3 geographic positions determined.

In March the work was begun of determining by triangulation the geographic positions of three beacons in the mouth of North Edisto River, S. C., erected in 1913 for the use of the Bureau of Lighthouses. Scaffolds and signals 25 feet in height were constructed at each of these beacons and at two old triangulation stations and a pole was erected on the roof of the Rockville church, the steeple of which had been destroyed. A search was made for triangulation stations "Haul-over" and "Burrill," but these were found to have been destroyed, nor could many other of the old stations be found. Five lines were found to be obstructed by high trees and on two of them heavy cutting was necessary.

The old stations "East Base," "First Mile Stone," "Second Mile Stone," and "Seabrook Island" were used, and four new stations were established.

The geographic positions of the three beacons were determined.

Preparations were made in the latter part of May for completing a tertiary triangulation of the Cape Fear River from the work by the Coast and Geodetic Survey in 1913 up to Wilmington, to include connection with the old stations of the Coast and Geodetic Survey and with the triangulation of the United States Engineers, and also a determination of the geographic positions of all lights and day marks established by the Bureau of Lighthouses.

Information relating to the triangulation by the United States Engineers was obtained from their office at Wilmington, N. C., and all arrangements for the work were completed, when the observer was instructed to suspend operations and proceed to the coast of South Carolina.

On June 7 work was begun on the erection of 7 large hydrographic signals for the use of the party on the steamer *Bache* on the coast of South Carolina, in vicinity of Cape Romain. This work was in progress at the close of the fiscal year. Observations on known positions were made from the signals, and from Cape Romain and Georgetown Lighthouses such signals as were visible were observed upon.

NORTH CAROLINA.

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

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 75 miles, 200 square miles of area covered. Triangulation: 200 square miles of area covered, 77 signal poles erected, 3 observing scaffolds and tripods built, height 30 feet, 67 stations in main scheme occupied for horizontal measures, 14 stations in supplemental schemes occupied for horizontal measures, 137 geographic positions determined. Topography: 3 square miles of area surveyed, 10½ miles of shore line of rivers surveyed, 12½ miles of roads surveyed, 1 topographic sheet finished. Hydrography: 9 square miles of area sounded, 253.2 miles run while sounding, 14,165 soundings, 2 tide stations established, 7 hydrographic sheets finished.

From December 22 to May 6 the *Hydrographer* was engaged in the survey of the Pamlico River, N. C.

A new scheme of triangulation was run from stations of the Coast and Geodetic Survey triangulation which had previously been established by Assistant J. W. Maupin, up the Pamlico River to Washington, N. C., and a scheme was carried up the Pungo River to Leechville from a line of the Pamlico River work. Especial effort was made to recover stations of the old triangulation of 1871-1873, but only one was found, Cedar Grove near Washington.

The work was connected with the triangulation of the United States Engineers from Washington to a point 10 miles below. Nearly all of the stations of the United States Engineers were recovered. All lights and other objects of importance to navigators and others were determined in position, both in the Pamlico and Pungo Rivers. At the request of the United States Engineers a scheme of triangulation was carried up Slades Creek. No old stations were found in the Pungo River.

All main scheme stations were permanently marked and reference points were established.

The hydrography consisted in the development of certain spots, points of shoals, etc. A complete development of Pamlico River outside of the dredged cut and above Fort Point was made to show the limits of the dumping grounds on which the material from the cuts had been deposited. In several these are bare at low water. A shoal carrying 5½ feet near Fort Point was located and another off the mouth of Broad Creek. All buoys were located.

To show the improvements along the water front of Washington and vicinity a topographic survey on a scale of 1:5,000 was made.

Assistance was rendered the U. S. Torpedoboat *Foote* by pulling her off a reef upon which she had dragged in a gale in the harbor of

Washington, N. C. At the request of the commander of the United States Naval Battalion, an officer of the *Hydrographer* was detached to navigate the *Foote* from Elizabeth City to Washington. Aid was rendered the keeper of the United States lighthouse depot at Washington in relighting and repairing beacons. A launch and the services of several men were temporarily placed at his disposal for this purpose.

NORTH CAROLINA AND SOUTH CAROLINA.

[J. B. BOUTELLE.]

SUMMARY OF RESULTS.—Triangulation: 35 square miles of area covered, 9 stations occupied for horizontal measures, 6 geographic positions determined. Topography (shore line only): 30 miles of general coast line surveyed, 2 topographic sheets finished. Hydrography: 47 square miles of area covered, 634 miles run while sounding, 4,215 positions determined, 26,266 soundings made, 3 hydrographic sheets finished.

The party on the steamer *Endeavor* began hydrographic work in St. Helena Sound, S. C., on February 4. A number of old triangulation stations were recovered, signals were erected and determined in position by triangulation, and the sounding and topography of the shore-line changes was begun and continued until April 18. The shore line on the south and east sides of Otter Island at the mouth of the Ashepoo River and at the northeast end of Hunting Island was found to have changed considerably. Between the mouth of Johnsons Creek and Harbor River a long point covering considerable area has built out extending up the channel of Harbor River south of Egg Bank. The northeast end of Hunting Island has been cut away for about three-tenths mile from a point about one-half mile south of Hunting Island Lighthouse. These changes have caused corresponding changes in the hydrography, new channels and shoals having formed on this area. The entrance to Harbor River is nearly closed up by new shoals with narrow channels between them with depths ranging from about 8 to 14 feet. With an easterly swell the sea breaks all over this area and it is unsafe for any but light-draft boats with a pilot or with local knowledge to attempt to enter Harbor River from the sea. There is a good channel with a least depth of 8 feet on the western side of Egg Bank extending from Morgan to Harbor River, and this is used by all local boats. It has recently been marked by four day marks, consisting of a large pile and target. A new channel has cut through Pelican Bank about north from Egg Bank, from the main channel of the sound into Morgan River. It has a least depth of 8 feet and is about 500 feet wide.

Considerable change was found over the area on the south and west side of Ashepoo River, known as Combahee Bank. The beacon which was formerly on the point of the shoal is now in 4 fathoms of water. The two long shoals on either side of the main channel of St. Helena Sound which were reported to have moved one-half mile southwest were found to be in practically the same position as charted. The main channel was sounded from the mouth of the Coosaw River to the bell buoy outside the bar, the work extending as close as possible to the shoals on either side.

On April 20 the party proceeded to Cape Fear and surveyed the Slue Channel around the end of the cape, the eastern side of the

Middle Ground and channel at entrance to Cape Fear River, and made a plane-table survey of the shore line from Bald Head around the cape and thence to Carolina Shoal Beach. Extensive changes were found here, the cape having been cut away for about one-half mile and a new slue channel formed. This channel has a least depth of 13 feet and is about 400 feet wide with two turns. It has been used for several years by the fishing steamers drawing 9 to 10 feet, and the Beaufort, N. C., pilots take yachts through to avoid the long trip around Fryng Pan Shoals. The slue has been recently buoyed, but owing to the very strong currents and to the sea breaking heavily here with an easterly swell the buoys are liable to drag out of position. The shore line from the cape to the Carolina Shoal Beach also shows extensive changes, and the two inlets, Corncake and New Inlet, have both moved to the north.

FLORIDA.

[N. H. HECK.]

SUMMARY OF RESULTS.—Triangulation: 3 square miles of area covered, 3 stations occupied for horizontal measures, 1 geographic position determined. Topography: 0.3 square mile of area covered. Hydrography: 29 square miles of area dragged, 0.1 square mile of area sounded, 102.2 miles run while dragging, 2.8 miles run while sounding, 6,166 positions determined, 511 soundings made, 4 hydrographic sheets finished.

Work of examining with the wire drag the approaches to the harbor of Key West was resumed early in January.

The instructions for the season's work included the development of a shoal ridge outside of the outer reef, a complete examination of the Northwest Channel, the dragging of areas previously omitted and the examination of the result of operations by the Corps of Engineers, United States Army, in improving the main ship channel to a least depth of 30 feet mean low water over a width not less than 300 feet.

The first work taken up was that in the main ship channel. The removal of a portion of the Western Triangle shoals was completed by the United States Engineers, and with the cooperation of the Bureau of Lighthouses buoy C3 was removed and then replaced in a position to indicate the full width of the channel as improved. The northeast part of Western Head, charted at 22 feet, was completely removed by the Engineers to a depth greater than 30 feet. Several additional shoals were buoyed for the use of the United States Engineers in locating them for removal. In the channel through the outer reef the project of the United States Engineers included a 300-foot channel 30 feet deep at mean low water, 15 feet on each side of the entrance range. In order to make an immediately available deep channel the engineer first removed the 24-foot shoal eastward of the range. The method of removal was to blast near the deep water first, so that the material might be removed by gravity assisted by the action of the current on the finer material resulting from the explosion. This operation was found to be partly successful, but the survey indicates that the available depth of the channel is no greater than before, as lumps remain over which the depth has not been increased. The engineer was supplied with the necessary information for completing the channel to the required depth.

The weather during the season was generally favorable for the examination of the outer reef. As a result the indicated outer ridge was almost completely developed from Pelican Shoal to Vestal Shoal. The depths over the ridge are greater than 40 feet except in certain places. Ridges lying off Sand Key and Southeast Channel entrance were previously examined and developed as follows:

Off Vestal Shoal, Satan Shoal, and Western Dry Docks, western extension of ridge off Southeast Channel, two parallel ridges off Middle Sambo Shoal. Depths were found generally from 30 to 39 feet, the former depth occurring in a number of places.

At the close of the season on March 31 the dragging of the Northwest Channel was completed except in a few small areas, and over the greater part of it the effective depth was only 15 feet. This depth is fixed as a maximum by the presence of two uncharted shoals. A special effort was made to leave no area unfinished on which there is a depth of less than 17 feet.

Areas left unfinished in previous work were dragged as opportunity offered, those nearest Key West being first taken up. Some special soundings were taken in the boat harbor at Key West.

The new position of the Northwest Beacon Light was determined by triangulation. Some chart revision work was done to show a new wharf and changes in the railway terminal.

All bench marks at Key West and the staff of the automatic tide gauge were corrected by leveling.

A number of improvements were made in the methods of recording and plotting the wire drag work. The description of the long wire drag was revised for publication.

FLORIDA, ALABAMA, MISSISSIPPI, AND LOUISIANA.

[W. E. PARKER.]

In the latter part of April work was begun on examination of certain inland waters along the Gulf coast east of the Mississippi not included in the examination of the previous year or requiring reexamination on account of reported changes. From Fort Myers, Fla., a trip was made down the Caloosahatchee River and into Pine Island Sound and another trip up that river and into Lake Okechobee. At Tampa, Fla., information was obtained from the office of the United States Engineers in regard to the canal under construction between Boca Ceiga Bay and Clearwater Harbor. A reexamination was made of Anclote River to determine the positions of new lights which were reported to have been established.

From Carrabelle, Fla., an examination was made of Crooked and Ocklocknee rivers and Ocklocknee Bay. Information was obtained from the Florida State drainage engineer regarding the extension of the State drainage canals from Lake Okechobee to the Atlantic. The eastern part of the canal from Apalachicola River to St. Andrews Bay was reached by hired launch from Apalachicola and the western part by launch from Panama City on St. Andrews Bay. All of the branches of St. Andrews Bay were examined. From Panama City the route was to Pensacola and from there to Perdido Bay, where an examination was made of the bay and entrance.

The Mississippi River from New Orleans to the Gulf, Lakes Borgne and Pontchartrain and all of the navigable passages on the

eastern side of the Mississippi for which complete information was lacking were examined.

A careful examination was made of improvements recently completed at Eau Gallie, Fla.

All field work was completed by June 6.

FLORIDA AND TEXAS.

[CHARLES C. YATES, Commanding Steamer *Bache*.]

SUMMARY OF RESULTS.—Hydrography: 240 square miles of area covered, 1,188 miles run while sounding, 6,677 soundings made, 800 miles run with submarine sentry, 609 positions determined, 121 lines of astronomical positions observed, 1 tide station established, 2 hydrographic sheets finished.

On April 29 the steamer *Bache* began a survey of that portion of Sabine Bank in the vicinity of Sabine Bank Lighthouse, the object of the work being to investigate the existence of shoals on which several ships were supposed to have grounded in 15 or 25 feet, and reported as being three-fourths to 1½ miles from the lighthouse.

The results of this survey showed that the existing charts of the locality are less in error than appeared from the reports of the shipmasters, and indicate that the vessels had probably grounded much nearer to the light than reported.

The survey made will furnish all information necessary for the correction of the charts so that similar accidents will not occur in the future. The removal of the buoy located on the eastern side of the channel to the western side on the shoalest point making out to the eastward from the light was recommended.

On the voyage from Key West to Sabine Bank and in returning a survey was made to develop a 10-fathom shoal reported by fishermen where the charts show depth of 25 to 35 fathoms, situated about 100 miles northwest of Tampa. During the first part of the search for this shoal the ground was covered rapidly by going full speed with a submarine sentry set at 20 fathoms and by soundings taken every half hour. For three nights and days this method gave no indication of the shoal; but on the last day the sentry struck bottom and a sounding of 17 fathoms was obtained where the chart showed more than 25 fathoms.

On the return voyage the search was continued by taking soundings every five minutes but no depth was found of less than 14 fathoms. The bottom is very rocky and consecutive soundings showed abrupt changes of 5 to 7 fathoms.

ALABAMA, FLORIDA, GEORGIA, AND MISSISSIPPI.

[WALLACE M. HILL.]

STATIONS OCCUPIED.—*Alabama*: Anniston, Double Springs, Hamilton, and Vernon. *Florida*: Archer, Blountstown, Bonifay, Bradentown, Bristol, Clearwater, Dunnellon, Fernandina, Gainsville, Green Cave Springs, Jasper, Macclenny, Montello, Pensacola, Plant City, Quincy, Sanford, and Tallahassee. *Georgia*: Alamo, Clyde, Cochran, Conyers, Dallas, Darien, Eatonton, Hinesville, Jeffersonville, Macon, Savannah, St. Marys, Springfield, and Wrightsville. *Mississippi*: Aberdeen and Corinth.

Between January 21 and June 30 magnetic observations were made at the stations above mentioned, most of which were new stations. At some places both old and new stations were occupied.

Meridian lines were established at Double Springs and Heflin, Ala.; Blountstown and Gainsville, Fla.; Alamo, Conyers, and Darien, Ga.

Most of the stations were marked with stone posts 30 by 6 by 6 inches, with bronze magnetic station marks set in the top.

From the observations it would appear that the magnetic declination is now decreasing in some parts of Florida and Georgia.

INTERIOR STATES.

ALABAMA, CALIFORNIA, COLORADO, LOUISIANA, NEW MEXICO, OREGON, TENNESSEE, TEXAS, AND WASHINGTON.

[J. W. GREEN.]

STATIONS OCCUPIED.—*Alabama*: Huntsville. *Arizona*: Tucson and Yuma. *California*: Barstow, Chico, Dunsmuir, Gazelle, Glendale, Grants Pass, Indio, Red Bluff, San Bernardino, and Stockton. *Colorado*: Trinidad. *Louisiana*: Alexandria and La Fayette. *New Mexico*: Deming and Tucumcari. *Oregon*: Cottage Grove, Corvallis, Eugene, Glendale, Hillsboro, Junction City, and Portland. *Texas*: Amarillo, El Paso, Groesbeck, and Wichita Falls. *Washington*: Seattle.

Magnetic observations were made at the stations named between February 25 and June 16.

At Groesbeck and Wichita Falls, Tex., meridian lines were established. The observations at Tucson, Ariz., were for a comparison of magnetometer No. 20 with the observatory instruments.

At Chico, Cal., and Glendale and Junction City, Oreg., the observations for declination seemed to indicate local attraction. Observations at auxiliary stations failed, however, to indicate the presence of such local attraction.

ARKANSAS, MISSISSIPPI, AND TENNESSEE.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Base lines: 1, primary, 6,020 meters in length. Triangulation: 200 square miles of area covered, 10 stations in main scheme occupied for horizontal measures, 4 stations in supplemental scheme occupied for horizontal measures, 14 stations occupied for vertical measures, 18 geographic positions determined, 18 elevations determined trigonometrically.

Between May 2 and May 13 the Capleville base line was measured. This base is partly in Tennessee and partly in Mississippi, and is 6,020 meters in length. Two-thirds of its length is in Mississippi. It is situated about 7 miles south of Germantown, Tenn. It crosses two small creek beds and passes through two small stretches of timber; otherwise it extends over rolling ground, either cultivated or pasture. When the base was measured the ground was in good condition for stake setting and the crops just coming up were damaged but little. Where the base crosses the State line road a concrete mark was set and connected with the triangulation by tape and one observed direction. Mr. J. S. Bilby assisted in the measurement.

After the completion of the Capleville base the observation of angles was begun in the scheme of primary triangulation between Huntsville, Ala., and Memphis, Tenn. From Northwest Base, in the vicinity of Germantown, Tenn., the work was continued westward to Memphis, where connection was made with three stations of the Mississippi River Commission and the United States Engineers, of which stations one is a permanent bench mark of the adjusted,

level net. Ten primary stations and 4 supplemental stations were occupied by June 30. At all main scheme stations, with the exception of Exchange, which is on top of the Cotton Exchange Building at Memphis, observing towers were used.

Work was then resumed in the vicinity of Germantown and continued eastward.

NEBRASKA, COLORADO, UTAH, IDAHO, MONTANA, AND IOWA.

[H. E. McComb.]

STATIONS OCCUPIED.—*Nebraska*: Lincoln, Beaver City, and Trenton. *Colorado*: Greeley, Golden, Central City, Cripple Creek, Lake George, Salda, Leadville, Breckenridge, Fairplay, Saguache, Alamosa, Creede, Durango, Silverton, Telluride, Ridgeway, Ouray, and Grand Junction. *Utah*: Green River, Provo, Heber, Ogden, Morgan, Coalville, Brigham, and Logan. *Idaho*: Idaho Falls. *Montana*: Helena and Butte. *Iowa*: Dunlap, Exira, Griswold, and Mondamin.

The above-mentioned stations were occupied for magnetic observations during the season between July 1 and September 5.

Stations were reoccupied at Lincoln, Nebr.; Grand Junction, Colo.; Green River and Ogden, Utah; and Helena, Mont. A new station was established near the site of a former one at Greeley, Colo.

The magnetic stations were marked with limestone posts 6 by 6 by 20 inches, with a brass plate countersunk in the top. The stones were usually set flush with the ground. Considerable local disturbance was noticed at Central City and Creede, Colo., and at Butte, Mont.

Between June 13 and 30 observations of magnetic declination, dip and intensity were made at Lincoln, Nebr., and Dunlap, Exira, and Mondamin, Iowa.

As the values for the magnetic declination differed considerably from the expected values, auxiliary stations were established at each place. Three such stations at Griswold, Iowa, showed practically the same declination as the primary station. Two such stations at Exira and Dunlap, Iowa, also gave practically the same declination as the primary stations. At Mondamin, Iowa, however, values were obtained which differed considerably on going only a short distance from the primary station. Six auxiliary stations were occupied besides the primary station and two extra stations were occupied for dip alone. Local magnetic disturbances appear to be common in this section of Iowa, and surveyors encounter considerable difficulty in using the compass.

MONTANA, WYOMING, IDAHO, COLORADO, UTAH, TENNESSEE, ARKANSAS, AND MISSISSIPPI.

[J. S. Bilby.]

SUMMARY OF RESULTS.—Reconnaissance: 850 miles of progress made, 44,050 square miles of area covered, 185 lines of intervisibility determined in main scheme and S1 secondary scheme, 69 points selected for main scheme and 22 for secondary scheme, 3 base lines selected 14,400, 6,650, and 7,590 meters in length. Base lines: 3 primary base lines 11,300, 6,650, and 6,000 meters in length, prepared and measured in cooperation with observing party. Triangulation: 4 stands for instruments built 29 observing tripods and scaffolds built; average height, 82 feet.

The measurement of the El Paso base line, begun on July 7, was completed on July 23 and preparations were at once begun for the

measurement of a base line at Cheyenne, Wyo., in the vicinity of the line Waddill-Whitaker.

Between July 28 and August 11 the base site was prepared, the necessary levels run, the base measures made, and the base connected with the triangulation. In the measurement of these two base lines Mr. Bilby cooperated with C. V. Hodgson.

On the completion of the measurement of the Cheyenne base line arrangements were made for beginning a reconnoissance from Salt Lake to the Canadian boundary. This work was begun on August 20 and was completed by October 31.

The line Ogden Peak-Pilot Peak was selected for the base starting from the transcontinental triangulation, and connections were made at the northern end of the scheme in the vicinity of Sweet Grass hills with the triangulation along the forty-ninth parallel. The distance from the base starting from the transcontinental triangulation to the forty-ninth parallel triangulation as measured through the scheme is 555 miles. The work was completed, including the field records, in $2\frac{1}{2}$ months, and the total cost was about \$850, or \$1.52 per mile of progress. This is the lowest unit cost of which there is record.

All of the stations except 3 are on mountain peaks and can be approached over fairly good roads to the foot of the mountains and by pack animals from there to the station. In all there are 26 primary stations in the main scheme, including base net and Laplace stations. Only one signal is required, a 30-foot signal at Chester west base. Practically no clearing of timber is required, and only stands for the instruments are needed. A base line was located in the vicinity of Chester, Mont., near the northern end of the scheme, and 2 Laplace stations were selected, one at Bozeman, Mont., and the other at Chester, Mont.

Connections were made with 4 bench marks, with monuments of the Wyoming-Idaho and Idaho-Montana boundaries, with the triangulation of the Missouri River and that of the forty-ninth parallel, and with stations of the United States Geological Survey at many points along the scheme.

Between November 1 and February 9 a reconnoissance was made for primary triangulation from Little Rock, Ark., westward to a point on the ninety-eighth meridian.

Field work was begun November 25, the intervening time being occupied in travel to the field and making the necessary preparations. By February 9 all field work and records had been completed and the party equipment made ready for shipment to the next locality of work.

The reconnoissance was begun at stations Shinall-Reynolds in the vicinity of Little Rock, the two most westerly points of the reconnoissance made in 1912. Starting from these two points the scheme was swung to the southward of the Arkansas River; westward to the vicinity of McAlester, Okla., and thence westward to Arbuckle Mountain, Table Mountain, and Purcell, triangulation stations of the ninety-eighth meridian. The distance measured through the axis of the scheme is about 295 miles. In the eastern half of the scheme the country is very rough, the stations are on the high ridges and mountains, and with few exceptions the points can be reached only with pack animals. The country is heavily timbered in this part of the

scheme, but on the tops of the ridges and peaks the timber is small and of no value, so that the lines can be readily cleared and only stands for the instrument are required.

On the western half of the scheme nearly all of the stations can be reached by wagon, and the hills and ridges are flat and covered with timber, so that signals are necessary to overcome obstructions. In all there are 43 primary stations in the main scheme, including the base-net stations and 2 Laplace stations. Signals ranging from 30 to 60 feet in height are required at 17 stations and stands for the instrument at 26 stations. The average height of the signals was 42 feet.

During the progress of the work provision was made for two Laplace stations and one base line. Connections were provided for with 3 leveling bench marks and 4 posts marking the boundary between Arkansas and Oklahoma, and also with several triangulation stations of the United States Geological Survey.

In March work was begun on the erection of signals for the triangulation between Memphis, Tenn., and Huntsville, Ala., beginning at Memphis and working eastward. By June 30 signals had been built at 25 primary stations and at 4 secondary stations, all of which were marked with station and reference marks.

Tripods and scaffolds were built at all stations, the average height of the tripod head being 62 feet above the station mark. In addition to this a 20-foot superstructure was built on each of the signals, making the average height of the light stand 82 feet.

On May 8 and 9 the chief of the signal-building party aided in the measurement of the Capleville base line.

MONTANA.

[JOHN H. PETERS.]

SUMMARY OF RESULTS.—Leveling: 190 permanent bench marks established, 554.5 miles of levels run.

On July 7 work was begun for extending the line of precise levels from the bench marks established at Butte, Mont., northward along the Great Northern Railway to Shelby, Mont., and thence eastward along the Great Northern Railway toward Crookston, Minn.

In order to check the elevations of the bench marks at Butte the line of levels was extended to the southward of Butte for a distance of 7 miles, touching upon 8 bench marks of the existing level net.

Going northward from Butte the line follows the Great Northern Railway through the cities of Helena and Great Falls to Shelby, and thence eastward a distance of 18 miles to the small town of Devon, Hill County, Mont., at which point the season's work ended.

In accordance with supplemental instructions a line was run from the main line at Shelby westward a distance of $2\frac{1}{2}$ miles to Virden, Mont., and thence northward along the Canadian Division of the Great Northern Railway to the United States and Canada boundary at Sweetgrass, Mont. (Coumts, Canada), at which point a connection was made with bench marks of the United States and Canada Boundary Survey and with bench marks of the United States Geological Survey.

At frequent intervals during the progress of the work connection was made with bench marks established by other surveys, including, besides the organizations named, the Missouri River Commission, the United States Reclamation Service, and the Great Northern Railway. Whenever a line of levels of another survey was intersected, special effort was made to secure a connection with at least two bench marks of that line. In all 114 permanent bench marks were established and 336 miles of progress was made.

In the latter part of March work was begun on the extension of a line of precise levels from Butte, Mont., to Pasco, Wash., via Spokane, Wash., with spur to the Canadian boundary from Sand Point, Idaho. Work was begun at Missoula, Mont., from which point the line was extended 84 miles westward along the branch of the Northern Pacific Railway, which follows the Clark Fork River. The line was then extended southeastward to Silver Bow, Mont., where connection was made with bench marks of the adjusted level net. The party was then moved back to the westward of Missoula, where it began working toward Spokane, Wash. One motor and one hand velocipede car were used for transportation in the work of the two seasons, and the rate of progress made averaged 72.5 miles per month. By June 30 the line had reached Plains, Mont., a distance of 218.5 miles from Silver Bow.

MINNESOTA AND NORTH DAKOTA.

[C. M. CADE, July 1 to Sept. 9; GEORGE D. COWIE, Sept. 10 to Nov. 10, 1913, and May 1 to June 30, 1914.]

SUMMARY OF RESULTS.—Leveling: 505 miles of line completed, 250 bench marks established.

On July 1 a party was organized at Crookstown, Minn., to carry the line of precise leveling from that place westward along the line of the Great Northern Railway toward Butte, Mont.

Two of the bench marks in the city of Crookstown had apparently been disturbed by the settling of the structures on which they were placed. Two others were found of which the elevations were practically uncharged, and one of these (City) was taken as the initial bench mark for the line of levels.

With the permission of the Great Northern Railway velocipede cars were used for the transportation of the party and instruments.

On September 10 the charge of the party was transferred to George D. Cowie.

The line of precise leveling was carried to Berthold, N. Dak., closing on bench marks T4, U4, and V4. Then a branch line was run from Minct, N. Dak., to Portal, N. Dak., along the Minnesota, St. Paul and Sault Ste. Marie Railroad tracks, and a connection made with bench marks whose elevations had been determined by Canadian surveyors at the boundary monument west of the Canadian Pacific Railway station.

The grades throughout the line were low and the weather during the latter part of the season was excellent.

Permanent bench marks were established along the line of the railroads every 2 or 3 miles and on public buildings in towns. The for-

ward and backward runnings were made on different days and under different conditions of weather.

The bench marks used were Coast and Geodetic Survey bronze discs set in buildings or bridge abutments, iron posts with bronze caps on top and iron flanges at the bottom, stone and reinforced concrete posts with bronze discs, and hollow squares cut in masonry foundations of water tanks and in the steps or copings of permanent buildings.

Permanent bench marks were set out but not connected by levels along the line of the Great Northern Railway west of Berthold as far as Manitou, a distance of 45 miles, for use during the next field season.

Work was resumed in May, 1914, at Berthold, N. Dak., and by the close of the fiscal year the work had been carried to the vicinity of Calais, Mont., a distance of 164 miles.

Field work closed for the season on November 10.

ARKANSAS, MICHIGAN, MINNESOTA, MISSOURI, AND WISCONSIN.

[WALLACE M. HILL.]

STATIONS OCCUPIED.—*Arkansas:* Charleston, Conway, Fayetteville, Fort Smith, Huntsville, Lonoke, Morrilton, Ozark, and Paris. *Michigan:* Athens, Battle Creek, Caledonia, Lowell, Ludington, and Wayland. *Minnesota:* Bethel, North Branch, Rush City, and Zimmerman. *Missouri:* Kansas City (new station). *Wisconsin:* Balsam Lake, Birchwood, Clintonville, Cumberland, Frederick, Hurley, Ingram, Park Falls, Rice Lake, Seymour, and Tomahawk.

During the season from July 1 to December 13 new magnetic stations were established and magnetic observations were made at the stations named above.

Old stations were recovered and magnetic observations were made at Kalamazoo, Mich., Ladysmith, Wis., and Kansas City, Mo. (old station).

Magnetic observations were made for the investigation of the extent of local magnetic disturbances at Green Bay, Albert Storm's farm, Black Creek, Appleton, Van Buskirk, Saxon, and Mellen, all in Wisconsin. These places were occupied in an attempt to determine the approximate area over which an unusual local disturbance was found to affect the magnetic elements, but the stations were not marked.

Observations were made at the first four places on account of an unusual disturbance about Seymour, Wis., and at the last three places on account of a similar disturbance at Hurley, Wis. Meridian lines were established at Wayland, Mich.; Seymour, Birchwood, and Balsam Lake, Wis.; and Ozark and Conway, Ark. A meridian line at Fort Smith, Ark., was verified.

The local disturbances at Seymour and Hurley, Wis., are probably due to large deposits of magnetic ore. At these places there is much uncertainty as to property lines. All surveys are made with the compass, and the magnetic declination is found to differ as much as 1 degree in 6 or 7 miles.

In nearly all cases the stations established were marked with stone posts approximately 30 by 6 by 6 inches, with bronze marks set in the tops.

COLORADO, MONTANA, WYOMING, SOUTH DAKOTA, NORTH DAKOTA, ARIZONA, NEW MEXICO, AND TEXAS.

[C. V. HODGSON.]

SUMMARY OF RESULTS.—Base lines: 2 primary, 11,289 meters and 6,650 meters in length. Triangulation: 25 square miles of area covered, 4 stations in main scheme occupied for horizontal measures, 4 stations in main scheme occupied for vertical measures, 2 geographic positions determined, and 2 elevations determined trigonometrically. Latitude and azimuth work: 37 latitude stations occupied, 2 azimuth stations occupied.

The work of this party during the season from July 15 to October 15, 1913, consisted in primary base measure and latitude observations along the one hundred and fourth meridian triangulation between Colorado and the Canadian border. Two bases, the El Paso base and the Cheyenne base, were measured with satisfactory results, and 25 latitude stations and 2 azimuth stations were occupied.

A motor truck was used for the transportation of the party and equipment, resulting in a considerable saving of time and expense.

The latitude observations were made with a zenith telescope, and it was found that with this instrument the observations of 18 pairs of stars on a single night were sufficient to insure the required degree of accuracy, which was a probable error of $\pm 0''.10$. A portable wooden tripod was used as a stand for the instrument. During the next season a very much lighter stand, made of aluminum, was used.

The El Paso base was measured in cooperation with J. S. Bilby, who prepared the base, ran the levels, and furnished the additional men required. The same tapes and method of measurement were used as on the Provo base during the previous season.

The Cheyenne base was also prepared for measurement by Mr. Bilby, and the same methods were used in the measurement as on the El Paso base.

The work of observing latitudes was begun after the measurement of the El Paso base, and was continued without interruption during the remainder of the season, except for the measurement of the Cheyenne base.

During August, besides the measurement of the Cheyenne base and the occupation of 4 triangulation stations, 10 latitude stations were occupied, the roads in the region traversed being in better condition than those encountered later in the season.

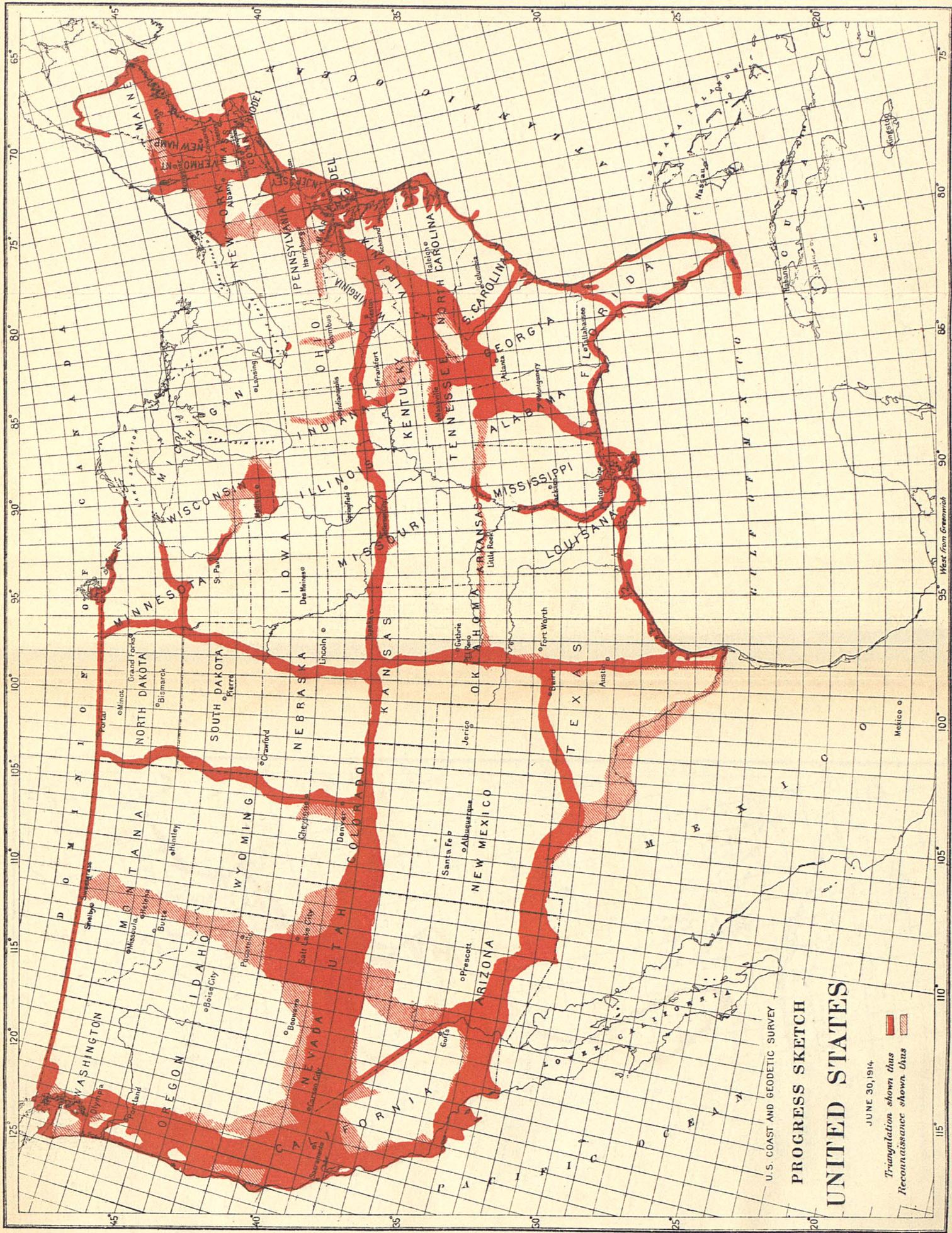
In May observations were begun for the determination of latitude at stations along the Texas-California arc of primary triangulation and on the California-Nevada boundary.

For the transportation of the party and equipment the motor truck used during the previous season on the one hundred and fourth meridian between Colorado and the Canadian border was brought from Denver, Colo., to the first station to be occupied at Barstow, Tex. From this point the work progressed steadily, and by June 30, 12 latitude stations had been occupied.

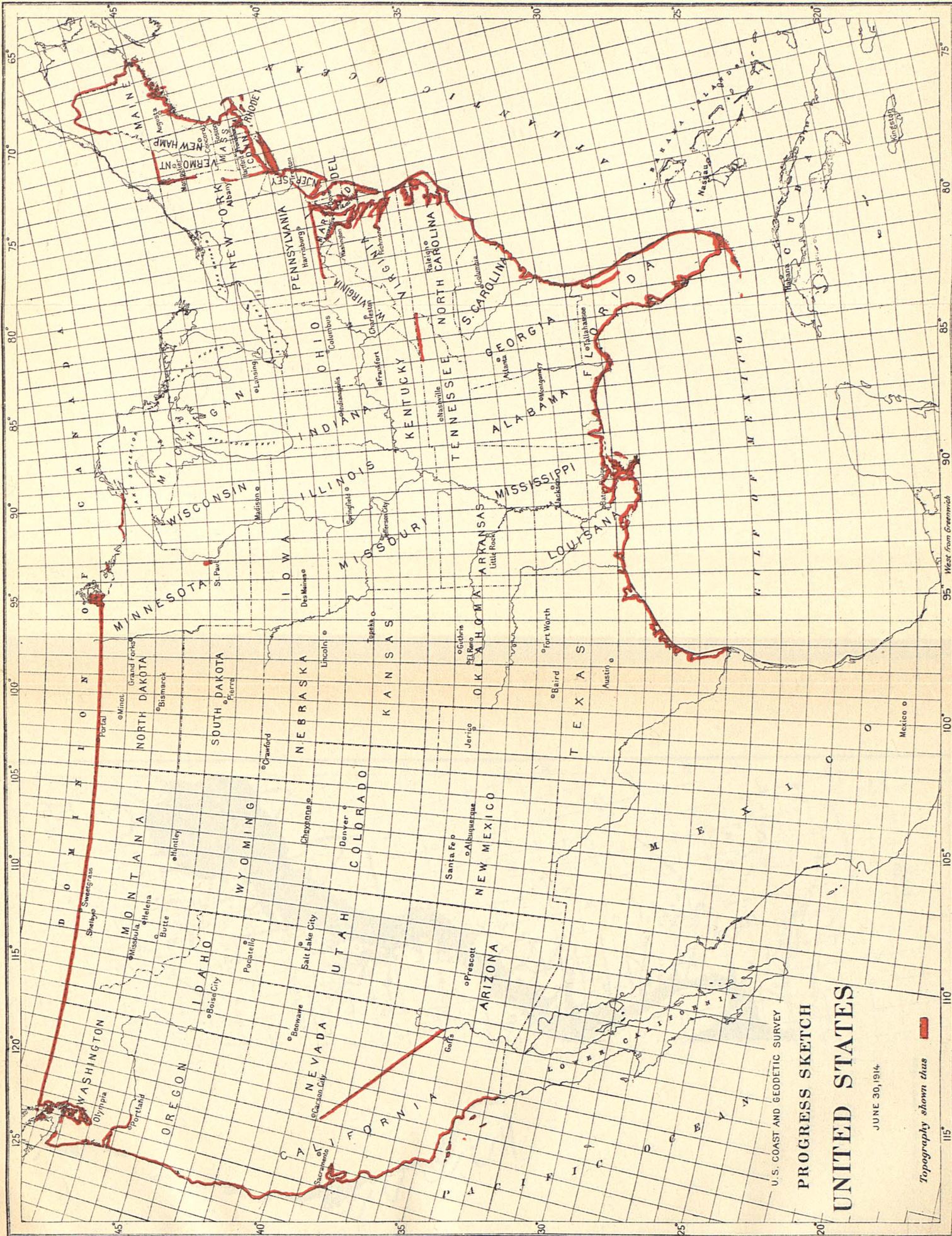
ARIZONA.

[W. W. MERRYMON and A. F. BEAL.]

The regular observations of the three magnetic elements were continued during the year at the Coast and Geodetic Survey magnetic observatory at Tucson, Ariz., without serious interruption.



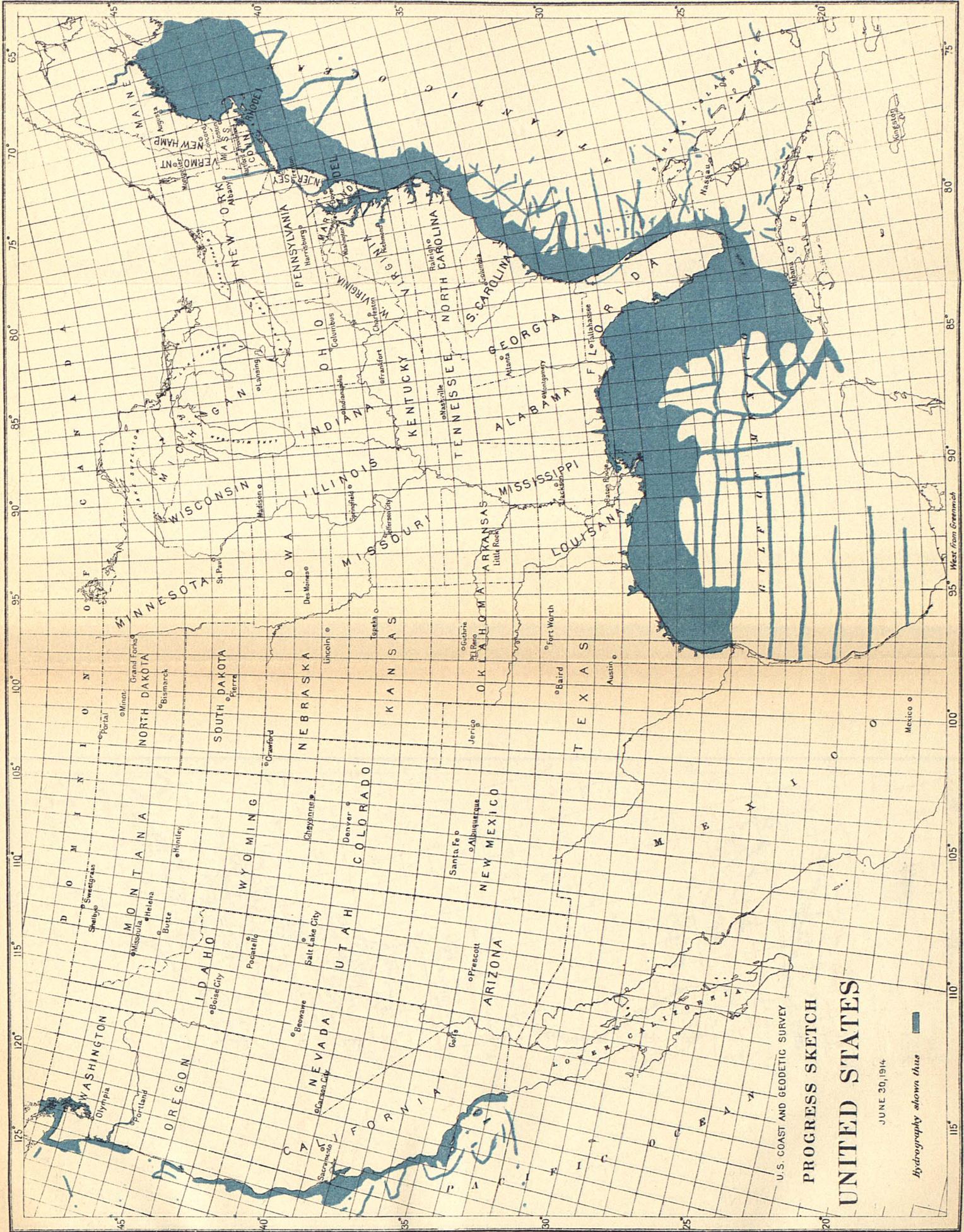
U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
UNITED STATES
 JUNE 30, 1914
Triangulation shown thus
Reconnaissance shown thus



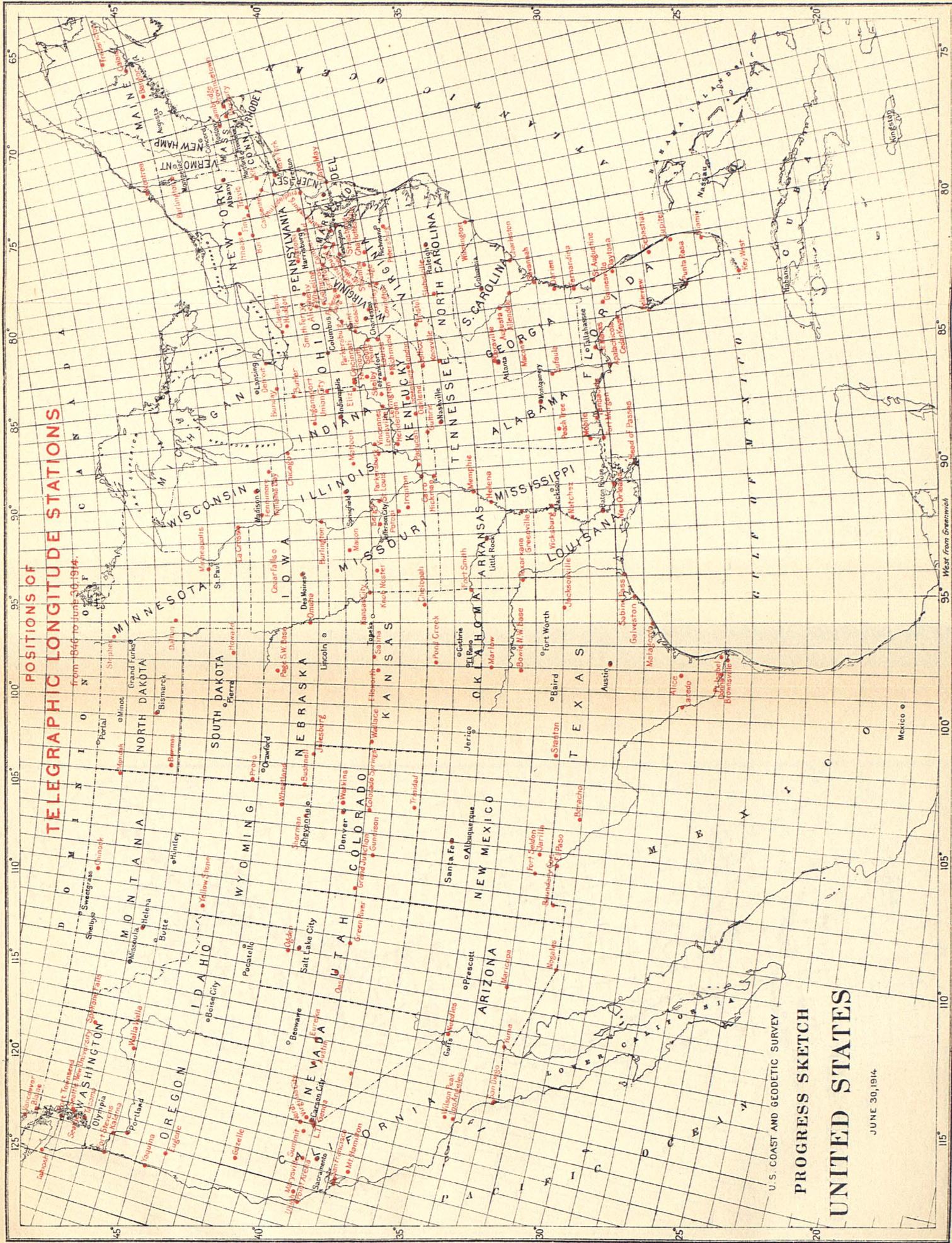
U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
UNITED STATES

JUNE 30, 1914

Topography shown thus 



U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
UNITED STATES
 JUNE 30, 1914
Hydrography shown thus

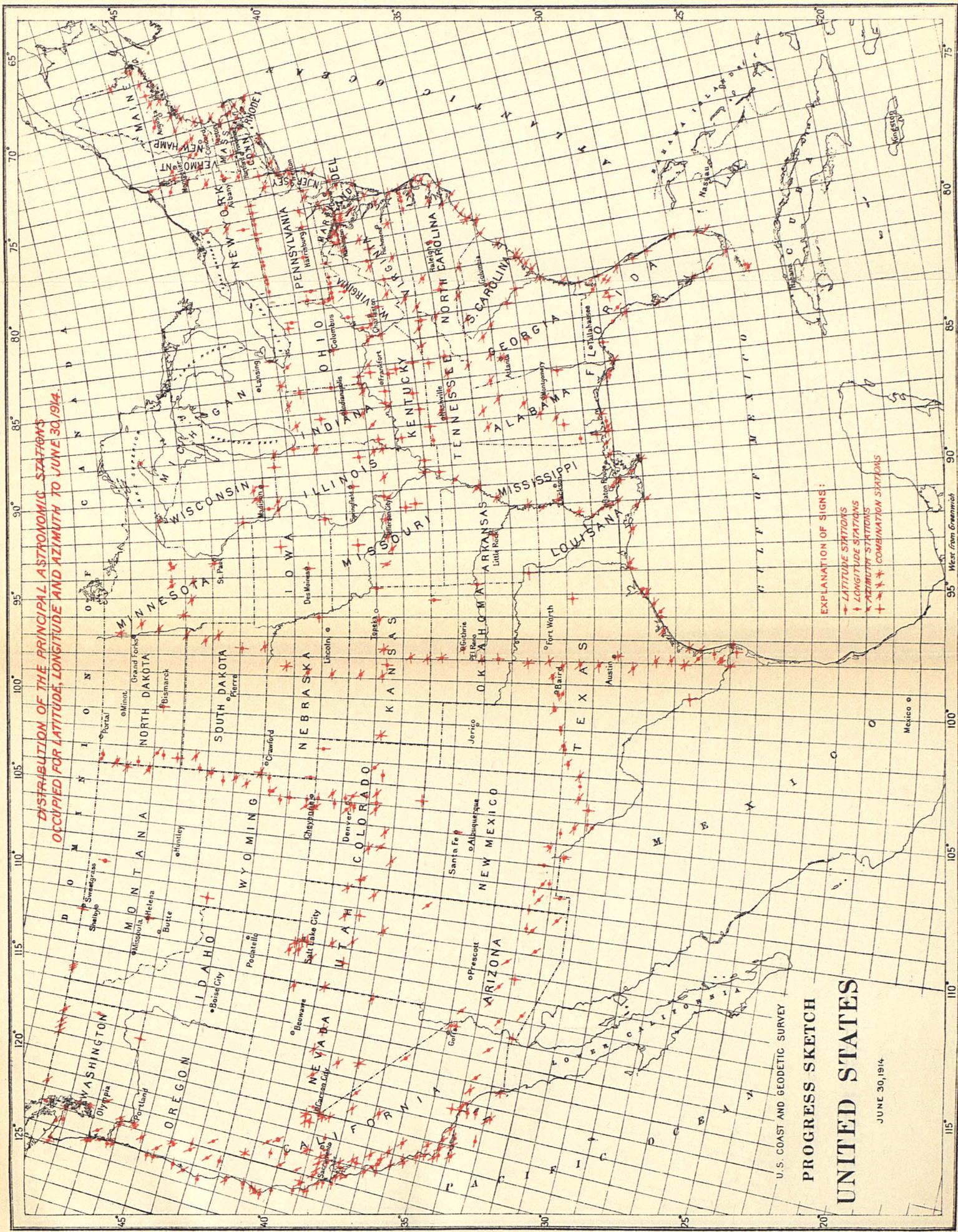


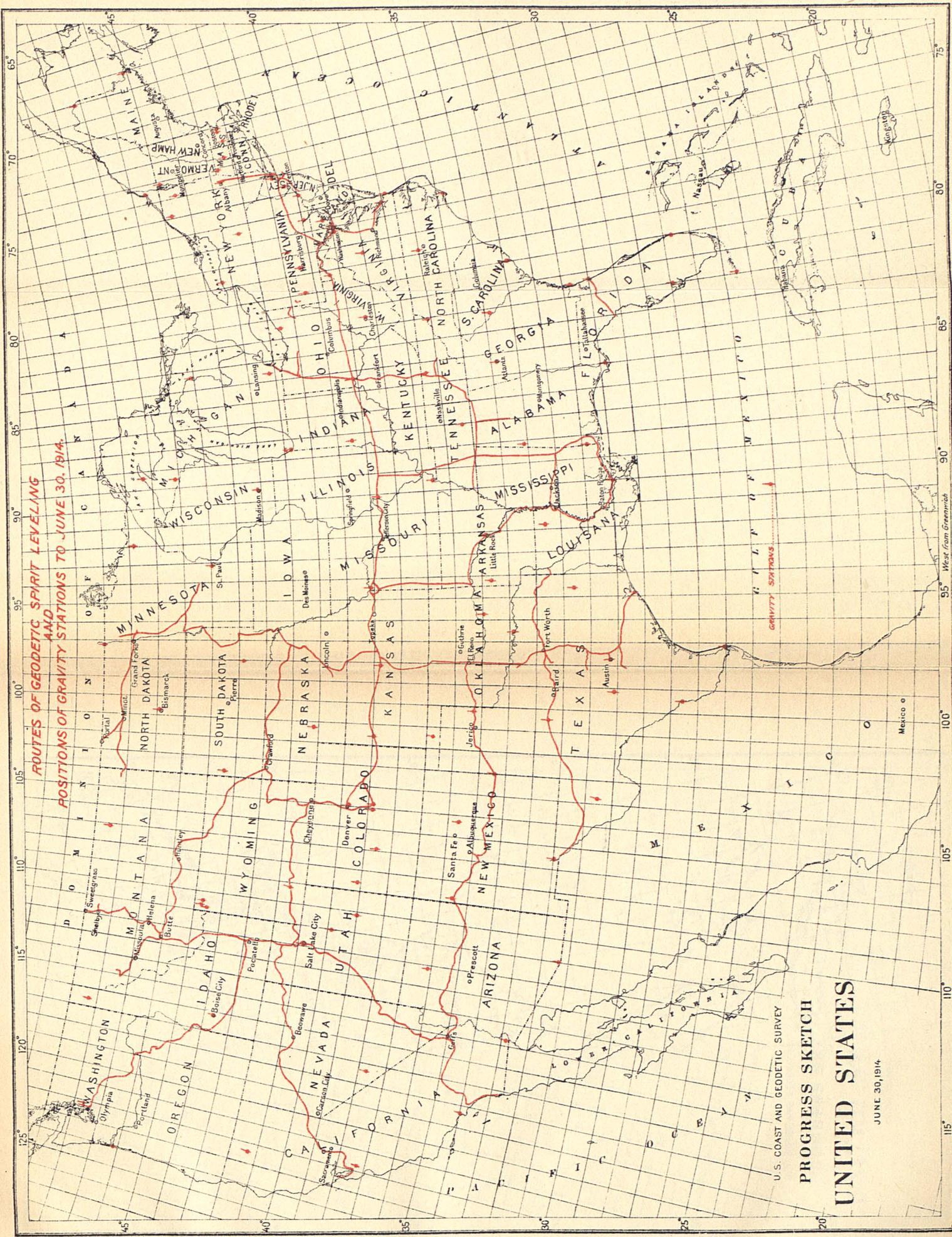
POSITIONS OF TELEGRAPHIC LONGITUDE STATIONS

from 1846 to June 30, 1914.

U. S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
UNITED STATES

JUNE 30, 1914

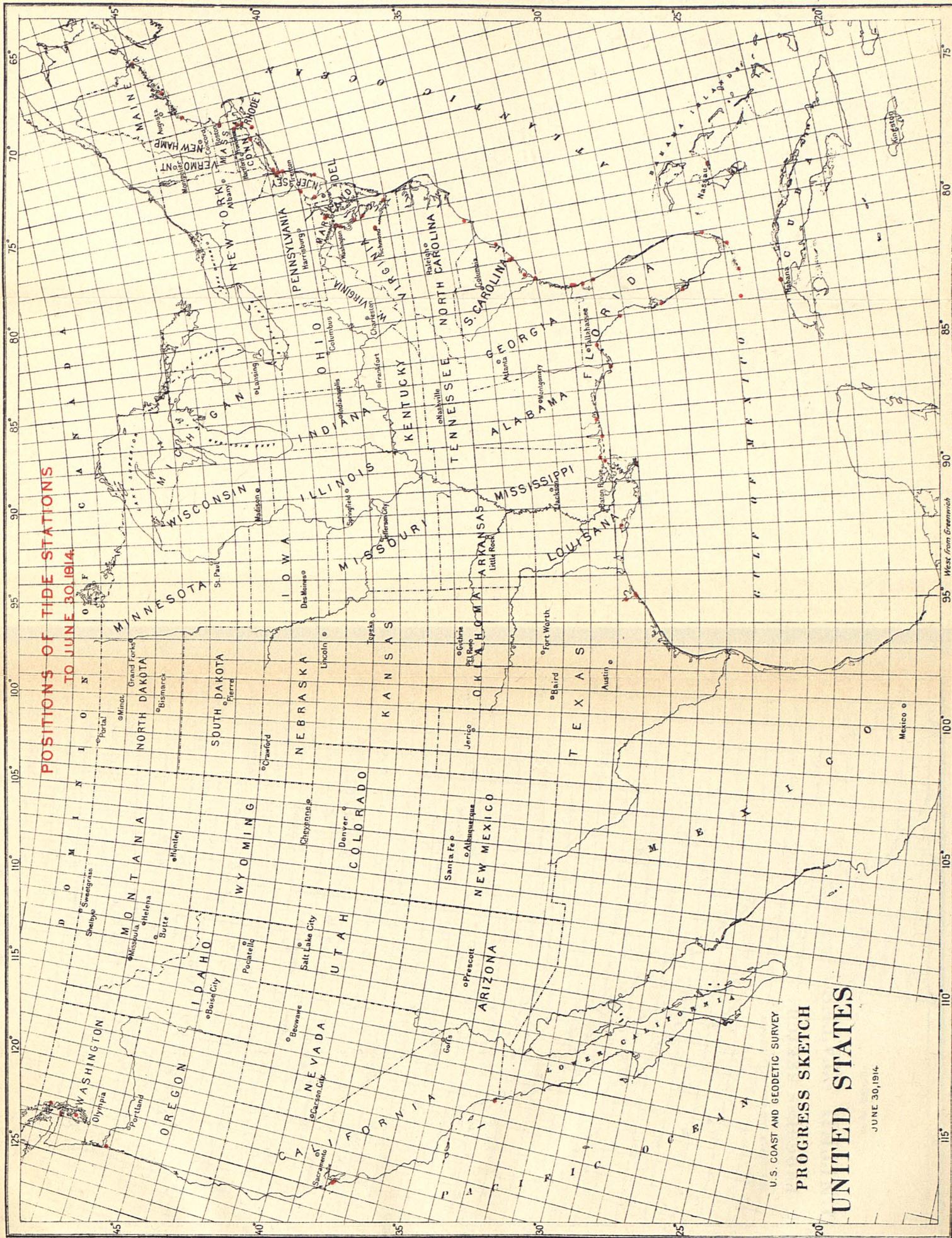




**ROUTES OF GEODETIC SPIRIT LEVELING
AND
POSITIONS OF GRAVITY STATIONS TO JUNE 30, 1914.**

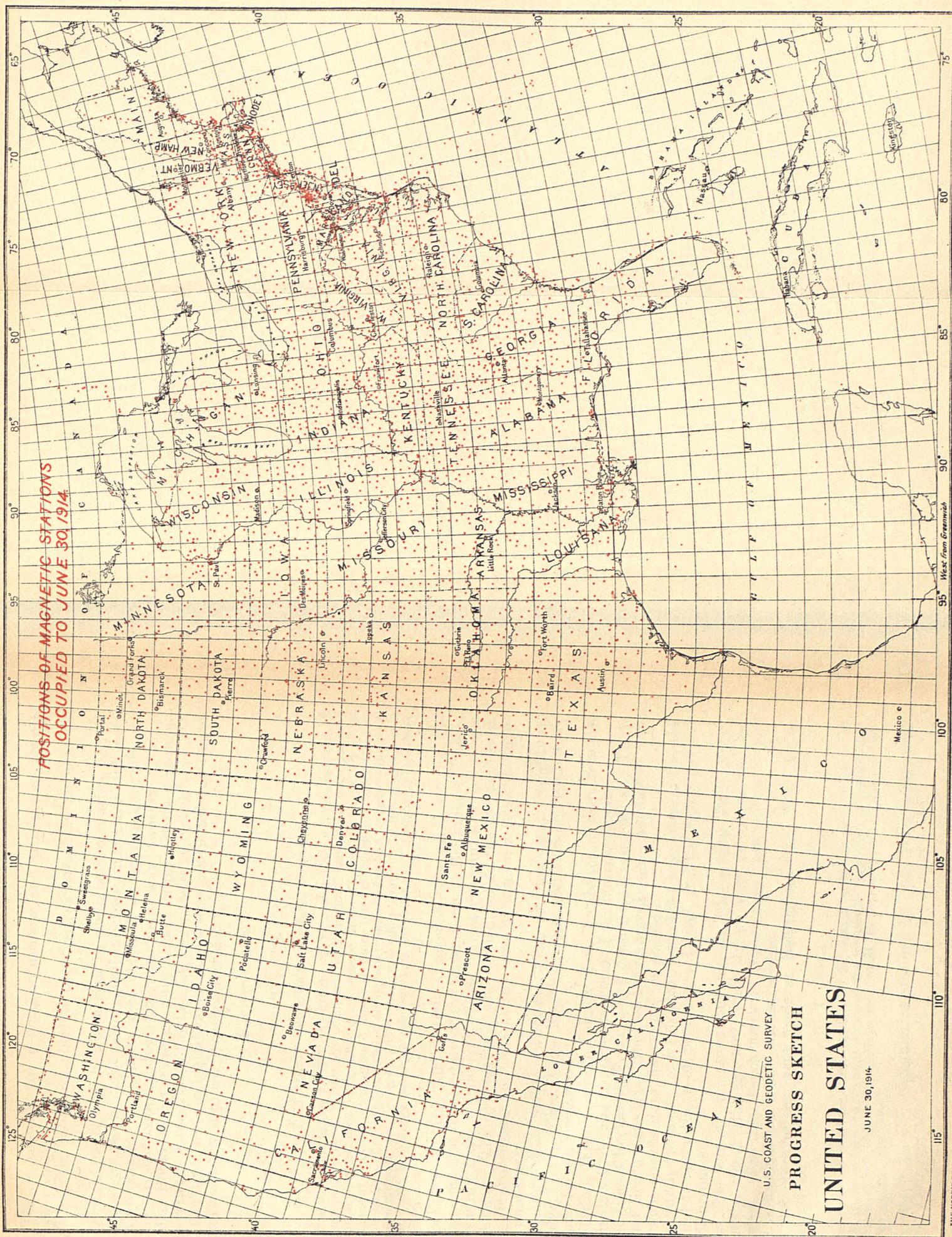
U.S. COAST AND GEODETIC SURVEY
**PROGRESS SKETCH
UNITED STATES**

JUNE 30, 1914



**POSITIONS OF TIDE STATIONS
TO JUNE 30, 1914.**

U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
UNITED STATES
 JUNE 30, 1914.



**POSITIONS OF MAGNETIC STATIONS
OCCUPIED TO JUNE 30, 1914**

U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
UNITED STATES

JUNE 30, 1914

The instruments are in good adjustment and satisfactory records have been obtained.

The scale value and absolute observations have been made at the usual times.

The magnetograph has been kept in continuous operation, recording changes in declination, horizontal intensity, and vertical intensity.

Chronometer corrections were obtained at regular intervals and time was also obtained from observations of solar transits.

The Bosch-Omori seismograph was kept in practically continuous operation. Twenty-four earthquake shocks were recorded.

The usual meteorological observations were continued and the results transmitted to the Weather Bureau.

PACIFIC COAST.

WASHINGTON.

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

SUMMARY OF RESULTS.—Triangulation: 31 square miles of area covered, 8 signal poles erected, 7 stations occupied for horizontal measures, 9 geographic positions determined. Topography: 6 square miles of area surveyed, 16 miles of general coast line surveyed, 3 miles of shore line of rivers surveyed, 2 miles of shore line of creeks surveyed, 2 topographic sheets finished. Hydrography: 5 square miles of area covered, 177.6 miles run while sounding, 4,186 angles measured, 9,208 soundings made, 2 tide stations established, 1 hydrographic sheet finished.

Between January and March a revision was made of the hydrography and topography of the water front at Bellingham, Wash., extending from a little east of the cement company's wharf to the bell buoy. The hydrography was carried out to the 30-foot curve. The improvements on Eliza Island were shown on a separate topographic sheet.

Triangulation stations Francis, John 2, Chuckanut, Sandstone, Hodge, Gnarl, Eliza, Three Rocks, Spring, and Lummi South were recovered and re-marked.

Stations White, Samish, Inianti, Rain, Fairhaven, Dump, Sehome, Eldridge, Crib, and Town were searched for but not found.

Stations Chuckanut, Francis, and John 2 were occupied and Town 2 and Beach were established and determined and a number of conspicuous objects were determined in position.

A search was made for a reported rock off the west coast of Cyprus Island in the vicinity of Strawberry Island, and the report proved to be erroneous.

In this vicinity triangulation stations Obstruction Pass, North Blakely, South Blakely, and North James were recovered and re-marked. The tidal bench mark in Obstruction Pass was recovered and re-marked and a new one established.

Tidal observations were made at Bellingham from February 6 to March 23.

[G. T. RUDE.]

SUMMARY OF RESULTS.—Triangulation: 27 square miles of area covered, 10 signal poles erected, 10 stations occupied for horizontal measures, 54 geographic positions determined, 9 old stations re-marked, 10 new stations marked, 47 reference marks established.

A search for old triangulation stations on Lake Washington was begun February 18.

A number of the old stations were found and re-marked and new stations were established where necessary.

On March 24 a reconnoissance was made of Union Bay in order to connect with a monument of the Army Engineers at the east end of the Lake Washington Canal, then in course of construction. Station Monument of the Engineers, near the shore, was found and connected with the triangulation scheme of the Survey, and two disc reference marks were established.

Observation of angles was begun March 9 and continued until March 28.

All stations were marked with Coast and Geodetic Survey disc triangulation marks set in concrete posts weighing from 250 to 400 pounds each. Three reference marks were established near and connected with each station.

Old stations Cot, Brush, Bay, Groat, Ash, High, Ruin, Pick, and Dry were recovered and re-marked. New stations Clear 2, Kane, Lake, Sand 2, Brick 2, and Golf 2 were established and marked. Stations Clear 2, Lane, Kane, Cot, Sand 2, Brick 2, Brush, Golf 2, Bay, and Monument were occupied with a theodolite for horizontal angles. Forty-three intersection stations were located.

Owing to the high stage of water on the lake many of the stations were under water, making the work of re-marking difficult and in some cases impossible. When water is let into Lake Union through the new canal the water level in Lake Washington will be lowered 7 feet. This will materially change the shore line and make necessary a new survey of the water front. The stations under water at the time of this survey may then be readily found and re-marked.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 60 miles, 2,100 square miles of area covered, 18 lines of intervisibility determined, 13 points selected for scheme. Triangulation: 600 square miles of area covered, 2 signal poles erected, 10 observing tripods and scaffolds built with heights from 60 to 215 feet, 6 stations in main scheme occupied for horizontal measures, 6 stations occupied for vertical measures, 29 geographic positions determined, 29 elevations determined trigonometrically.

At the beginning of the fiscal year a party was in the field engaged in reconnoissance, signal building, and occupation of stations in the secondary triangulation between Grays Harbor and the Strait of Fuca.

In this work it was regarded as desirable to establish stations at intervals of not greater than 10 miles, and for the reason that the method of clearing lines between stations in a heavily wooded country would permit determination of only a comparatively small number of points the plan was adopted of building above the trees so as to obtain an unobstructed view of the horizon, by which means a large number of intersection stations can be obtained with the degree of accuracy required in secondary work.

Construction work in such a country is expensive, but not as much so as the observation of angles, and the latter therefore should be done at the most favorable season, which is between the middle of July and the middle of September.

In the reconnoissance, which was made between May 29 and September 20, stations were selected which would control the important

topographic features and also furnish a scheme having lines which may be observed without difficulty under ordinary conditions of weather. Considerable work was done in cutting trails to aid the construction party in reaching the stations. The construction work was done between June 5 and October 3 by a party consisting of a foreman and 5 men. Six stations were prepared which required but little work, and 15 at which building or cutting, or both, were necessary. Six miles of trail were constructed for pack animals and 9 miles of other trail. At station Sooes suitable small trees were found for a separate instrument stand and observing platform. At Ozette a large forked tree was sawed off about 60 feet from the ground and the instrument mounted in the same tree as the platform with satisfactory results. At Ellis the tops of two trees were brought within 10 feet of each other and a platform and stand built between them about 120 feet from the ground. At Lapush a platform and stand were built in three trees 187 feet above ground. At Moclips, an intersection station, a large spruce was cut off 215 feet above ground and a crow's nest built in the top. The highest point of Mount Olympus was marked and a cairn erected over the point to be used as an intersection station.

At two stations, Hoh and Taholah, a new type of signal was built. The tallest tree was selected for the stand; two other trees were felled against it as braces, and the stand and platform, in one, built upon it.

Construction work was completed except in a few instances, where slight changes in the scheme may be found necessary.

The observing party consisted of 4 persons—the observer, a recorder, a packer, and a lightkeeper. No heliotropes were used and all of the observations were made on lamps and signals. A 7-inch Berger theodolite fitted with lighting device was used in this work, as it could be easily packed over the trails and with it vertical angles could be measured, doing away with the extra instrument for verticals required with a direction instrument.

The four stations Arch Rock, Vancouver, Ozette, and Carroll, all reached by water, were first occupied, and afterwards station Sooes and Ellis. Further observations were prevented by unfavorable weather. The two quadrilaterals at the north end of the scheme were completed. The work of the season closed on November 30.

WASHINGTON, OREGON, AND CALIFORNIA.

[H. A. SERAN.]

SUMMARY OF RESULTS.—Reconnoissance: Length of scheme 64 statute miles, 600 square miles of area covered. Triangulation: 1,785 square miles of area covered, 17 signals erected, 20 stations in main scheme occupied for horizontal measures, 16 stations occupied for vertical measures, 43 geographic positions determined, and 41 elevations determined trigonometrically.

Under instructions issued June 23 work was begun on the extension of the secondary triangulation in southwestern Oregon to the southward from the vicinity of Gold Beach to connect with the coast tertiary triangulation at a point between Sister Rock and Reddings Rock off the coast of California.

Work was begun at a point slightly to the eastward of Gold Beach in the latter part of July.

After a preliminary reconnoissance made between July 29 and August 4, during which 2 stations of the triangulation of 1907 were recovered, a construction party was put at work clearing lines of sight, building trails, and erecting signals, while the chief of party continued the reconnoissance to the southward. The type of signal selected was a four-sided pyramid about 18 feet in height and from 6 to 8 feet in width at the bottom.

Fog and bad weather interfered with the progress of reconnoissance, but by September 1 stations were selected as far south as the Klamath River, Cal., and the work of observing angles was then begun in the vicinity of Gold Beach, Oreg., the construction party continuing to the southward. After the construction party had completed the programme originally laid out a search was made for the old stations of the tertiary triangulation along the coast near the mouth of the Klamath River, and 3 stations of this work were recovered.

The observation of angles was continued until November 26, when the work was closed on account of bad weather, the last station occupied being Red Mountain, about 4,000 feet in height.

In all 11 stations in the main scheme were occupied for observations of horizontal and vertical angles.

On April 28 work was resumed on the extension southward of the secondary triangulation from southwestern Oregon southward to connect with the tertiary triangulation along the California coast at some point between Sister Rock and Redding Rock, Cal.

Between April 28 and May 4 a portion of the party was engaged in a search for the old triangulation stations along the coast, established about 40 years previously. In the interval so many changes had taken place that the old descriptions of these stations were rendered practically useless. The instructions called for a connection with three of the old stations, and this was made with the stations High Bluff, Flint Rock, and Flint Ridge. High Bluff and Flint Rock had been recovered at the close of the 1913 season. These stations were re-marked with standard disc triangulation stations marks and reference points were established and similarly marked. An unsuccessful search was made for station Klamath South. Between May 7 and June 14 observations were made at stations Klamath South 2, Mound, High Bluff, Flint Rock, Flint Ridge, Red Mountain, Rattle, Child, and Gordon Mountain. Red Mountain, Child, and Gordon Mountain had been occupied in 1913, but were reoccupied in order to establish a central point in the triangle from which the work was afterwards extended and connected with the coast triangulation.

At the end of June the party had completed the connection with the coast triangulation in northern California and had been moved to Clallam Bay, Wash., to take up the work needed to complete the triangulation in the Olympic Peninsula, begun in 1913 by the party of E. H. Pagenhart.

OREGON.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Triangulation: 73 square miles of area covered, 150 signal poles erected, 129 stations in main scheme occupied for horizontal measures, 12 stations in supplemental schemes occupied for horizontal measures, 271 geographic positions determined. Topography: 16 geographic positions of light stations determined topographically.

The work of determining the geographic positions of aids to navigation and prominent objects along the Columbia River was in progress at the beginning of the fiscal year. In this work the triangulation stations established by the United States Engineers were used wherever practicable.

The positions of light stations between Puget and Walker Islands were determined by sextant angles and tape measurements plotted on photographs of the original sheets. On this stretch of the river conditions during the high-water stage were unfavorable to the carrying forward of a triangulation with stations on the banks of the river which would see the light stations.

From Walker Island Light Station to Swan Bar (upper) Light Station, in the city limits of Portland, Oreg., all light stations except Coffin Light were determined by triangulation.

The triangulation from the base Mount Coffin, Rinearson, Huntington (recovered Coast and Geodetic Survey stations), extends down the river to Walker Island Light Station and to the United States Engineer's line Quarry-Slaughter.

From the line Slaughter-Quarry (United States Engineers and Coast and Geodetic Survey, 1913) the triangulation is completed to the line H26₂-H23₂ (United States Engineers) through a system of single triangles.

Overlapping this work is the Coast and Geodetic Survey triangulation from recovered base Carr-Drays Mound, extending down the river to Cowlitz River Light Station. The triangulation from the base Carr-Drays Mound joins the United States Engineers triangulation on the line H10 and H22₂. From this line the triangulation consists of the observations of the United States Engineers combined with those by the Coast and Geodetic Survey party, and with a connection at Martins Bluff (Coast and Geodetic 1878-1913) extends to the recovered Coast and Geodetic Survey base Gatton-Howell.

From the United States Engineers station 42 at the junction of the Columbia and Willamette Rivers to United States Engineers station 39₂ above the Northern Pacific bridge there is computed a system of single triangles observed by the United States Engineers alone. From the base Caples (Coast and Geodetic Survey, 1883) to Scott (Coast and Geodetic Survey 1881-1883), there is a triangulation of United States Engineers and Coast and Geodetic Survey observations combined which extends to the line P 44.

The triangulation of 1913 combined with that by the United States Engineers consists of well-determined points near the river bank from Portland to the Columbia River entrance, except between Walker Island and Cathlamet, a distance of about 17 miles.

In the progress of the work numerous directions were observed on wharves, tangents to shore line and other artificial and natural features useful for a topographic revision, and notes were made of changes for use in correcting the charts and sailing directions.

OREGON AND CALIFORNIA.

[J. W. MAUPIN.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 15 statute miles, 8 square miles of area covered, 148 lines of intervisibility determined, 58 points selected for scheme. Triangulation: 4 signal poles erected, 92 old stations recovered, 86 old stations re-marked. Topography: 110 square miles of area revised, 64 miles of general coast line revised, 20 miles of creeks revised, 50 miles of roads surveyed.

Between January 21 and May 31 chart-revision work on the south coast of California was carried from the south side of Newport Bay to the town of La Jolla, a distance of 6.4 miles with a width of from 1 to 3 miles. This area was thoroughly gone over with special attention to the seaward slope, and all changes affecting the charts were noted. The positions of a number of permanent objects were determined. The old triangulation stations were permanently re-marked with standard station and reference marks set in concrete piers.

On June 8 work was begun on a resurvey of Yaquina Bay, Oreg. The work done before the close of the year was confined to reconnaissance, cutting lines of sight, signal building, and station marking. The stations, except 3, were marked with standard station marks set in concrete piers.

CALIFORNIA.

[FREMONT MORSE.]

SUMMARY OF RESULTS.—Reconnaissance: 9.9 square miles of area covered, 42 lines of intervisibility determined, 16 points selected for scheme. Triangulation: 9.9 square miles of area covered, 2 signal poles erected, 5 stations occupied for horizontal measures, 14 geographic positions determined. Hydrography: 4 square miles of area sounded, 90.3 miles run while sounding, 1,588 angles measured, 3,534 soundings made, 3 tide stations established, 3 hydrographic sheets finished.

On April 12 work was begun on a hydrographic survey at the mouth of Mare Island Straits and in Suisun Bay to develop changes reported to have taken place and to indicate the proper position for aids to navigation.

Work was begun at the mouth of Mare Island Straits; signals were erected and a tide station was established on the Magazine Wharf at Mare Island and referred to the old Bradford bench mark. Two old triangulation stations were recovered and occupied with the plane table for the purpose of cutting in the hydrographic signals. These together with a few hydrographic points that could be occupied were sufficient for the location of all points used. The survey at the mouth of Mare Island Strait served to outline the edge of the flats and the channel and indicate the proper location for the entrance buoy.

On March 22 the party moved from Vallejo to Pittsburgh to take up the work on sheet No. 2. Five triangulation points were recovered by means of which the necessary signals were located. Sounding was begun March 28 and completed March 31. The location of tule islets on the middle ground near Middle Point, the running of the tule line around Chain Island, along the shore of Van Sickle and Chipps Islands and at the entrance to New York Slough, and the location of new wharves in New York Slough occupied the party until April 3.

On April 4 the party moved to Benicia to take up the work on sheet No. 3. From two triangulation stations recovered near the western end of this sheet a triangulation was carried to the east end of Roe Island, including nearly all the hydrographic signals used on the sheet. Sounding was begun on April 11 and completed on April 15. On April 16 and 17 the positions of the new wharves within the limits of the sheet were determined and the triangulation observations were made. Work was closed on April 17.

[F. WESTDAHL.]

An officer of the Survey has continued on duty as inspector for the coast of California and in charge of the suboffice of the Survey at San Francisco.

The office work includes the collection of data relating to the charts of the Pacific coast, reported dangers, changes in aids to navigation, and furnishing information to the public concerning the work of the Survey.

Attention is also given to forwarding instruments and supplies sent from the office at Washington, the transportation of officers traveling to or from the Pacific coast points or the Philippine Islands, directing the work of the tide observer at Sausalito, carrying on the necessary official correspondence, and various other duties.

ALASKA.

[GILBERT T. RUDE, Commanding Steamer *Taku*.]

SUMMARY OF RESULTS.—Base lines: 1 base line measured. Triangulation: 261 square miles of area covered, 76 signal poles erected, 50 stations occupied for horizontal measures, 132 geographic positions determined. Magnetic work: 3 land stations occupied for observations of magnetic declination. Topography: 72 square miles of area surveyed, 66.7 miles of general coast line surveyed, 6 topographic sheets finished. Hydrography: 40 square miles of area covered, 273 miles run while sounding, 1,454 angles measured, 2,324 soundings made, 3 tide stations established, 3 hydrographic sheets finished.

At the beginning of the fiscal year the party on the steamer *Taku* was at work in Prince William Sound and had just begun the survey of the east arm of Simpson Bay. The topography and hydrography in this locality were completed by July 15. In the meanwhile a sub-party was engaged in extending the triangulation up Sheep Bay from the work of H. P. Ritter in Orca Bay.

Work was then taken up in Sheep Bay, with an advance party extending the triangulation up Port Gravina from Orca Bay. A tide staff was erected in Comfort Cove and a datum plane established. The erection of signals and topography of Sheep Bay were

begun on July 23 and the hydrography on July 1. Work was suspended in this locality on August 6 for the purpose of making a survey of the hydrography and topography at the head of Passage Canal. A subparty was left to continue the triangulation of Port Gravina.

A tide staff was erected in the small bay on the south side of Passage Canal about 6 miles from its head, and observations for the establishment of a datum plane were at once begun. Signal building was begun August 11 and completed on August 13. A preliminary measurement of a base was made with a 50-meter tape across the gravel flats at the head of the canal for topographic use. A scheme for future triangulation was laid out and the stations marked. These stations were then located, together with intermediate points for hydrographic use, by plane table triangulation.

The hydrography and topography were begun August 15. The topography was completed, with the exception of the contouring, on August 19 and the hydrography on August 18. The contouring was completed on August 22.

Further instructions being received to carry the topographic work from the head of the canal, at least to the crest of the divide, in the direction of Turnagain Arm, the topographic survey of the valley was begun on September 4.

The topographic work was done on two sheets, one extending from station South Base at high water mark on the gravel flats at the head of the glacier, over the glacier and across the divide to the gravel flats between the west end of Portage Glacier and Turnagain Arm, including Tunnel and Turnagain shoulders, and the other, including the peaks to the southward, forming the large basin in which Portage Glacier lies.

A traverse line was run up the valley for the control of the topographic work.

It was impossible at that season of the year to get entirely across the glacier and down to the gravel flats on the Turnagain Arm side on account of deep crevasses, some of which were probably over 200 feet in depth and from 20 to 50 feet in width. The last half mile of the traverse was particularly difficult. One afternoon was consumed making this half mile and back to the smoother part of the glacier. This time was spent in cutting ice steps and in searching for snow bridges on which to cross the crevasses. The snow bridges were very unstable and dangerous.

A good view was had of the flats between Tunnel and Turnagain shoulders and of the main flats toward Turnagain Arm. Two light-colored rocks, one on each side of these flats, were determined in location and elevation by intersections from stations on the glacier, as were also a number of points on the slope of Turnagain shoulder. Tangent cuts were also taken to each side of the valley toward Turnagain Arm and the 200-foot contour sketched showing the approximate limits of the gravel flats. Numerous elevations were determined on the slope of Tunnel shoulder. It was impracticable to get any cuts on the west slope of this hill or to get into a position on the glacier where a good view of it could be had. The contours of this part of the hill were sketched on the sheet in broken lines.

Tunnel shoulder on its east side is composed of sandstone and shale. This formation continues through Taku Pass. The approxi-

mate location and elevations of possible tunnel openings were indicated on a topographic sheet which shows all the possibilities of a tunnel location and descent to tide water in both directions.

The gravel flats at the head of Passage Canal are of sufficient size, about one-half mile square, to furnish room for a railroad terminal.

The hydrographic sheet of the head of the canal shows the possible locations for a dock paralleling the shore line of the south side near the head of the passage and along the delta of Whittier Glacier. The gravel flats forming this delta are of sufficient extent for the location of coal bunkers and tracks. None of the glaciers discharge ice into Passage Canal.

The hydrographic survey was carried 5 miles down the passage from its head on a scale of 1:10,000.

The main part of the canal is too deep for anchorage, ranging from 100 to 200 fathoms. An anchorage of limited area, about three-quarters by one-quarter mile, was found and developed on the south shore about 3 miles from the head of Passage Canal, with depths ranging from 10 to 20 fathoms sticky bottom. The head of the canal is landlocked and no swell enters from outside.

After the completion of the survey of Passage Canal on September 9 a detached survey was made of Chamberlain Bay and Jackson Cove on the south shore of Glacier Island. The signal building and topography were begun on September 11, a tide staff erected, and continuous readings for datum plane begun. The hydrographic work was begun on September 12 and completed on September 16, and the topography was completed on the same date. This is a detached survey on a scale of 1:10,000. Good anchorage for small craft may be had in 5 fathoms, mud bottom, near the head of Jackson Cove. In heavy easterly weather considerable swell rolls in toward the cove, but is broken by the narrow entrance and does not enter. This entrance is very narrow but has sufficient water for any small boats or launches which would attempt to pass into such a confined channel. Anchorage for larger craft may be had in 14 and 15 fathoms, mud bottom, at the head of Chamberlain Bay.

Work was resumed in Sheep Bay on September 23 and continued until September 28. After preparing the steamer *Taku* and boats for the winter the party proceeded to Seattle arriving there October 14.

On November 22 the magnetic station at the University of Washington, at Seattle, was occupied with declinometer No. 733 for determination of vernier correction. During the season five stations were occupied with declinometer for variation, and the ship was swung once for deviation.

In the latter part of March the work of preparing the steamer *Taku* for use during the season of 1914 was begun. The party arrived at Cordova, Alaska, on April 12. Repairs to the steamer were completed May 12, and field work was begun on Passage Canal on May 16. Signal building for the triangulation to join the survey of 1912 with that of 1913 was completed June 5, when the observation of angles was begun and continued until June 19.

A base line was measured at the head of Passage Canal on June 8 and 9. The topography and hydrography were begun June 20 and 23, respectively, and were in progress at the close of the fiscal year.

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

SUMMARY OF RESULTS.—Triangulation: 192.5 square miles of area covered, 39 signal poles erected, 1 observing station and scaffold built, 12 feet in height, 38 stations in main scheme occupied for horizontal measures, 45 geographic positions determined. Leveling: 11 permanent bench marks established, 1 mile of levels run. Latitude, longitude, and azimuth: 1 latitude station occupied, 1 longitude station (chronometric) occupied. Magnetic work: 2 land stations and 2 stations at sea occupied for magnetic observations, ship swung at 2 stations at sea. Topography: 45 square miles of area surveyed, 83.5 miles of general coast line surveyed, 4 topographic sheets finished. Hydrography: 735 square miles of area covered, 1,737.1 miles run while sounding, 6,433 positions determined, 22,708 soundings, 6 tide stations established, 16 current stations occupied, 8 hydrographic sheets finished.

During the season of 1913 the steamers *Explorer* and *Yukon* worked in conjunction on the survey of the approaches to the Kuskokwim River.

To give a connected account of the work done it is necessary to review briefly the progress made in the two preceding years.

In 1911 a party on the steamer *Explorer* measured a base at Goodnews Bay, and from this base extended the triangulation about 5 miles to the southward and 10 miles to the northward. Hydrography and topography were executed at the entrance to Goodnews Bay.

In 1912 the *Explorer* extended this work to the southward and determined points by triangulation along the shore between Goodnews Bay and Cape Newenham to control the intermediate topography, and as hydrographic signals for offshore work. One hydrographic sheet was partly completed, extending from Cape Newenham northward to the latitude of Goodnews Bay and from the shore westward to about longitude 162 degrees 25 minutes. The topography was completed between Goodnews Bay and Cape Newenham.

In 1913 parties on the *Explorer* and *Yukon* extended the survey to the westward and northward. The triangulation was carried from Goodnews Bay to Quinhagamut, a distance of 40 miles. By this means numerous mountain peaks were accurately determined for use in the hydrography.

The shore line was surveyed between Cape Newenham and Cape Peirce and from Goodnews Bay northward to Quinhagamut.

Hydrography was executed from Cape Newenham northward to latitude 59 degrees 32 minutes and from the shore westward to longitude 162 degrees 50 minutes.

This hydrography requires some detail work in places to give further development of shoal areas but is sufficiently close to give accurate information of the prevailing depths.

Astronomic observations were made to determine the latitude and longitude of a station in the triangulation with sufficient accuracy for purposes of navigation. The weather conditions were more favorable than in the preceding season and about three times as much work was accomplished. No time was lost that might be devoted to hydrography. The largest day's work was 140.5 miles.

The general plan adopted in the hydrography was for the *Explorer* to complete the survey of the area included in the 1912 sheet and then carry the work to the westward and northward, while the *Yukon* worked in the region abreast Carter Spit, confining her work to the area of alternating channels and shoals to the westward of Carter

Spit (known locally as the Crossover) and determining only the limits of the extensive shoal areas bordering the shores.

The instructions for the season directed that the hydrography of the channel from Cape Newenham to Carter beacon should be completed, and the best water developed across to the main channel of the river and of the main channel to the sea. This part of the instructions has been carried out, but it remains to be determined which of the channels traced out are the ones which lead into the river. On two occasions during the seasons efforts were made to trace into the river what seemed to be the most promising channel, but neither attempt was successful. On the first the party on the steamer *Yukon* made a reconnaissance as far as Eek Island. The results of this trip are as follows: A line of soundings in the Warehouse Channel from a point a little north of Quinhagamut to a position about 4 miles north of Warehouse Bluffs and a fairly good determination of these bluffs which form the best landmark on the lower river. Tide and current observations were made at Apigak, and a general idea obtained of the conditions to be met with in the continuation of a survey of the river.

On September 9 a second attempt was made to trace a channel into the river by a party with the steamer *Yukon*. Good water was found to a point abreast Quinhagamut, but was finally lost just above that point.

For the season beginning April 27 the following program of work was laid out for the *Explorer*:

To locate the canneries and wharves at Hooniah and Idaho Inlet, and of the submerged rock reported off the eastern entrance of South Inian Pass; to make a complete survey of Excursion Inlet and Icy Passage; and to make a hydrographic survey of Glacier Bay up to the foot of Muir Glacier.

The work was taken up in the order named, but in the meanwhile the Alaska railroad bill was passed by Congress, the Alaskan Engineering Commission had been organized and had started for the head of Cook Inlet to make location surveys preliminary to the final designation of a route by the President. Under these circumstances it became necessary for this service to carry its surveys to the head of Knik Arm, and in the latter part of May orders were issued to the *Explorer* to suspend the work originally undertaken and to proceed to Cook Inlet for this work. Accordingly, on the completion of the surveys in Excursion Inlet and Icy Passage the *Explorer* proceeded to Cook Inlet, arriving on June 6 at Ship Creek, where work was in progress at the close of the fiscal year.

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

SUMMARY OF RESULTS.—Triangulation: 32 square miles of area covered, 3 signal poles erected, 1 observing tripod and scaffold built (42 feet in height), 3 stations in main scheme and in station in supplemental scheme occupied for horizontal measures, 4 geographic positions determined. Topography: 75 square miles of area surveyed, 43.5 miles of general coast line surveyed, 2 miles of rivers surveyed, 1 topographic sheet finished. Hydrography: 240 square miles of area covered, 884.55 miles run while sounding, 2,286 positions determined, 12,060 soundings made, 1 tide station established, 1 current station occupied, 1 hydrographic sheet finished.

The party on the steamer *Yukon* was organized at Seldovia in the latter part of April to continue, in cooperation with the party on

board the steamer *Explorer*, the survey of the approaches to the Kuskokwim River. On May 8 a rock was located at the entrance to English Bay, Port Graham.

On May 9, necessary repairs to the vessel having been completed, the *Yukon* proceeded to Port Graham where the launch *Alpha* was caulked and painted preparatory to shipment to Goodnews Bay. The *Yukon* arrived at Kodiak on May 11.

On May 21 the new cannery in Anchorage Bay was located on the chart. On the run from Chignik the courses and distances were recorded, a rough sketch was made of the shore, and various landmarks were noted. On May 29 the *Yukon* anchored off Morzhovoi in Sanotski Straits, but owing to bad weather no field work was possible there.

Passing out of the northern entrance to the straits at high water on June 1 and following the channel shown on the chart the shoalest water obtained until outside Chunak Point was 17 feet, when outside of this point and about 500 meters from it and 40 meters from the beach a sounding of 10 feet was obtained. A tide staff and bench marks were established in Traders Cove and tide observations begun. The *Yukon* arrived at Goodnews Bay on June 3 and after making arrangements for the storage of supplies and putting the *Alpha* in commission, a line of soundings was run northward to Carter Spit and a short distance into Jack Smith Bay.

As the important work was the development of the channels, plans were made for utilizing all of the available daylight hours in extending the hydrography to the northward from a line west of station Head for a distance of about 15 miles offshore.

As the topographic sheets of the locality did not include the prominent mountain range which extends about 16 miles back from the coast cuts were made upon it from the triangulation stations and the contours were traced in.

One 40-foot signal was erected at Carter for the triangulation and hydrography. One triangulation figure was completed by the occupation of Beluka, Head, and Carter. Another station, Tooth, was established and marked but not occupied. The topography from Jack Smith to Quinahagak was completed, and a reconnoissance made up the river to Apigak.

The season's work was closed on August 30, and on August 31 the party returned to Goodnews Bay where arrangements were made to lay up the *Yukon* for the winter.

[R. R. LUKENS, Commanding Steamer *Yukon*.]

The party on the steamer *Yukon* began work about the middle of June on the survey of the approaches and mouth of the Kuskokwim River.

On June 18 the main river channel was found and located from Eek Island to a junction with the survey of 1913. Work was in progress at the close of the fiscal year.

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

SUMMARY OF RESULTS.—Triangulation: 1,131 square miles of area covered, 41 signal poles erected, 27 stations occupied for horizontal measures, 9 stations occupied for vertical measures, 80 geographic positions determined, 36 elevations determined. Magnetic work: 6 land stations occupied for magnetic observations, 4 compass declinometer stations, 3 swings of ship for magnetic deviation, magnetic elements observed at 3 stations at sea. Topography: 135 square miles of area surveyed, 176 miles of shore line surveyed, 6 miles of rivers, creeks, and ponds, 5 topographic sheets finished. Hydrography: 702 square miles of area covered, 3,313 miles run while sounding, 34,256 soundings, 9,658 positions determined, 3 tide stations established, 7 hydrographic sheets completed, 2,362 miles run with submarine sentry. Physical hydrography: 13 current stations occupied, 652 surface temperatures of water taken, 4 deep-sea soundings made.

At the beginning of the fiscal year the party on the steamer *Patterson* was engaged in surveys of the coast of the Alaska Peninsula while a detached party on land was at work on the Shumagin Islands, 120 miles distant, where it remained until October 11.

During the entire season from June 18 to October 14 the *Patterson* was occupied in a search for the reported Leonard and Anderson rocks. The whole time of the vessel was devoted to this examination to the exclusion of any other work so far as weather conditions permitted.

The Leonard and Anderson rocks are reported to lie 70 miles eastward of Unimak Pass, 45 miles off Unimak Island, and 30 miles off Sannak Island. The reports place them in 3 localities 17 miles apart and near the 100-fathom curve. One reported position falls in a depth of 400 fathoms, one in a depth of 60 fathoms, and a third in 45 fathoms. These positions are well separated from the Sannak Reefs, and well outside any indications of foul ground, and the contours of the bottom have no connection with the Sannak Reefs. The bottom is extremely flat, with very gradual slopes, except outside the 100-fathom curve, and generally has only a few fathoms slope to the mile. It is composed of black gravel and sand throughout. Although rocky bottom has been reported here no positive indications of it have been found, and in places where no sample is brought up the lead seems to show coarse shingle instead of solid rock. There is no lava or pumice.

It was proposed at the beginning of the season to cover the doubtful region with lines of soundings one-sixth mile apart, and soundings one-sixth mile apart, making necessary 3,000 miles of lines and 18,000 soundings. One-quarter of this, or 790 miles and 3,700 soundings, was completed, and the area for $3\frac{1}{2}$ miles on each side of the 100-fathom curve was gone over with the submarine sentry. The ship also passed many times over the reported positions of the rocks, in every sort of weather, cruising, riding to a sea anchor, hove to, or riding to a kedge anchor dragging over the bottom. Under all these conditions no indication of any rock was found, no breaker was seen, and no suspicious shoaling was found. The bottom contours are regular in shape and the 100-fathom curve especially so. A special effort was made to be in the doubtful region at low water of spring tides, and this was done at each new and full moon during the season with but few exceptions. At the July and August spring tides especially this was carefully observed. The Bassnett sounding tubes

were used with great success in the hydrography, verified by a vertical cast each tenth sounding. Two new style power sounding machines with releasing clutches were used simultaneously, and there was no difficulty in securing six soundings per mile in a depth of 35 to 45 fathoms at full speed. It would have been impossible to make satisfactory progress if each sounding had been made a vertical cast, at these intervals. All the sounding lines were rigidly located by sextant angles and none of them by dead reckoning. It is not possible to use the dead-reckoning method successfully here, as the currents are strong and variable. For the work with the submarine sentry, however, this method was used, and the outside limits covered were located by bearings, Sumner lines, and by the 100-fathom curve, which is fixed by the hydrography.

The survey of the Shumagin Islands was conducted by a camping party with power launches and boats. Complete surveys were carried through Popof Straits, and all of Popof Island and one-half of Unga Island were completed, including Zachary Bay and the four important anchorages of Humboldt Harbor, Coal Harbor, Baralof Bay (also called Squaw Harbor), and Delarof Bay. This comprises the most important part of the Shumagin Islands, where all the traffic passes. The other islands, harbors, and passages are used only by cod fishermen.

Triangulation was done which covered Unga, Popof, Korovin, and Andronica Islands, and a part of Nagai, and two stations were established on the mainland. It was found possible at the close of the season to complete the connection with the triangulation of 1911 at Delgoi Island. A base line one-half mile long and an azimuth had been measured at Sand Point at the beginning of the season. The length of the triangulation along its axis was about 79 miles.

The topography covers one-half of Unga Island and all of Popof Island and was included on four sheets. Humboldt Harbor and Delarof Harbor were surveyed on a scale of 1:10,000 and the remainder on a scale of 1:20,000. The planetable was used, and traverses were carefully closed on triangulation points except along one portion of the precipitous shores. The contours of the land were sketched.

The hydrography of this locality was done with a steam launch. This work was completed in the waters adjacent to Unga Island from the northern point by way of Popof Strait to Sealion Rocks, a distance of 30 nautical miles, and along the shores of Popof Island except on the northeast coast. The work was done on five sheets. Humboldt Harbor and Delarof Harbor were surveyed on a scale of 1:10,000 and the remainder on a scale of 1:20,000. Important parts of harbors and channels, including Zachary Bay and Coal Harbor, were covered with sounding lines one-thirty-second to one-sixteenth mile apart, and general development of bottom, where no dangers were suspected, by lines one-fourth and one-third mile apart. Doubtful spots were carefully examined. All local authorities were consulted and several rocks were found by this means. Zachary Bay was found much more difficult to enter than had been reported, and also the north entrance to Popof Strait. In the south end of Popof Strait a dangerous rock was found almost on the vessel track.

Baralof Bay or Squaw Harbor, on Unga Island, was found to be a good harbor.

Tides were recorded with an automatic gauge at Sand Point throughout the season and a series of comparative tide observations was made in Zachary Bay.

Currents were observed from the ship when at anchor in a favorable position; a good series was obtained in Humboldt Harbor and some observations were made in Unga Strait and other positions from there, westward to Unimak Island. As is well known there is a continuous current westward along the Alaska Peninsula. This is strongest at the beginning of northeasterly or easterly storms and on the day before they begin. The tides at such times have but little effect on the current. The magnetic observations secured include a new station at Sand Point and ship swings for the three elements in Popof Strait, Pavlof Bay, and off Sannak Island. An unsuccessful search was made for local attraction reported between Dolgoi Island and the mainland. There are apparently small local attractions of 2 or 3 degrees at many places along this coast and among the islands, and many of the pebbles found along the shore will affect a sensitive needle if held near it, but no large attraction was found in the places visited. Four ship swings were made on the voyage from Unalaska to Honolulu, for variation only. The usual meteorological observations were made for the Weather Bureau during the season.

Before starting for Alaska the ship was fitted with a radio telegraphic set which was in use throughout the season. The greatest distance over which signals were sent was 1,300 nautical miles on the voyage from Unalaska to Honolulu.

The survey of the Shumagin Islands was resumed in May. The season's work was planned to include a careful survey of the outer coasts of Unga and Popof Islands and all of Korovin.

The work done by June 30 consists in the location of additional intersection stations by triangulation, the beginning of the topography and hydrography on Nagai Island, and the completion of the survey of the two principal harbors on Nagai Island, and of a large area off the coast. The above work was done by a detached party.

The party remaining on the ship was engaged on work in various localities as the conditions permitted. The triangulation was extended northeastward along the mainland coast, and topographic and hydrographic reconnaissance was carried along with it. Some work was done as far as Kupreanof Harbor and Ivanov Bay. A complete line of soundings was run from Cape Newenham to Unimak Pass, in Bering Sea, a distance of 305 miles.

Tides were registered by an automatic gauge in the Shumagin Islands. Current observations were made by the ship at anchor whenever the anchorage was open to currents. Magnetic observations were made at sea and five swings of the ship secured. Surface temperatures of sea water were taken on the voyage from Honolulu to Alaska.

In June the *Patterson* conveyed the Yukon party from Unalaska to Goodnews Bay and assisted in launching the steamer *Yukon*, which had been hauled out during the winter.

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

SUMMARY OF RESULTS.—Reconnaissance: 189 square miles of area covered, 29 lines of intervisibility determined, 8 points selected for scheme. Triangulation: 555 square miles of area covered, 44 signal poles erected, 38 stations occupied for horizontal measures, 10 stations occupied for vertical measures, 77 geographic positions determined, 50 elevations determined trigonometrically. Latitude, longitude, and azimuth work: 2 latitude stations occupied, 1 longitude station (chronometric) occupied, 2 azimuth stations occupied. Magnetic work: 9 land stations occupied for magnetic declination, ship completely swung at 10 sea stations for magnetic deviation. Topography: 111½ square miles of area surveyed, 109½ miles of general coast line of rivers surveyed, 2 miles of shore line of creeks surveyed, 2 miles of shore line of ponds surveyed, 4 topographic sheets finished. Hydrography: 386½ square miles of area covered, 1,858.4 miles run while sounding, 9,650 positions determined, 30,335 soundings made, 4 tide stations established, 12 current stations occupied, 5 hydrographic sheets finished.

During the season ending September 25 the party on the steamer *McArthur* completed the following work in Cook Inlet:

The topography of the shore line was completed from the termination of the work by the same vessel in 1911 southward around Chinitna Point, including Dry Bay, Oil Bay, Iniskin Bay, and Ursus Cove, to a point just south of Rocky Cove and joining the topography of Iliamna Bay previously executed.

The triangulation was extended from signals Chinitna and Augustine (1908) through several figures to a line from the south side of Bruin Bay to the southwest side of Augustine Island, giving a good and readily accessible base for extending the triangulation into Kamishak Bay. The triangulation locates signals for the control of the entire survey, and connects with the survey of Iliamna Bay, previously on independent data.

Inshore hydrography was completed from a point northward of Chinitna Point and following the shore line to the southern side of Ursus Cove and including Oil Bay, Dry Bay, and Iniskin Bay, and joining the previous hydrography of Iliamna Bay.

The ship hydrography joins the inshore work and covers with lines spaced one-quarter mile apart the entire area northward from 1 mile north of Augustine Island and eastward to meridian 153 degrees 10 minutes. No hydrography or topography was done at Augustine Island but outside tangents were cut in with the ship.

Automatic tide-gauge observations were made at Seldovia Bay throughout the entire season. Staff readings were taken at Iniskin Bay, Seldovia, and Iliamna Bay.

Current observations were made on several days in Iniskin Bay and at various places along shore when the vessel was anchored at night.

No outlying dangers were discovered in the track usually followed by vessels. No dangers were found farther than 2 miles offshore. One shoal in the entrance to Iniskin Bay and one shoal about 2 miles east of Rocky Cove were found.

Between April 29 and June 30, 1914, the *McArthur* was engaged in general surveys in Nichols Passage, Alaska.

An automatic tide gauge was established on the wharf at Metlakatla and another on the lighthouse wharf at Ketchikan. Several old bench marks were recovered at Ketchikan and connected with the tide staff by leveling. At Metlakatla the old bench mark of 1882

was recovered and three new marks were established and connected with the tide staff by leveling. Old stations established in 1913 in Port Chester were recovered and furnished distances for the plane-table survey until the triangulation could be extended from the work of 1912. Soundings were begun as soon as the signals were located.

Four signals of the 1912 work were found standing, and two of them were selected as a base for extending the triangulation into Nichols Passage. The triangulation was connected with three of the stations in Tongass Narrows.

The triangulation was also carried into Port Chester and connected with a base line measured there in 1913, and preparations were made to continue the work into Felice Strait.

All of the stations established were marked with standard station marks, and reference points were established and similarly marked.

Topography was begun on the Port Chester sheet on a scale of 1:10,000, which was practically completed. The sheet joining Tongass Narrows, on the same scale, was completed. The remainder of Nichols Passage is being surveyed on a scale of 1:20,000.

The hydrography of Port Chester was completed and the work was extended to the southward from Tongass Narrows.

The magnetic station at the University of Washington, at Seattle, was occupied before sailing; observations were made also at the station of 1907 at Ketchikan and two triangulation stations near Metlakatla. Ship observations, consisting of swinging ship, were made at Seattle and Port Townsend, and an incomplete swing in Fraser Reach.

On May 30 assistance was rendered the Ketchikan Power Co.'s barge *Blanche*, which was waterlogged and in danger of foundering. The pumps of the *McArthur* were used in freeing the barge of water.

[R. B. DERICKSON, July 1 to Nov. 21. F. H. HARDY, Nov. 22 to June 30, Commanding Steamer *Gedney*.]

SUMMARY OF RESULTS.—Triangulation: 61 square miles of area covered, 46 stations occupied for horizontal measures, 65 signal poles erected, 57 old stations recovered, 54 geographic positions determined. Leveling: 12 permanent bench marks (tidal) established, 1.25 miles and levels run. Magnetic work: 3 land stations occupied for magnetic declination. Topography: 90.5 square miles of area covered, 203.9 miles of general coast line surveyed, 8 topographic sheets finished. Hydrography: 125 square miles of area sounded, 1,716.3 miles run while sounding, 8,783 positions determined, 27,311 soundings made, 5 tide stations established, 7 hydrographic sheets finished.

At the beginning of the fiscal year the party on the steamer *Gedney* with subparties using the launch *Cosmos* and launch *No. 117* were at work on the west coast of Prince of Wales Island to the northward of San Cristoval Channel. On June 29 the *Gedney* had determined the position of the pinnacle rock struck by the steamer *Curacao*.

As it was necessary for the *Gedney* to return to Ketchikan for coal, advantage was taken of the opportunity to make supplementary soundings in Rose Inlet in the vicinity of the rock off the cannery wharf. A tide staff was erected and connected with suitable bench marks. The datum plane was obtained by simultaneous readings with a staff erected at the Kasook Inlet tide station. On July 14 the

Gedney returned to Rose Inlet and Cape Muzon. Work was carried on at Cape Muzon as the condition of the weather permitted until August 2.

On August 28 the launch *Cosmos* left the *Gedney* to locate the wreck of the steamer *State of California* in Gambier Bay and the rock on which she struck. This work was completed and the *Cosmos* rejoined the main party on September 6. From that date to the close of the season the entire party was engaged in the development of the channels through San Alberto Bay and Klawak Inlet. Surveying operations were closed on October 2.

Fifty-five old stations of the triangulation executed in 1906 were recovered and served as a base for the topography and hydrography.

The shore line of the main ship channel from Cape Lynch to Cape Suspiro and Parida is included on four sheets, the first extending from Cape Lynch to Point Desconsido, and the other three covering the shore line from Culebra Island through San Cristoval Channel, San Alberto Bay, and the south end of Klawak Inlet to Cape Suspiro. This includes most of the islands forming the northeastern boundary of San Alberto Bay and the east side of San Fernando Islands from the Palisades to Fern Point. These sheets cover the most intricate part of the coast line along the West Coast Passage from San Juan Bautista Island to Cape Lynch.

A plane-table triangulation was carried from the known position of signal Cape and the azimuth station Cape to signal Y to the southern extremity of Dall Island. About 1 mile of shore line was run in the vicinity of the outlying rocks to determine the most southerly point of the island.

In order to locate signals from the development of the rocks and shoals upon which the steamer *State of California* was reported to have struck, a base was measured in Gambier Bay and about 2 miles of shore line were rodded in. The work includes an outline of the wharf and cannery of the Admiralty Trading Co. in Gambier Bay. The topography on all of the sheets was confined chiefly to the shore line.

The hydrography completed extends from Cape Lynch to Cape Flores, connecting the surveys of 1912 with previous work at the mouth of Davidson Inlet.

A steam sounding machine was constructed at the beginning of the season for use on the *Gedney*. All soundings were taken with the wire vertical. In depths less than 10 fathoms the hand lead was used. A channel sweep was used in investigating shoals and suspicious soundings.

At Cape Muzon the hydrography was done with the ship's whale-boat. Very close development was made of the waters in the vicinity of the outlying rocks at the south extremity of Dall Island.

In Gambier Bay the hydrography was confined to locating and developing the two rocks and the wreck of the steamer *State of California*.

An automatic tide gauge was maintained throughout the season at Cruz Bay. Staff gauges were established and read in various localities during the progress of the hydrography.

Three land stations were observed for determining the magnetic declination, one in the Gulf of Esquibel, one at the north end, and one at the south end of San Alberto Bay.

At the beginning and close of the season some preliminary work was done with a view to beginning a hydrographic and topographic survey of Port Chester. A short base was measured in the vicinity of the Coast and Geodetic Survey boathouse and a scheme of triangulation laid out to extend up and down Nichols Passage and connect with the triangulation of Clarence Strait and Tongass Narrows. Four stations were occupied for the measurement of horizontal angles. All stations occupied in the reconnaissance were marked and described.

In the latter part of April the *Gedney* left Ketchikan, Alaska, arriving at Craig on April 28. An automatic tide gauge was erected at Craig and operated continuously to the close of the fiscal year. On May 1 the *Gedney* left Craig for Tonawek Bay. While at Craig the triangulation of Klawak Inlet was completed and a reconnaissance made to the northward.

The topography from the northern limit of the *Gedney's* work of 1913 was completed through Tonawek Narrows to join with previous work in Sea Otter Sound. The triangulation of this area was also completed.

The hydrography from the northern limit of previous work by the *Gedney* through to the previous work in Sea Otter Sound was completed. In the southern part the hydrography was not extended eastward of the line from the small island off Culebra Island to the small island about $2\frac{1}{2}$ miles to the northward of it. To make a complete chart this should be done, but for the purpose of a channel through to Sea Otter Sound it was unnecessary.

The channel was dragged over with a wire set at 6 fathoms. The bottom was found to be very irregular and much time was spent in developing localities where shoals were indicated, most of which were gone over with the drag.

Some hydrography was done in the southern part of the area surveyed in previous years, and the drag work was extended through the channel inside the island on which triangulation station Peep is located to the 20-fathom curve. The cannery buildings at Kar-been were located, and the light on which they are situated was both dragged and sounded.

On June 13 surveys were begun in Trocadera Bay and Klawak Inlet. By June 30 the topography of Klawak Inlet was completed. The triangulation of Tonawek Bay was completed, and about 300 miles of soundings had been run and 60 miles of shore line surveyed.

[F. L. ADAMS, July 1 to June 16; J. W. GREEN, June 17 to June 30.]

The usual records of the three magnetic elements have been obtained with the photographic recording instruments at the Sitka Magnetic Observatory. The records are continuous except for slight accidental interruptions.

During the early part of the year electric power was introduced in Sitka. No effect was observed on the instruments from this cause.

Ten earthquakes were recorded during the first half of the fiscal year, and nine during the second half year.

The required absolute observations, scale-value determinations, and daily meteorological observations were made.

OUTLYING TERRITORY.

PORTO RICO.

[GEORGE D. COWIE.]

SUMMARY OF RESULTS.—Triangulation: 9 signal poles erected, 10 stations in supplemental scheme occupied for horizontal measures, 9 geographic positions determined. Leveling: 1 tidal bench mark established, one-sixteenth mile of levels run. Hydrography: One-eighth square mile of area sounded, 3 miles run while sounding, 90 positions determined, 250 soundings, 1 tide station established.

In January reconnoissance, signal building, and observations of horizontal angles were begun on Culebra Island, the use of a lighthouse tender having been obtained for transporting the party.

Buoys were determined in position and a preliminary search made for reported shoals in the entrance to Great Harbor, Culebra Island. The lighthouse tender was at the same time engaged in setting buoys in that vicinity.

One new triangulation station, Resaca 2, was established, the positions of five range beacons were determined, and all of the buoys in Great Harbor and its approaches, "the Sound" and on Grampus Shoal, were located. Beacon B, the inner beacon on the outer range, and the mooring buoys used by the Navy have been removed.

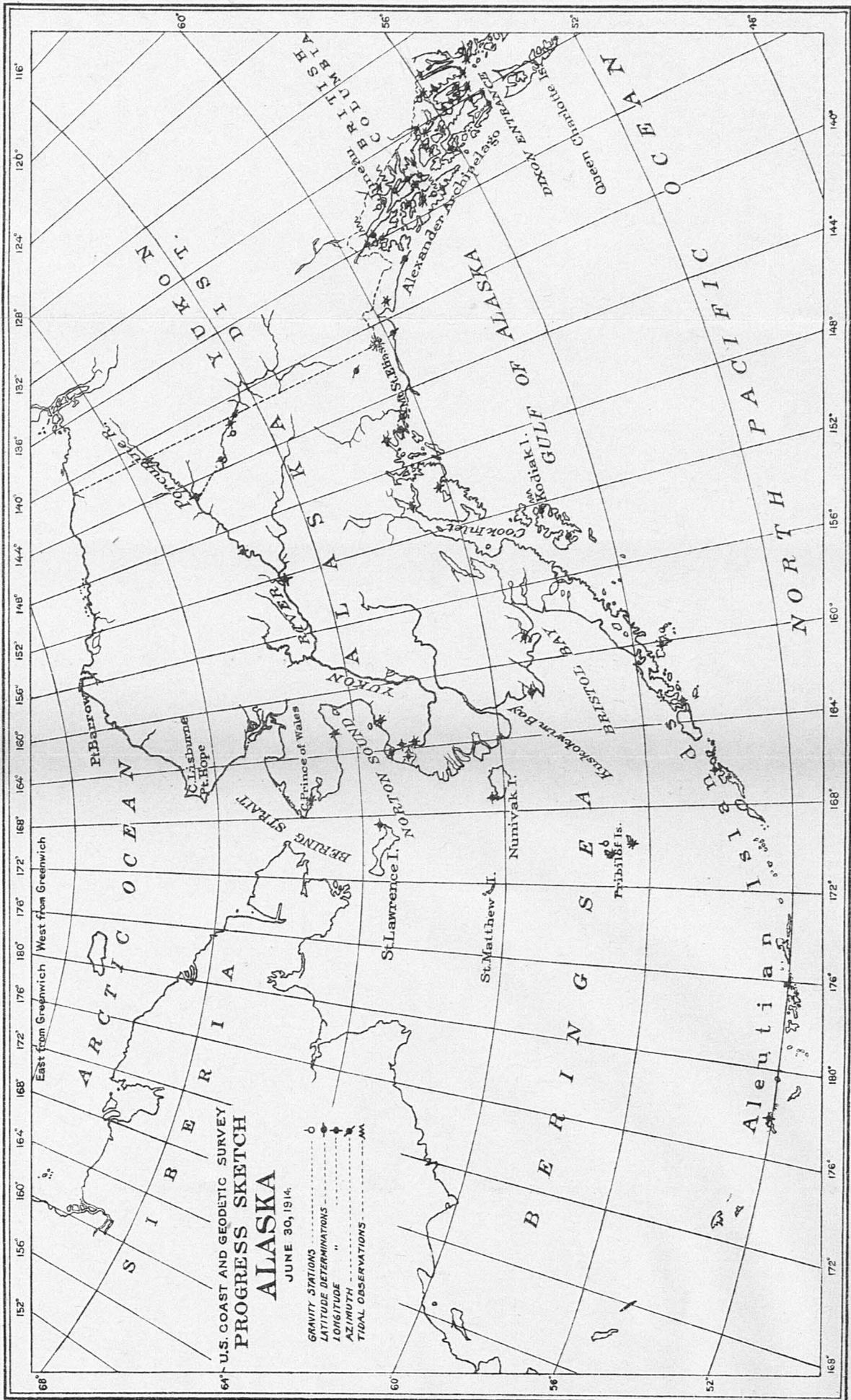
Search was made for station marks at East and West Base, but neither was found, they probably having been destroyed.

The signal building and triangulation at Fajardo for the purpose of locating hydrographic signals having been completed and a temporary tide gauge established, an examination was made of the northwest quadrant of a circle 1,400 meters in diameter with the middle point of Obispo Cayo as its center. This area was sounded over with a launch, and two shoal spots were found, as reported, with 9 and 12 feet of water over them, but no other indication of shoals. These shoals are both of coral rock and of small extent. A search was made with an improvised wire drag for shoals in the entrance to Great Harbor, and the two shoals shown on the chart were examined. Twenty feet were found on a reported 18-foot spot, 200 feet west southwest of buoy N 2½, and 20 feet on a reported 13-foot spot near the same buoy. Both are coral heads of small area. The drag, 150 feet long, was set for 22 feet depth and failed to show any shoal spots, other than those mentioned, of less than that depth, although the entire area of the shoals was examined.

Assistance was rendered by the officers and crew of the lighthouse tender at San Juan, especially in locating the shoal spots in Fajardo Harbor and the buoys near Culebra Island.

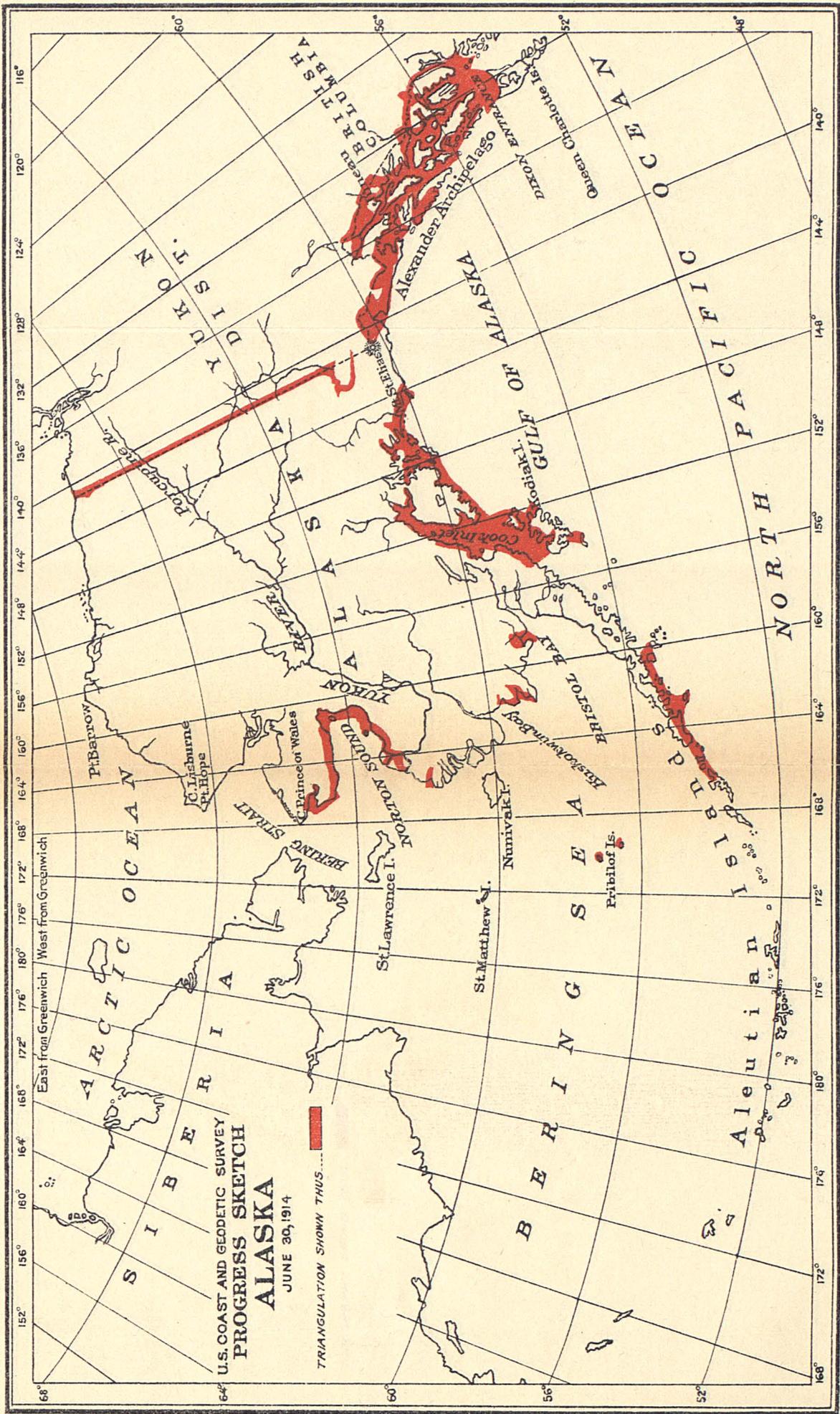
[FRANK NEUMANN, July 1 to Apr. 12; HAROLD W. PEASE, Apr. 13 to June 30.]

The regular work of the magnetic observatory at Vieques, P. R., has continued with but slight interruption during the year. Extra absolute observations were made whenever changes of base line occurred. The instruments generally were in good adjustment. Scale-value observations were made at least once each month. Time observations were made every week or 10 days with a sextant. Daily meteorological observations were made. During March and April special observations were made with magnetometers.



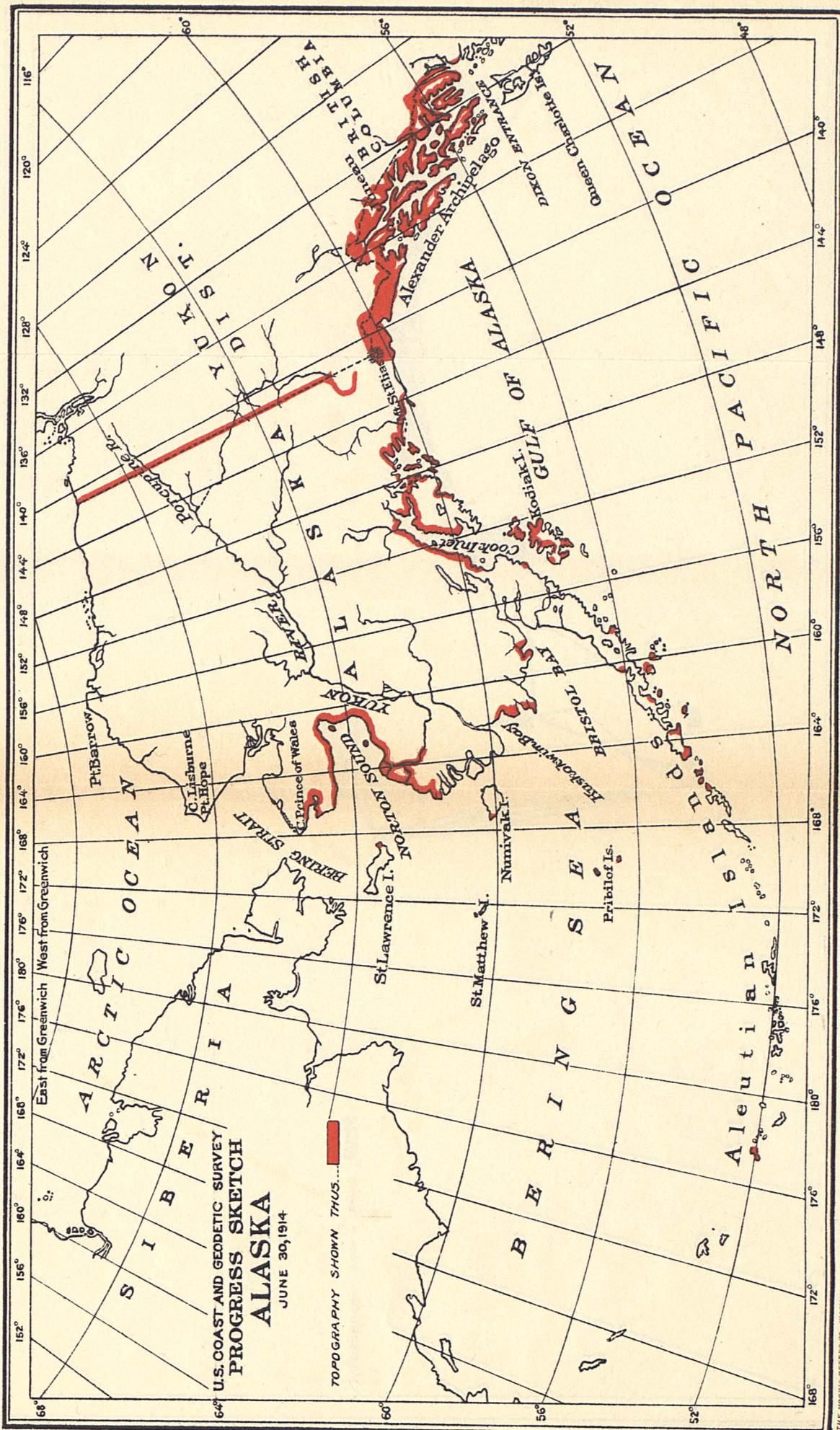
U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
ALASKA
 JUNE 30, 1914.

- GRAVITY STATIONS
- LATITUDE DETERMINATIONS
- LONGITUDE "
- AZIMUTH "
- TIDAL OBSERVATIONS



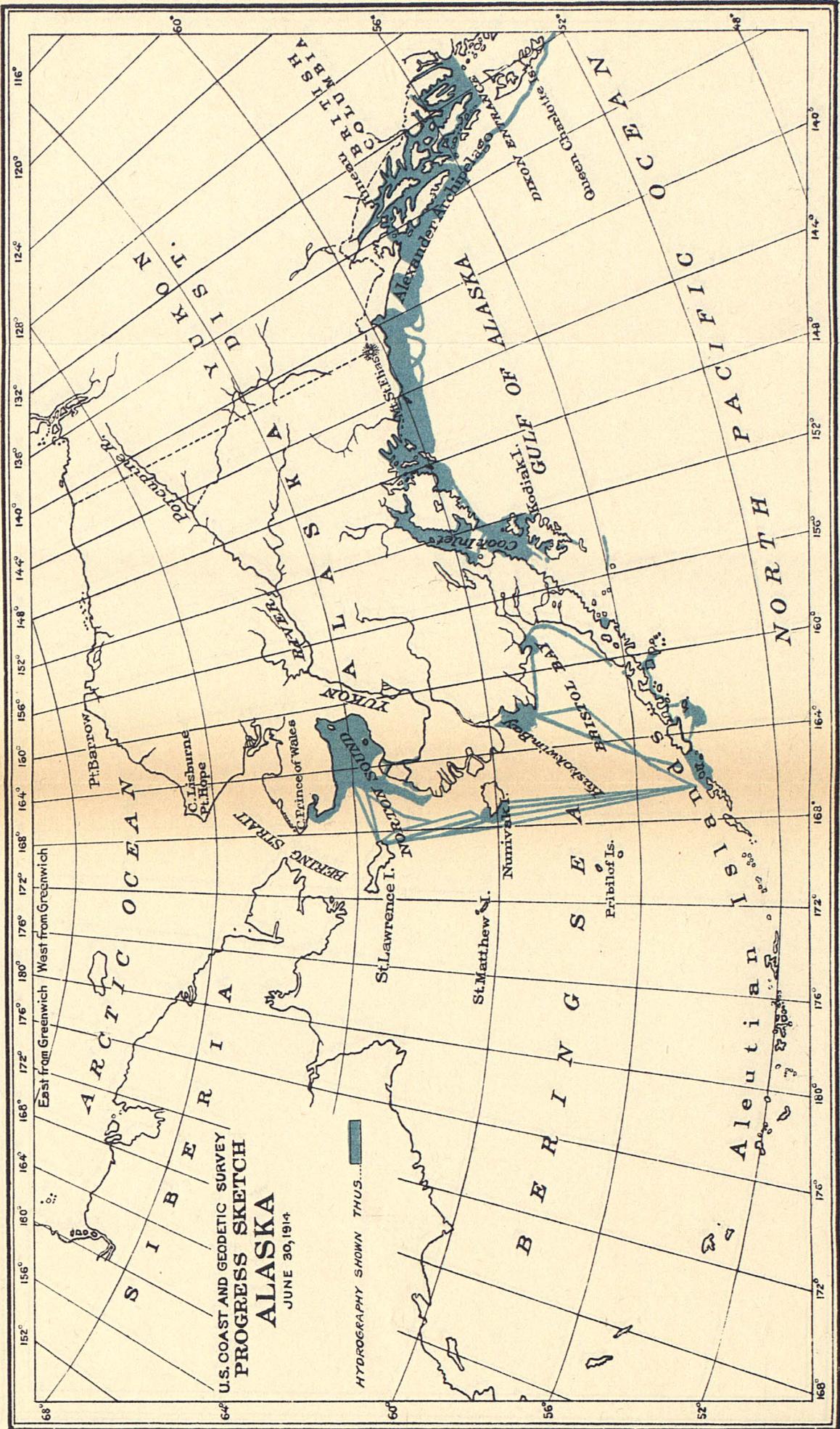
U.S. COAST AND GEODETIC SURVEY
ALASKA
 JUNE 30, 1914

TRIANGULATION SHOWN THUS.....



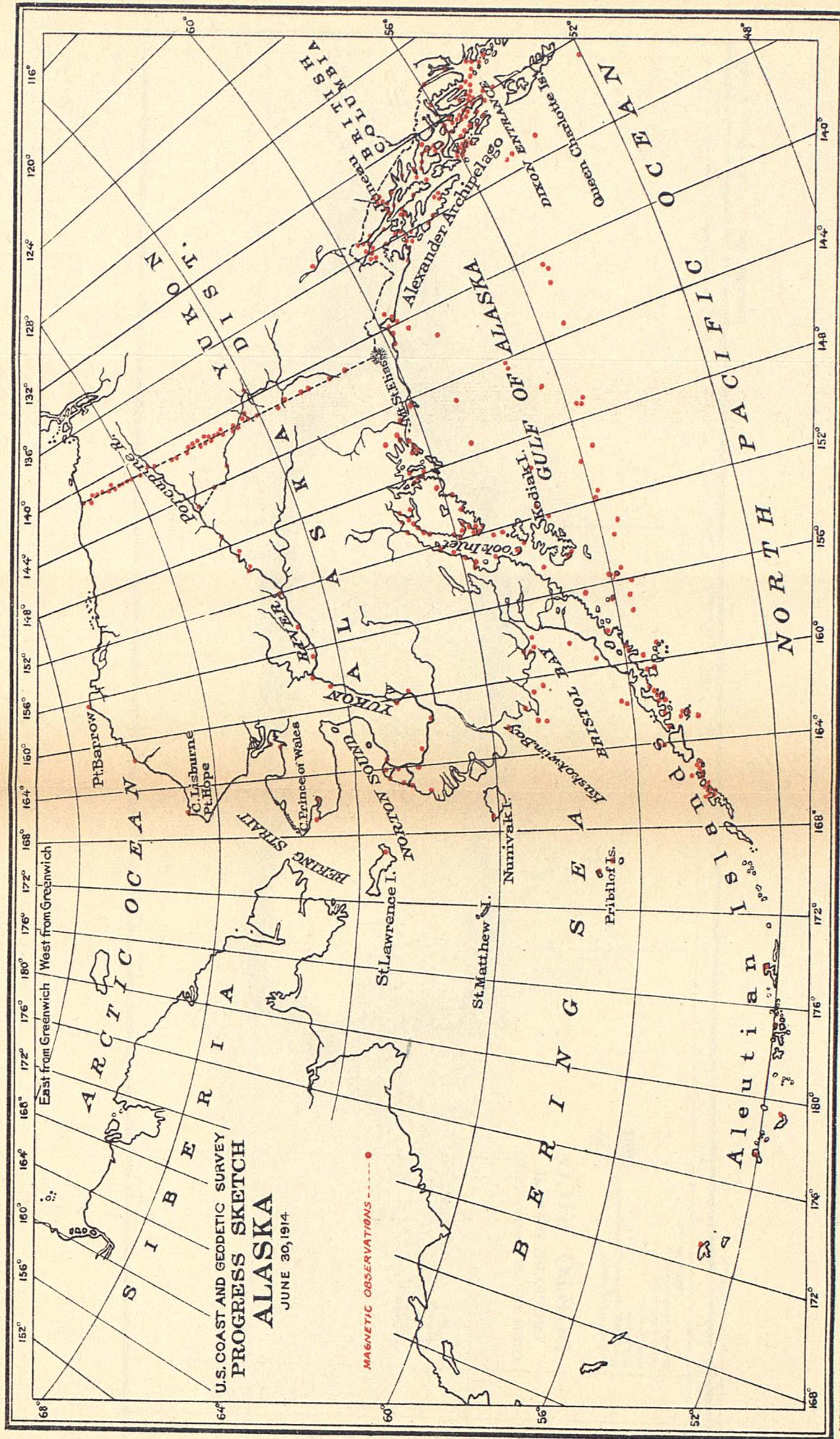
U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
ALASKA
 JUNE 30, 1914

TOPOGRAPHY SHOWN THUS... [Red line symbol]



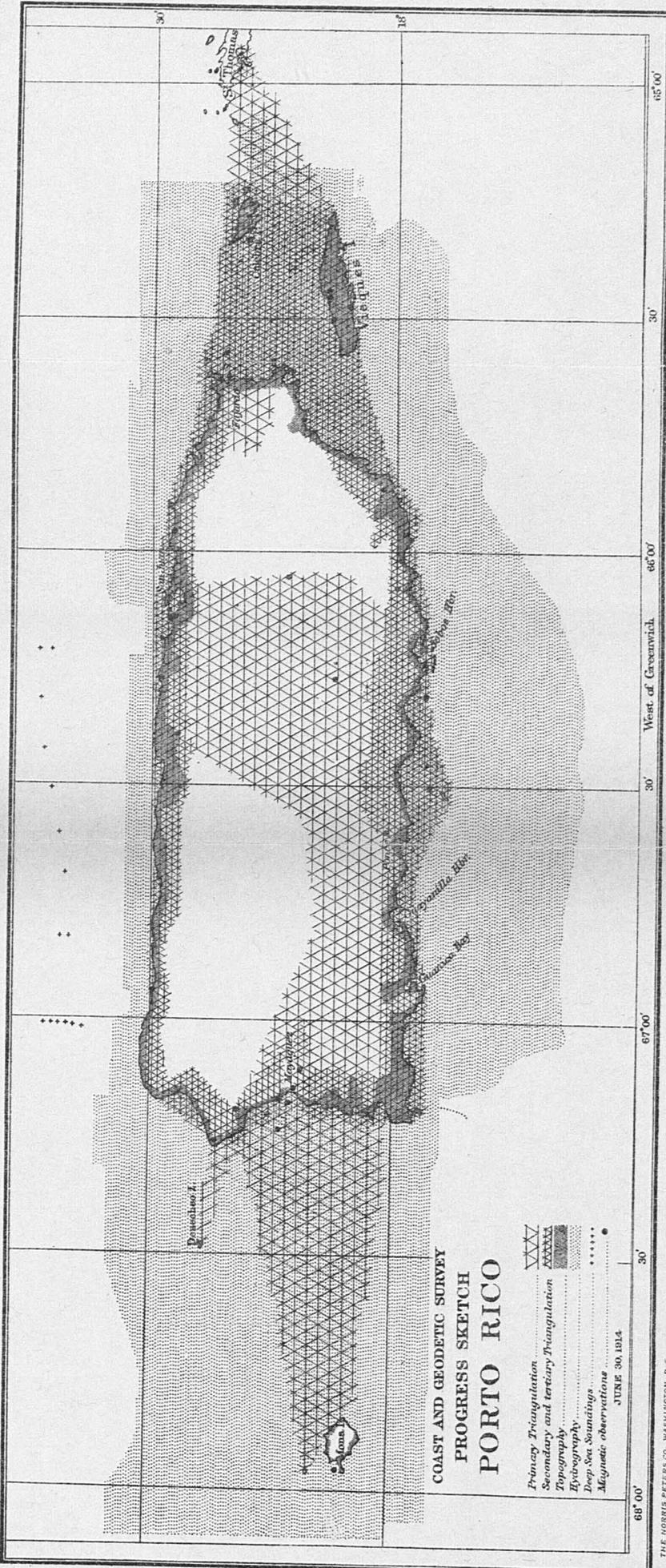
U.S. COAST AND GEODETIC SURVEY
ALASKA
 JUNE 30, 1914

HYDROGRAPHY SHOWN THUS...



64° U.S. COAST AND GEODETIC SURVEY
 PROGRESS SKETCH
 ALASKA
 JUNE 30, 1914.

MAGNETIC OBSERVATIONS - - - - -



COAST AND GEODETIC SURVEY
 PROGRESS SKETCH
PORTO RICO

- Primary Triangulation..... XXXXX
- Secondary and tertiary Triangulation..... XXXXX
- Topography..... XXXXX
- Hydrography..... XXXXX
- Deep Sea Soundings..... XXXXX
- Magnetic observations..... XXXXX

JUNE 30, 1914

PHILIPPINE ISLANDS.

[P. A. WELKER, Director of Coast Surveys, July 1 to Feb. 28; W. C. Hodgkins, Director of Coast Surveys, Mar. 1 to June 30.]

The Director of Coast 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 issues instructions to field parties. The results of 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 expenses between the Government of the United States and the Philippine government which has applied since January 1, 1902, was observed during the year.

Except during the periods when repairs were necessary, the parties attached to the five steamers available for duty were continuously engaged in surveying.

There has been the usual exchange of results and harmonious cooperation with the naval and military authorities and the various officials under the government of the Philippine Islands.

Under the direction of the commanding officers of the vessels long series of automatic tide-gauge observations were obtained at various places throughout the islands. These are referred to in detail in the individual reports of these officers. Two gauges were loaned to the Bureau of Lands for a period of about three months in exchange for the results of the tide observations which an observer detailed from that bureau obtained with these gauges in the vicinity of the mouth of the Cotabato River, Mindanao. The automatic gauge at Manila was in constant operation during the entire year. The results of these observations prove to be of great value for use in the establishment of reference planes for surveys and in the preparation of tide tables for the use of the navigator.

The annual revision of the table of distances between ports in the Philippine Islands for the use of the Board of Rate Regulation has been continued.

The Director of Coast Surveys has continued to serve as secretary of the Philippine committee on geographic names, on which he was appointed August 9, 1911. Good progress has been made in the compilation of a list of geographic names.

The necessity for having coaling and water supply stations nearer to the localities of work has been overcome to a certain extent by the establishment of an excellent station at Port Uson, which will serve as a base for the surveys of the entire region about the Calamianes and Northern Palawan.

The dispute in relation to the rights for fishing within certain boundaries in Manila Bay was referred to the Bureau of Surveys by the Secretary of Commerce and Police of the Philippine government. The points involved were thoroughly investigated and the delimitation of the boundaries indicating the rights in accordance with the best information available was indicated upon maps and transmitted to the secretary of commerce and police.

The work of reduction of the tidal and hydrographic records was kept practically up to date, and the adjustment of the triangulation and computation of geographic positions was continued.

Tracings for the publication of charts were completed and forwarded to the office at Washington for publication. The plotting of soundings on hydrographic sheets and the inking of topographic sheets turned in by the field parties were continued.

The distribution and sale of charts and publications of the Survey and the hand corrections required to charts previous to issue are attended to by the Manila office.

The preparation of notices to mariners and sailing directions for the Philippine Islands was continued.

During the year 1,612 square miles were covered by reconnoissance, 8,137 square miles of triangulation completed, 1,177 miles of coast line surveyed, 902 square miles of topography surveyed, and 37 topographic sheets completed. The hydrographic work covered 12,445 square miles, 22 tide stations were occupied, and 35 hydrographic sheets were completed.

Several new maps of the Philippine Islands were compiled in the geographic division, 5 maps were published, and progress was made in the compilation of a number of other maps, including a map of the entire archipelago on a scale of 1:1,000,000, which will conform to the plan adopted by the International Geographic Congress for an atlas of the world.

[H. C. DENSON, Commanding Steamer *Pathfinder*, July 1 to Dec. 31, 1913.]

SUMMARY OF RESULTS.—Triangulation: 1,800 square miles of area covered, 28 signal poles erected, 11 observing scaffolds and tripods built with heights from 25 to 140 feet, 47 stations in main scheme occupied for horizontal measures, 29 stations occupied for vertical measures, 134 geographic positions determined, 113 elevations determined trigonometrically. Topography: 160 square miles of area covered, 153.5 miles of general coast line run, 27 miles of shore line of rivers run, 5½ topographic sheets finished. Hydrography: 1,736½ square miles of area covered, 2,544 miles run while sounding, 6,410 positions determined, 23,549 soundings made, 1 tide station established, 7½ hydrographic sheets finished.

On July 1, the *Pathfinder* was engaged in general surveys, consisting of triangulation, topography, and hydrography, on the east coast of the island of Mindanao, between Lianga and Caraga Bays. This work was continued until October 10, when it was necessary to suspend operations on account of unfavorable weather conditions. The work accomplished during the season practically completed the entire survey of the east coast of the island, which had been in progress during the two preceding seasons. The result was gratifying as furnishing the data for the preparation of charts of a region dangerous to navigation and previously almost unknown.

The field season in this locality having closed, the steamer proceeded via Cebu and Manila to Olongapo Naval Station, where arrangements were completed on October 22 for the installation of wireless telegraph apparatus and for minor repairs. During the intervals while this work was in progress the computations, inking of topographic sheets, plotting of hydrographic sheets, and preparation of progress sketches, descriptive reports and statistics, all relating to the work on the east coast of Mindanao, were completed and submitted to the Manila office.

While the work of installation of wireless apparatus and repairs was still in progress at Olongapo, on November 1, the survey of the approaches to Manila Bay, between Subic Bay and Fortune Island, was commenced.

On November 6, the repairs and installation having been completed, the steamer proceeded to the Cavite Naval Station for coal and supplies, and, on November 10, returned to the vicinity of Subic Bay to resume the field work, which was continued without interruption until December 24, when it was necessary to return to Manila for the purpose of preparing inventories and reports and making arrangements for transferring the command.

With the survey of the approaches to Manila Bay still in progress, the transfer of the command of the steamer *Pathfinder* was effected at the close of the calendar year, 1913.

R. B. DERICKSON, Commanding Steamer *Pathfinder*.

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 20 miles, 150 square miles of area covered, 4 lines of intervisibility determined, 3 points selected for scheme. Base lines: 1 primary, 4,204 meters in length measured. Triangulation: 529 square miles of area covered, 5 observing tripods and scaffolds built, heights 15 to 125 feet, 12 signal poles erected, 15 stations in main scheme occupied for horizontal measures, 3 stations in supplemental scheme occupied for horizontal measures, 8 stations occupied for vertical measures, 16 geographic positions determined. Leveling: 1 permanent bench mark established, 3.95 miles of levels run. Topography: 144 square miles of area surveyed, 141.8 miles of general coast line surveyed, 46.1 miles of shore line of rivers surveyed, 43.5 miles of creeks and sloughs surveyed, 12 miles of roads, streets, and trails surveyed, 7 topographic sheets finished. Hydrography: 5,219 square miles of area covered, 2,277 miles run while sounding, 10,439 angles measured, 23,617 soundings made, 3 tide stations established, 8 hydrographic sheets finished.

During the second half of the fiscal year the survey at the entrance to Manila Bay was completed.

Five triangulation stations were occupied between Subic Bay and Fortune Island and the triangulation on the north side of the bay was connected with that on the south side. Topographic and hydrographic signals were located and the position of the lighthouse on Corregidor Island was determined. The survey of the shore line was continued from Mapalan Point to Cochinos Point on the north side of the entrance to Manila Bay and from Companario Island to Carabao Island on the south side. This topographic survey was confined to the immediate shore line and as much of the adjacent country as could be contoured from the coast stations.

The hydrography consisted of deep-sea soundings by the *Pathfinder* over several doubtful areas situated 6 to 10 miles off the coast, together with a complete inshore development extending approximately to the 30-fathom curve between Panibatujan Point and Monja Rock at the entrance to Manila Bay, a distance of about 28 nautical miles.

Tidal observations were continued at a station in Binanga Bay.

On March 6 work was begun on the southeast coast of the island of Mindanao in the vicinity of Parang.

A base line 4,204 meters long was measured in the delta of the Cotabato River and connected with the triangulation formerly executed in this region. Topographic and hydrographic surveys extending east of Bongo Island from Tugapangan Point over and

through the channels of the Cotabato delta, joining previous work on both the north and south sides. Reconnoissance for the triangulation was in progress at the date of last report.

In connection with the hydrographic work a tide staff was erected at the old naval wharf at Pollock.

While making passage from the working ground in the vicinity of Parang to Zamboanga and return, sounding lines were run, the ship's position being plotted by dead reckoning.

In June the vessel was moved to Linao Bay.

The completed topography and inshore hydrography extend from north of Linao Point to north of Sangay Point. A thorough development of Port Lebak and approaches was made. This is an excellent anchorage for vessels of any draft.

A line of deep-sea soundings was run from off Quidapil Point to Sibugay Island.

[W. M. STEIRNAGLE, Commanding Steamer *Research*.]

SUMMARY OF RESULTS.—Reconnoissance: 300 square miles of area covered, 14 lines of intervisibility determined, 5 points selected for scheme. Triangulation: 1,100 square miles of area covered, 24 signal poles erected, 11 stations occupied for horizontal measures, 11 stations occupied for vertical measures, 43 geographic positions determined, 31 elevations determined trigonometrically. Topography: 77.3 square miles of area surveyed, 77.8 miles of general coast line surveyed, 5 miles of shore line of creeks run, 0.5 mile of roads surveyed, 4 topographic sheets finished. Hydrography: 539.8 square miles of area covered, 1,895.2 miles run while sounding, 7,737 positions determined, 23,480 soundings made, 4 tide stations occupied, 7 hydrographic sheets finished.

During the period of this report the steamer *Research* was engaged in the surveys of the northern part of Samar Sea, in the vicinity of San Bernardino Strait and between the islands of Samar and Masbate.

A chain of triangulation covering the western half of the area between Samar and Masbate was carried along the east coast of Masbate and over the outlying islands from Port Cataingan, north to southern Luzon and southern Ticao. The reconnoissance was also completed and stations for the continuation of the work were established to a junction with previous work in northern Ticao and Masbate. A reconnoissance was also used in the area between Burias, Ticao, and Luzon, which developed the fact that the proposed connection with the triangulation in Albay Gulf can be executed with much less difficulty, and more economically, by carrying it directly across the isthmus, instead of via Sorsogon Bay, as had been contemplated.

In the establishment of stations, little clearing was necessary except for one station on Masbate and one on Ticao. At the latter place, 14 days were spent in clearing lines of sight. In several places mounds of earth and rock, supposed to be old Spanish stations, were found.

The topographic survey of Destacado Island and the entire Naranjos group was finished and also the east coast of Masbate from Port Cataingan to Black Rock Pass. The work extended over the entire areas of the smaller outlying islands and from 2 to 3 miles inland on Masbate Island.

The hydrographic work covered, approximately, that part of the Samar Sea lying between Dumurug Point on the east coast of Mas-

bate, and the outlying islands Tagapula and Capul and the southern part of Ticao Island. Inshore hydrography with a pulling boat was executed on the west sides of Dalupiri and Capul Islands, entirely around Destacado Island and the Naranjos group, and along the east shore of Masbate from Dumurug Point to Black Rock Pass. The offshore work was all executed with the steamer.

Strong tidal currents prevail in San Bernardino Strait and the approaches. This is especially true about the shoals, where hydrographic development was extremely difficult. The currents are frequently in the nature of tide rips, running in opposite directions at places only short distances apart.

An automatic tide gauge was in operation at Mauo River, Samar, from July 1 to August 28, when it was discontinued. On the following day, August 29, it was installed at Naro Bay, on Masbate Island, where continuous observations were obtained until the close of the season in that locality, on December 16. For reduction of soundings in the immediate vicinity of the work around Naranjos Islands, a temporary tide staff was maintained in Sabariog Bay, where readings were obtained as occasion required from July 24 to September 23. For work in the vicinity of Port Cataingan, a staff was erected at Mintag Point, at the south end of the port, where readings were obtained on various days from September 13 to 20.

On December 17 work in this locality was closed and the vessel proceeded to Manila for general overhauling and repairs. En route to Manila, from December 18 to 22, an investigation of a reported uncharted shoal at Port Laguimanoc was made. The steamship *Bustamente* was reported to have grounded upon such a shoal during the month of August of this year. After a fruitless search and the obtaining of information that the steamer grounded upon a shoal already charted and which was about 400 meters west of the reported position, the vessel continued to Manila, arriving there on December 23. The following day repairs were commenced by the Bureau of Navigation and at the close of the calendar year this work was still in progress.

[PAUL M. TRUEBLOOD, Commanding Steamer *Research*.]

SUMMARY OF RESULTS.—Reconnaissance: 1,182 square miles of area covered, length of scheme 50 miles, 17 lines of intervisibility determined, 4 new stations selected for main scheme, 17 stations selected for tertiary scheme. Triangulation: 26 signal poles erected, 11 stations occupied for horizontal measures, 8 stations occupied for vertical measures, 35 geographic positions determined. Topography: 67 square miles of area surveyed, 22 miles of general coast line surveyed, 16.8 miles of shoreline of rivers and creeks surveyed. Hydrography: 80 square miles of area surveyed, 439 miles run while sounding, 1,459 angles measured, 4,775 soundings made, 2 tide stations established.

Work was resumed by the steamer *Research* in the latter part of February in the vicinity of Ticao Pass. An automatic tide gauge was installed on the southeast arm of San Miguel on Ticao Island and kept in operation while work was in progress. Tide staffs were erected on Murungburun Island in Ticlin Strait and in Butag Bay. Comparative readings were made at these stations, and bench marks were established.

Reconnaissance was made and stations selected and marked for the triangulation, and the observation of angles was begun. Intersection stations were established for the control of the topography, including

a number of mountain peaks. Upon these vertical angles were measured.

Topography was begun in Ticlin Strait, and after connecting with the work of 1902 was carried westward along the coast of Luzon. The work included a detailed traverse of the shore line controlled by triangulation stations at intervals of from 3 to 5 miles and the location of contours as far as visible from the shore line. Surveys were made of numerous salt lagoons and winding streams through the mangrove swamps. Numerous signals were located for the use of the hydrographic party.

The hydrographic work in Ticlin Strait was connected with the work executed in 1902 and 1913. The strait itself and the channels between the islands were thoroughly sounded out. A careful survey was made of the reef and bank to the southeast, south, southwest, and west of Calantas Rock. A least depth of 6 feet was found on part of the wreck of the steamer *Pharsalia*. This locality should be carefully avoided on account of the dangerous currents and eddies which sweep along the edge of the reef. Hamorauan Bank was carefully sounded and no depth less than 2 fathoms was obtained.

A search was made for a $2\frac{1}{2}$ -fathom spot shown on the chart south of Bunubug Point and at the entrance to Marinap Bay. This area was carefully gone over but no indication of shoal water was found.

During June triangulation was continued in Sorsogon Bay entrance and stations Dum and Mount Tiguib were occupied. Eleven points were determined in Sorsogon Bay entrance. The topography was continued up the Luzon coast from Agnas Point to Magallanes.

The ship hydrography was continued from Utabe Bay to a point west of Inamoc and was carried out past midchannel. The launch worked offshore from 1 to 3 miles and out to depth of 20 to 70 fathoms.

Tide observations were continued at Port San Miguel and comparative readings were made at Butag Bay and in Sorsogon Bay entrance.

On June 22 the steamship *Churruca* was sighted aground on a reef west of Bantigui Point and assistance was offered but declined. Her position was determined by cuts from two triangulation stations and a range.

A hydrographic development was made of a shoal at the east end of the Cebu sea wall, showing a least depth of 15 feet.

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

SUMMARY OF RESULTS.—Triangulation: 545 square miles of area covered, 38 signals erected, 27 stations occupied, 41 geographic positions determined. Magnetics: 2 sea stations occupied for magnetic declination. Topography: 91 square miles of area surveyed, 147 miles of general coast line surveyed, 4 topographic sheets finished. Hydrography: 508 square miles of area covered, 2,119 miles run while sounding, 8,874 positions determined, 23,518 soundings made, 3-tide stations occupied, $3\frac{1}{2}$ hydrographic sheets finished.

At the beginning of the fiscal year the *Romblon* was engaged in combined operations in the Calamianes and in building a wharf for use in establishing a coaling and water supply station at Port Uson.

Owing to the great expense and delay incident to traveling long distances between the field of work and a base of supply

where coal and water can be obtained, the necessity for establishing stations nearer to the field of work became very urgent during the previous fiscal year, and with this in view the commanding officer of the steamer *Romblon* was directed to make special examinations for locating the most favorable places about the Calamianes and northern Palawan, which resulted in the selection of Port Uson, on the northeast point of the island of the same name, and only 1 mile distant from the town of Coron, where mail and general supplies can be received about once in three weeks.

All of the coaling stations of the government of the Philippine Islands being operated by the Bureau of Customs, an attempt was made to have one established at Port Uson, which should be under similar arrangements, but, as this failed on account of the necessary facilities not being available and the estimated cost being too great, an arrangement was finally entered into under which the Bureau of Customs allotted 1,000 pesos (\$500) toward the expense of building the wharf, the Government of the United States to pay the expense for constructing the water-supply system.

In order to carry out this plan, the commanding officer of the *Romblon* was directed to purchase the necessary materials and build the wharf and water-supply system, with the force available on the steamer, without seriously interfering with the work of surveying. The materials were transported from Manila by the steamer *Romblon* and the work was commenced a few days before the close of the last previous fiscal year. By July 12, the wharf, reservoir, and water-pipe line were completed and there is now an excellent station available, which will serve as a base for the surveys of the entire region about the Calamianes and northern Palawan.

The wharf is 324 feet long and 8 feet wide, except the outer 24 feet, which is 16 feet wide. A concrete dam was built at the source of the water supply from which a pipe line was laid to the outer end of the wharf, a distance of about 600 feet, and the source of supply was surrounded by a wire fence.

As field work was in progress during the time of construction, the expense outside of materials and hire of a little extra labor was very slight.

On July 12, the wharf and water-supply system having been completed, the *Romblon* proceeded to Manila and on the following day, July 13, the steamer was turned over to the Bureau of Navigation for general overhauling and repairs.

Repairs were completed on September 8, and the ship left to resume work in the Calamianes and on the east coast of Palawan.

A considerable amount of tertiary triangulation was executed during the period of this report. This work extended from Taytay Bay, on the east coast of Palawan, to the most northern point of that island and to a connection with the work of the previous year on Linapacan Island. The actual observing of the executed scheme presented no difficulties, as the lines were all short and weather conditions were favorable, but the establishment of the several stations and the clearing of the lines of sight required considerable time on account of the densely wooded country and the great elevation of the mountain peaks upon which some of the stations were located. In connection with the regular scheme, numerous subsidiary points were located for accurate control of the topography and hydrography.

The topographic work executed consisted of the mapping of the shore of the south coast of Batas Island, the north and west coasts of Maitiaguit Island, the shore of Sharks Fin Bay on Palawan Island, the west coast of Malabuctun Island, the western of the two bays on the north coast of Linapacan Island, the north coast of Galoc Island, all of Popototan Island, and a number of unnamed smaller islands. The topographic surveys extended from 2 to 5 miles inland from the shores of the larger islands and over the entire area of the smaller islands.

Launch and boat hydrography was executed in Sharks Fin Bay, and in the region between Maitiaguit and Batas Islands; also off the south, west, and north coast of Linapacan Island, and the north coast of Culion. In these localities there were many shoals and careful development was necessary. The ship hydrography covered the area from about 1 mile off the north coast of Linapacan Island to about 1 mile north of Culion Island and extending to the westward for about 15 miles off the coast of Culion, except a patch of about 2 miles in width off the coast of Culion, which had been completed during the previous year. The entire region about the Calamianes and the island of Palawan is filled with shoals and dangers to navigation, and hydrography requiring very close development is necessary.

On November 29 an automatic tide gauge was installed on the south coast of Batas Island where continuous observations were obtained during the remainder of the year. For the purpose of facilitating the reduction of soundings, tide staffs were erected at various places throughout the region of the work, where half-hourly readings were taken during the times when hydrographic work was in progress. The datum planes for these staffs were obtained by reference to the automatic gauge established by the *Fathomer* at Port Uson, or to the automatic gauge at Batas Island.

After January 1 work was done in the vicinity of the north end of Palawan Island until January 30, when the vessel sailed for Manila. On February 11 the command was transferred to W. M. Steirnagle.

A scheme of tertiary triangulation was carried about 15 miles down the west coast of Palawan. Topographic signals were located from the triangulation.

The shore line of the following localities was mapped: West coast of Malabuctun and Mobanen Islands, south coasts of Mobanen and Pinachinyan Islands, and west coasts of Pinachinyan and Caisian Islands, with the small adjacent islands, and the shores of Silanga Bay, extending into Taytay Bay. The topography was carried inshore from 1 to 3 miles.

The following areas were covered by the hydrographic work: The bay on the south coast of Linapacan was finished, the west and south coasts of Mobanen, Malabuctun, Casian, and Pinachinyan Islands, with adjacent islands, extending about a mile offshore, the inshore work of Silanga Bay, ship work west of Culion Island, and ship work west of Mobanen and Malabuctun Islands. Lines of soundings were run radially to the coast out to about a mile from shore and outside of that usually parallel to the shore. Inside the 20-fathom curve the lines were spaced about 100 to 200 meters apart, and outside

from 200 to 250 meters apart, except that in channels, passages, or harbors lines were run not over 50 meters apart.

The automatic tide gauge on Batas Island was continued in operation.

[W. M. STEIRNAGLE, Commanding Steamer *Romblon*.]

SUMMARY OF RESULTS.—Triangulation: 284 square miles of area covered, 19 signal poles erected, 15 stations in supplemental scheme occupied for horizontal measures, 22 geographic positions determined. Topography: 42 square miles of area surveyed, 103.5 miles of general coast line surveyed, 1 mile of shore line of rivers surveyed, 3 topographic sheets finished. Hydrography: 824 square miles of area covered, 3,486 miles run while sounding, 13,333 angles measured, 35,889 soundings made, 2 tide stations established.

After the transfer of the command of the steamer *Romblon* on February 11, work was continued on the northeast coast of Palawan to join with the work of the steamer *Marinduque*. Work was begun on the off-lying islands, beginning with Casian Island and working northward toward Iloc and Linapacan Islands. At the end of May work was being extended northward to a junction with the work west of Linapacan Island and also offshore to the northward to join with the surveys in vicinity of Culion Island.

Only such triangulation was done as was required to furnish points for the topography, the main scheme triangulation having been previously completed.

The execution of the topography was difficult, owing to the rocky coast line and numerous rocks and islets. This work was making satisfactory progress at the close of the year.

The inshore hydrography required close development on account of the many coral reefs and submerged rocks. A satisfactory fairway was found leading north and south along the west side of Mobanen, Malabuctun, and Iloc Islands. Only one important shoal was found with least depth of $5\frac{1}{2}$ fathoms. The bottom offshore is uneven but the submerged hills and valleys are well defined. The ship work was done with Tanner-Blish tubes and Cosmos hand-sounding machine. An automatic tide gauge was maintained at Batas Island from the beginning of the season.

In June triangulation for topographic control was done in the area between Linapacan and Cabulauan Islands.

The topography on the north and west sides of Iloc Island was completed and a beginning made on the east side of Linapacan Island.

The inshore hydrography around Iloc Island was finished and some work done on the east side of Linapacan Island. Some progress was made in the offshore hydrography.

Tides were observed at San Miguel on the east side of Linapacan Island and comparative readings made with the automatic tide gauge at Batas Island.

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

SUMMARY OF RESULTS.—Triangulation: 383 square miles of area covered, 19 signal poles erected, 3 stations in main scheme occupied for horizontal measures, 14 stations in supplemental schemes occupied for horizontal measures, 7 stations occupied for vertical measures, 19 geographic positions determined. Leveling: 5 tidal bench marks established. Topography: 92.5 square miles of area surveyed, 152.6 miles of general coast line surveyed, 1.3 miles of shore line of creeks run, 3.7 miles of roads surveyed, 5 topographic sheets finished. Hydrography: 527.5 square miles of area covered, 2,995.7 miles run while sounding, 15,622 positions determined, 87,815 soundings made, 2 tide stations occupied, 3 hydrographic sheets finished.

At the beginning of the fiscal year, from July 1 to July 11, the *Marinduque* was at Manila undergoing minor repairs. During this time the officers were engaged in compiling data of the previous season for the use of the Manila office, while the crew was engaged in cleaning and painting the ship and receiving supplies on board. On July 12 the steamer sailed from Manila for the east coast of Palawan, where field work was resumed on July 14. This was continued without interruption, except from unfavorable weather conditions during the remainder of the calendar year.

The field work of the previous season in this locality had brought the main scheme of triangulation from the Cuyos to the eastern shore of Palawan, and little additional triangulation was necessary for the commencement of the topographic and hydrographic surveys. One additional figure to this scheme was established and observed, and numerous subsidiary points for the control of the hydrography and topography were located.

Topographic work was completed on the east coast of Palawan and the outlying islands from Santa Cruz Point to 3 miles south of Bay Point, and on the east, south, and west coasts of Dumarán Island. The work was extended over the entire area of the smaller outlying islands and to a distance of about 2 miles, inshore, in Palawan and Dumarán Islands.

Inshore work, with boats and launch, was carried along the entire limits of the topographical work to an average distance of 4 miles offshore. Hydrographic work, with the steamer, was executed over about three-fourths of the area between Santa Cruz Point and southern Dumarán and extending, upon an average, about 31 miles offshore. The unfinished part of this area is immediately to the northward of Dumarán Island. Owing to the numerous shoals, dangerous to navigation, in this locality, an unusual amount of development was necessary, and the spacing of lines of soundings was much closer than is generally required. The development of all of these shoals had not been completed when it was found necessary to discontinue work on account of the unfavorable conditions during the season of the northeast monsoon.

An automatic tide gauge was operated at Araceli, where continuous observations were obtained during the entire period of this report. A subsidiary staff, for convenience in the reduction of soundings, was used at Ibobor Island, at the entrance to Calauag Bay, from which half-hourly readings were taken, daily, from August 16 to November 7.

While work was in progress in this region, coal and supplies were obtained at Puerto Princesa. Fresh water was obtained at the same

port, but under difficulty, as the source of supply was at a considerable distance from the anchorage and transportation in small boats was necessary.

At the close of the calendar year, the steamer *Marinduque* was still in the field with the work in progress.

From January 1 to 17 work was continued off the south and west coast of Dumarán Island, the vessel then being taken to Manila for repairs. The command was transferred to another officer on February 13.

[F. B. T. SIEMS, Commanding Steamer *Marinduque*.]

SUMMARY OF RESULTS.—Triangulation: 609 square miles of area covered, 21 signal poles erected, 1 observing tripod and scaffold built, 35 feet in height, 3 stations in main scheme occupied for horizontal measures, 20 stations in supplemental scheme occupied for horizontal measures, 26 stations occupied for vertical measures, 20 geographic positions determined. Topography: 67.2 square miles of area surveyed, 40.3 miles of general coast line surveyed, 2.2 miles of river surveyed, 2 topographic sheets partly finished. Hydrographic: 540 square miles of area sounded, 2,203 miles run while sounding, 10,600 angles measured, 53,853 soundings made, 1 tide station established.

From March 9 to June 30 the steamer *Marinduque* was engaged in combined surveys on the east coast of Palawan Island.

A subsidiary scheme of triangulation was extended from Dumarán Island to station Green, one of the proposed main scheme points, in order to furnish positions for the hydrography in advance of the completion of the main triangulation. It was necessary to build a signal on a $3\frac{1}{2}$ fathom shoal off Flechas Point, to carry on this scheme. The triangulation on the eastern part of Dumarán Island was connected with the line Norte-Dumarán by a central point figure. Numerous intersection points were determined for control of the topographic and hydrographic work. Some signals were built for the main scheme triangulation.

The ship's hydrography covers the area south of Dumarán Island and extends eastward to the 100-fathom curve. The location and extent of numerous shoals within 5 or 6 miles off the Palawan coast south of Palawan Island were determined.

The inshore hydrography included the area south of Dumarán to the 20-fathom curve and Dumarán Channel. Some shoal areas remain to be sounded in the vicinity of Langoy Island and elsewhere.

An automatic tide gauge at Araceli was in continuous operation during the season. A subsidiary tide gauge was established on one of the small islands in Dumarán Channel. An uncharted shoal was discovered in Iloilo Strait.

The topography extends from Dumarán Bay to the northwest point of Dumarán Island and from Esfuerzo Point to Barrio Colasian joining on with the topography to the northward. Numerous small islands in Dumarán Channel were included in the work.

In June the main scheme of triangulation was carried southwestward to the line Pagdanan-Green on Palawan Island, but station Pagdanan was not occupied. Points were selected to the southwestward. A detached party was engaged in triangulation on the west side of Palawan. Most of the inshore hydrography in Dumarán Channel was completed.

[T. J. MAHER, Commanding Steamer *Fathomer*.]

SUMMARY OF RESULTS.—Triangulation · 1,667 square miles of area covered, 54 signal poles erected, 8 stations in main scheme occupied for horizontal measures, 35 stations in supplemental scheme occupied for horizontal measures, 55 geographic positions determined. Magnetics: 5 land stations occupied for magnetic declination. Topography: 106.8 square miles of area surveyed, 289.6 miles of general coast line surveyed, 9.1 miles of shore line of creeks run, 5 topographic sheets finished. Hydrography: 2,291 square miles of area covered, 10,717.5 miles run while sounding, 38,623 positions determined, 84,951 soundings, 3 tide stations established, 45 current stations established, 2 hydrographic sheets finished.

At the beginning of the fiscal year the steamer *Fathomer* was engaged in surveying the extensive region having Quiniluban Islands about central and extending over the area bounded by Panay, Mindoro, northern Palawan, the Calamianes, and Apo Reef.

During the short periods from July 4 to July 11 and September 1 to September 10 the steamer was at Manila undergoing minor repairs, but during the remainder of the period of this report field work was constantly in progress.

A secondary scheme of triangulation was carried over Busuanga Island and the small outlying islands to the northward, closing a circuit in connecting with the work previously executed in the region about Culion and Linapacan Islands, thus completing the necessary triangulation for most excellent control of all the surveys to be executed in the Calamianes, northern Palawan, and the east coast of that island as far south as Dumaran Island. The three steamers *Fathomer*, *Romblon*, and *Marinduque* participated in this important piece of triangulation, and it is gratifying to note that it has been so successfully accomplished that the topographic and hydrographic surveys in this heretofore unsurveyed region can progress rapidly and under excellent control. In connection with the triangulation executed by the steamer *Fathomer* during the season, 50 intersection stations for topographic and hydrographic control were established, all of which were sufficiently well marked to insure their preservation at least until the surveys in the region have been completed.

Topographic surveys were executed on the south and east shores of Busuanga Island, on the east and west shores of Coron Island, and in the Cuyos. An effort was made to complete the topography in the vicinity of Coron Bay, but on account of the complement of officers being one short, a portion of this work remained unfinished at the close of the calendar year. The topography of Coron Island, which is now finished, presented considerable difficulty, as there is no beach, the rock being undercut, making a traverse almost impossible. The work in this region required a strong control. On Busuanga Island, topographic work was carried northward from the entrance to Coron Passage, but heavy seas and lack of control made it necessary to discontinue the work until a more favorable time. Work was then taken up on the south shore of Busuanga Island completing the section between Matunan Island and Quiuit. The small amount of topography executed in the Cuyos was for the purpose of developing an anchorage for the *Fathomer*, and work there was discontinued as soon as the result was obtained. Tagauayan Bay is the only anchorage in that vicinity and the wreck of a Spanish gunboat which was stranded there during a typhoon indicates that the locality can not be considered as being very safe.

Owing to the extensive area assigned to the steamer for the purpose of execution of hydrographic surveys, it was necessary frequently to change the locality of work, in order to take advantage of the most favorable weather conditions and best utilize the available time. All other work was confined, whenever possible, to the development of shoals. Between Mindoro and Busuanga, Framjee Bank and Magallanes Bank remain to be developed. Very few of the shoals in this region have ever been charted. There are numerous indications of dangers to navigation and it was necessary to space soundings in depths of 150 to 300 fathoms, as close as six to ten in 5 miles, and frequently much closer. This irregularity extends over an area of approximately 900 square miles. The submarine sentry was in use during the entire time while engaged in sounding in localities where there were indications of shoals and it proved very valuable in finding many shoals that would have been passed over if soundings had been taken in the ordinary manner.

The hydrographic work of the steamer was carried on during all of its movements, while transporting various working parties in the field and while en route for coal and supplies; the only time actually lost was while in port.

Fifteen stations for observations of the direction and strength of currents were occupied in the northern part of the Sulu Sea and in the southern part of Mindoro Strait.

Three tidal stations were in use during the season. The automatic gauge at Port Uson, established during the previous year, was in continuous operation during the entire period of this report, and at the close of the calendar year 13 consecutive months of observations had been obtained with that gauge. For convenience in the reduction of soundings tide staffs were erected at Bisucay and in Tagauayan Bay. The plane of reference at these staffs was established by means of simultaneous observations in connection with the automatic gauge at Port Uson.

Five stations were occupied for the determination of the declination of the magnetic needle. The compass courses were so slightly affected by changes in the magnetic variation that no ship swings were made.

Work was continued after January 1 and until the close of the fiscal year in the same general localities. In the early part of January hydrography between Mindoro and Busuanga Islands was continued and a partial development made of Narvaez Bank. Between January 8 and March 10 the vessel was undergoing repairs at Manila. From March 11 to the close of the year, with a slight interruption, the party was at work on the hydrography and topography of the south and west coasts of Busuanga Island, topography and hydrography in channel between Busuanga and Culion Islands, and signal building, triangulation, and hydrography in the Cuyos Islands.

The triangulation over Busuanga Island was completed and a tertiary scheme with numerous intersections carried over Coron Island. Some triangulation was done in the Tagauayan Islands to give control for an anchorage. Triangulation was begun in the Quiniluban group.

Topography was completed on the south coast of Busuanga Island and partly completed on the east coast. The north coast of Culion

Island and Port Culion were completed, and also Cocoro Island in the Tagauan group. Tagauan Island was partly finished.

The hydrography in the area between Apo Reef, Mindoro, and Busuanga Islands was nearly finished and that in the most difficult part of the area between Cuyos and Panay, including the development of some of the shoals. Some work was done in the area between Cuyos and Palawan and west of Busuanga Island. Areta shoal was partly developed. The channel between Culion and Busuanga Islands was completed. Current observations were taken at night when the ship was at anchor. Five sets of observations for magnetic declination were made. The tide observations of the automatic tide gauge at Port Uson were continued during the year. Staff gauges were read at Bisucay and Tagauayan.

All of the Cuyo Islands north of Bonbon, Cuyo Island, with the exception of Tabac Rock, were connected by triangulation and the topography of the islands was begun. Such hydrography was done among the islands as was practicable in connection with the foregoing.

HAWAIIAN ISLANDS.

[E. R. HAND.]

SUMMARY OF RESULTS.—Triangulation: 127.2 square miles of area covered, 25 signal poles erected, 23 stations occupied for horizontal measures, 10 stations occupied for vertical measures, 27 geographical positions determined. Topography: 64 square miles of area surveyed, 146.1 miles of general coast line surveyed, 46.3 miles of roads surveyed, 7 topographic sheets finished.

At the beginning of the fiscal year revision work was in progress on the island of Hawaii, the survey having been completed as far as the village of Kawaihae. By October 1 the surveys had been extended southward to Hanamalo Point, not far from the extreme southerly point of the island of Hawaii. This work includes an accurate delineation of the shore line and location of offshore rocks, a determination of the cliff heights at frequent intervals, a location of all prominent natural and artificial objects which would be useful to navigation or as hydrographic signals, and, where necessary, the development of the land forms by contours. This work was placed on four topographic sheets on a scale of 1:20,000.

The triangulation consisted in the recovery of all primary stations of the old Hawaiian Government survey which were close enough to the coast to be of value for the hydrographic work, and an extension based on these points for the purpose of locating lighthouses and other objects useful as landmarks or offshore hydrographic signals. All positions determined were intersection points, since the great number of primary stations recovered made any extension merely for topographic control unnecessary.

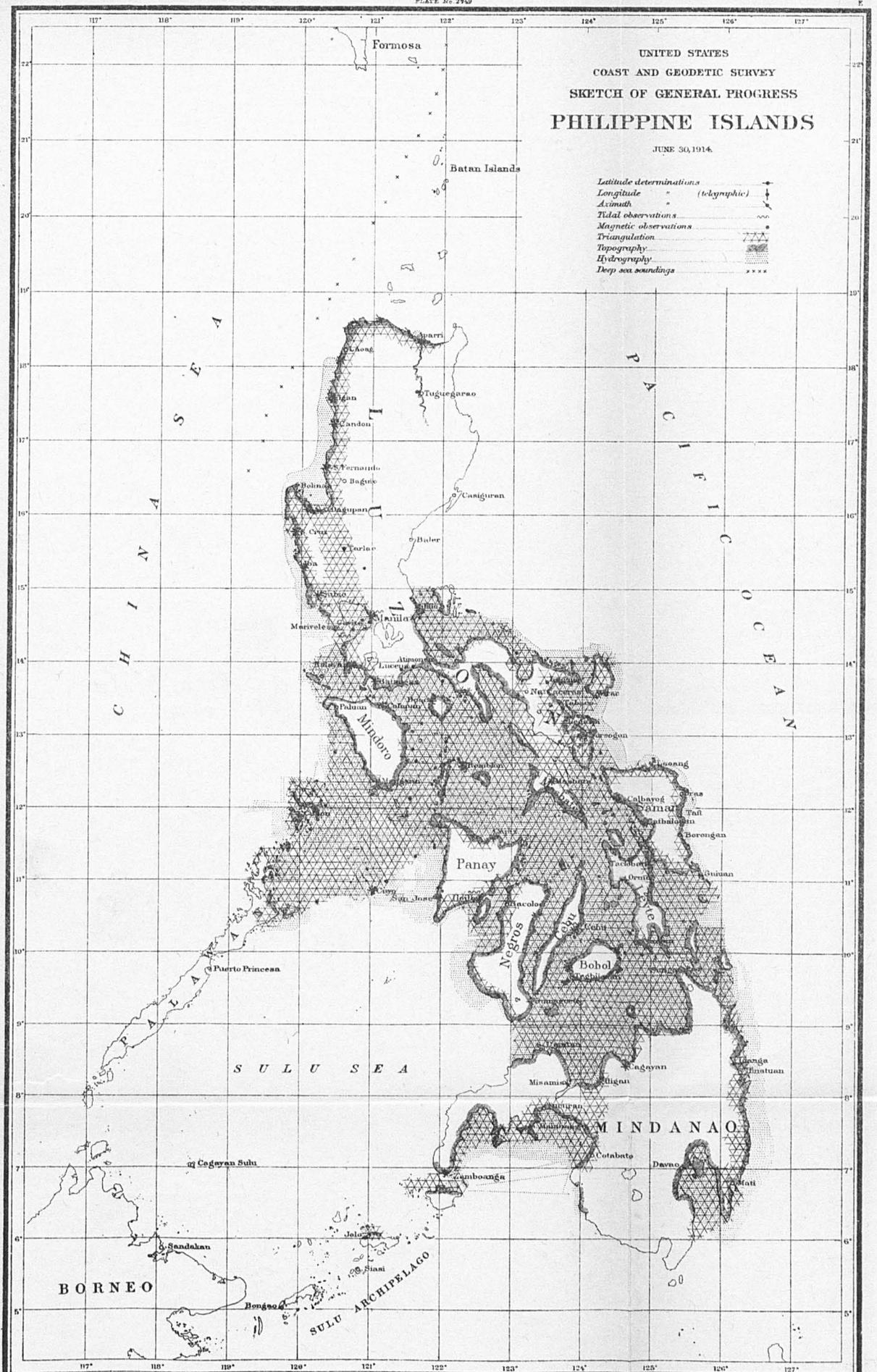
Four lighthouses are included in the limits of the work—at Kawaihae, Keahole Point, Kailua, and Napoopoo. These were located by triangulation and a careful determination of their heights was made.

A whaleboat was used for the transportation of the party. Between Kailua and Hanamalo Point but two sheltered anchorages were found and, as it was not safe or feasible to land on the occasional strips of beach and haul out the boat, it remained offshore all

UNITED STATES
 COAST AND GEODETIC SURVEY
 SKETCH OF GENERAL PROGRESS
 PHILIPPINE ISLANDS

JUNE 30, 1914.

- Latitude determinations
- Longitude
- Longitude (telegraphic)
- Azimuth
- Tidal observations
- Magnetic observations
- Triangulation
- Topography
- Hydrography
- Deep sea soundings



night, anchored when the weather was favorable but lying to when the swell made this dangerous, with two men standing watch alternately.

At the end of October field work was temporarily suspended.

During the second half of the fiscal year field work was continued on the surveys of the island of Hawaii from Hanamalo Point to the southward and eastward around the coast toward Hilo, the original starting point. The topography was completed from Hanamalo Point around South Point to the Keaiwa lava flow of 1868, or about 8 miles northeast of Punaluu Landing. The triangulation was extended about 10 miles beyond, or to station Puu Kapukapu, at Keauhou, below the volcano.

The triangulation consisted of the extension of the supplemental work from the lines of the original primary survey for the purpose of topographic and hydrographic control, marking new stations and old ones where necessary and preparing descriptions of stations. Because of the frequency of primary stations and the absence of good intersection objects no triangulation was done until the survey reached Honuapo, except that Ka Lae Light at South Point was determined from three primary stations. Northeast of Honuapo, however, there were no primary stations in the vicinity of the coast, excepting Kamehame, so that it was necessary to take the base Kamehame to Puu Enuhe and extend the work both ways, southwest to Honuapo, and northeast to Keauhou.

The topography consisted of an accurate delineation of the shore line, a determination of the cliff heights at frequent intervals, indicating the form of the terrain by contours as far back as would be useful for navigation, and of marking and listing the topographic stations with a view to their use in a hydrographic survey. Where necessary for their identification the natural objects used for stations were marked with white paint or whitewash.

[J. W. GREEN.]

Field magnetic observations were begun in August for the reoccupation of stations on the islands of Kauai, Maui, and Hawaii for secular variation and also to make a magnetic survey of the crater of Kilauea. Observations were begun on Kauai, where stations were occupied at Waimea and Port Allen. A station was occupied at Lahaina on the island of Maui. On the island of Hawaii observations were made at two stations on Hilo; at Kapoho, Ka Lae, and Kilauea, all of which were repeat stations.

In the magnetic survey of Kilauea the original plan was to establish four stations at the terminals of the long and short axes of the fire pit Haleamaumau and to secure repeat observations at these four stations as often as possible extending over a period of six weeks. This work was to be supplemented by two weeks' observations at stations to be selected around the outer rim of Kilauea. On account of the dense sulphurous fumes which pass off toward the south and southwest under the influence of the trade winds, no station was possible on this side of the pit. Three stations were therefore established, going as close to the fumes as practicable on either side and halfway between these stations on the north side. Station A, on the northwest side and about 40 feet from the rim of the crater,

was abandoned after the second set of observations on account of the unstable condition of the surface layer of lava rock, and a new station A² established about 125 feet nearly due north from A. Also station C, 75 feet from the rim of the crater on the southeast side, was abandoned on account of the fumes after the first set of observations and a new station C² established, about 75 feet nearly due east of C. After obtaining two complete sets of observations at station A, two at station A², four at station B, one at station C and three at station C², an analysis of the results indicated that while a normal diurnal variation might be expected at any one station yet the wide differences in the values of the elements obtained at the different stations are differences due to location and not to time.

Ordinarily it is to be expected that as the dip increases the horizontal intensity decreases. A comparison of the results obtained at the stations around Halemaumau showed anomalous conditions in several instances, the changes in the value of the horizontal intensity and dip following no regular lines of variation. It appears also that there are numerous local centers of disturbance. Consequently, it was deemed advisable to discontinue the repeat observations at these stations and establish as large a number of stations in the vicinity of Halemaumau as possible in the time available. Accordingly, five additional stations were established. At these five stations the same irregularity was manifested as at the stations already established, confirming the idea that the abnormal variations are purely local and are due to fixed centers of disturbance, perhaps near the surface, and in no way connected with the movement of the lava column at Halemaumau. A test of specimens of the lava rock showed that the surface fragments are all magnetic, and all exhibited polarity in a greater or less degree. A perceptible change in the direction of the declination magnet was produced by moving blocks of lava rock weighing from 50 to 75 pounds to different positions in the vicinity of the instrument.

Around the outer rim of Kilauea 7 stations were established about 1 mile apart in addition to the former station near the Volcano House Hotel. These stations extend almost around the crater, but there is a gap of 1.6 miles on the southwest side. At these stations the same irregularities in dip and horizontal intensity were noted as at the stations around Halemaumau.

Polarity was found in a marked degree in fragments of basalt thrown out from Kilauea by the explosion of 1790, and this polarity probably existed at the time they were thrown out, as the end of the rock lying toward the north in some cases attracted and in other cases repelled the north pole of the magnet.

At the request of the director of the Hawaiian Volcano Observatory declination observations were made at 7 observation stations established by him around the rim of Halemaumau. The results varied from 0 to 16 degrees and were uniformly greater on the east side than on the west side of the pit.

The ascent of Mauna Loa was made on the southeast slope, and the camp was located on the southeast rim of the crater. For the ascent of Mauna Loa the observer joined a small party sent out by the Hawaiian Volcano Observatory. Four pack animals were required to carry the outfit, camping material, and supplies. The ascent was made on September 29 and 30.

The crater of Mokuaweoweo covers $3\frac{1}{4}$ square miles and is 800 feet deep. Mauna Loa is 13,675 feet above sea level.

The only instrument carried on this trip was a dip circle, the observations obtained consisting of dip and total intensity by Lloyd's method. These observations do not show the wide range in the magnetic elements obtained at Kilauea, but yet the differences are considerable. During the four days spent at the summit observations were made at six stations along the eastern and southeastern rim of the crater. At station A an approximate determination of declination was made using the compass attachment of the dip circle.

Acknowledgement is made of assistance rendered in this work by Prof. T. A. Jaggar, jr., director of the Hawaiian Volcano Observatory, who furnished transportation for the observer and his equipment and placed the facilities of the observatory at his disposal.

[J. W. GREEN and WM. W. MERRYMON.]

The regular series of magnetic observations has been maintained at the magnetic observatory at Ewa, Hawaii.

On August 6 the charge of the observatory was transferred to Wm. W. Merrymon.

The magnetic, seismographic, and temperature variations instruments have been in continuous operations with a few slight interruptions.

The routine work of keeping the recording instruments in operation, taking weekly absolute observations of the magnetic components, caring for the observatory property, and keeping up the usual reports and correspondence, has been attended to.

Between July 1 and December 31, three magnetic storms were recorded, that of October 4 to 8 being of unusual intensity, six lesser magnetic disturbances were recorded. During the same period 125 earthquakes were recorded on the Milne seismograph, varying in amplitude from microscopic to greater than the semitrace, about 17 millimeters.

Between January 1 and June 30 there were 10 magnetic storms, and 98 earthquakes were recorded.

Meteorological observations were taken twice daily and sun altitudes for time about four times each month. Meteorological reports were rendered monthly to the local office of the United States Weather Bureau.

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

SUMMARY OF RESULTS.—Triangulation: 452 square miles of area covered, 10 stations occupied for horizontal measures, 20 geographic positions determined. Magnetic work: 1 magnetic station occupied for standardizing instruments. Topography: 16 square miles of area surveyed, 32 miles of shore line surveyed, 1 topographic sheet finished. Hydrography: 821 square miles of area covered, 1,895 miles run while sounding, 18,546 soundings made, 5,651 positions determined, 8 hydrographic sheets completed, 15 current stations occupied.

The work done by the party on the steamer *Patterson* during the winter season of 1913 to 1914, was chiefly hydrographic, since the other classes of work have been largely completed in the Hawaiian Islands.

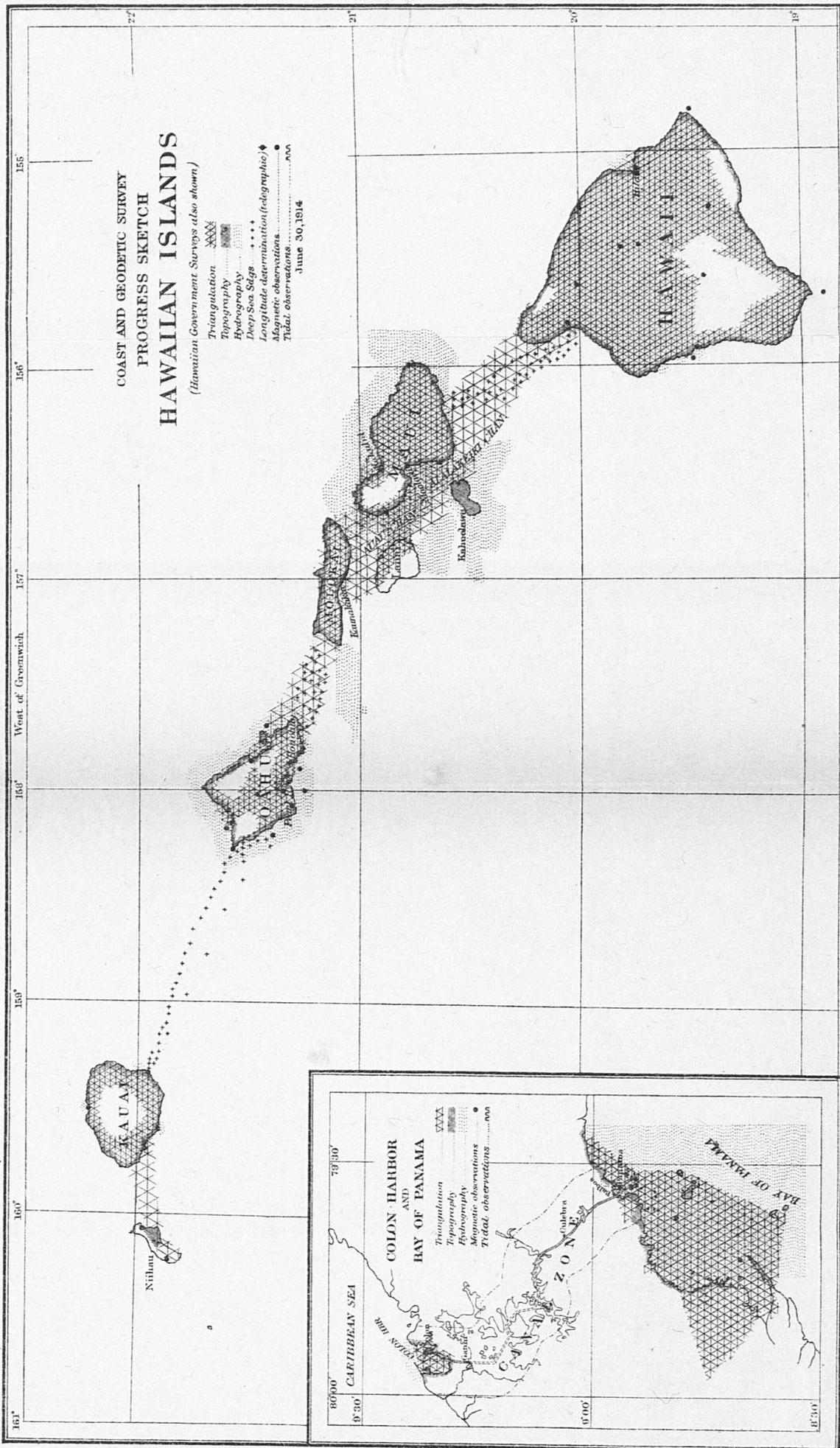
A small amount of tertiary triangulation was done to control the survey on Lanai Island. Concluded points were determined from old stations, and four new stations were established at important points.

The topographic work done includes the shore line of Lanai Island, from Kaea Point, around the southern, eastern, and northern sides to Kaena Point. Signals were located for the inshore hydrography and all features within one-half mile of shore were shown. No contours were determined as the shores are low, but where cliffs occurred their heights were determined. Thus, the work consisted solely of closed traverses between triangulation points.

Inshore hydrography from the shore to 27 fathoms was completed on the south coast of Maui Island from Kaupo Landing to La Perouse Bay, a distance of 22 statute miles, thus completing that island; on Lanai Island, on the southern, eastern, and northern coasts from Kaea Point to Kaena Point, a distance of 32 statute miles; and on Hawaii Island around the northwestern point from Kukuihaele to Puako, a distance of 47 statute miles. Special surveys in Mala Bay, Maui Island, and Kaiaka Bay, Oahu Island, included 4 miles of coast line. The development of all these coasts was made on the same scheme; that is, by sounding lines on and off shore one-eighth mile apart, with additional lines and soundings at critical or suspicious places. No harbors are found on these coasts. At landings the sounding lines were run one thirty-second mile apart and closer. Geographic positions for locating soundings were obtained from previous topographic sheets of Maui and Hawaii Islands, and on Lanai Island were located by new topography, as explained above. The coasts surveyed are almost entirely exposed to the trade winds, the southern Maui coast and the northeast Hawaii coast especially so, and are almost unapproachable when these winds are blowing strongly. During the past winter, however, the weather conditions were greatly disturbed and abnormal, so that advantage was taken of these conditions, and work was completed which would otherwise have been impossible.

The sounding was extended from the limit of the inshore work to a distance of about 9 miles off the coasts of Maui and Hawaii; around Lanai it was extended 2 to 5 miles offshore, accordingly as it joined previous work off Maui, or was intended to join later work off Molokai. The limits of old and new work are now fairly continuous and definite, and conveniently situated for extending. The soundings from 27 to 80 fathoms were made at one-third to one-sixth mile intervals, with pressure tubes. The usual program was followed for such soundings, and the tubes were standardized at each tenth sounding by vertical casts. Off Maui and Hawaii the deeper soundings reached 500 to 900 fathoms and these were made by vertical casts in the usual way. Off Lanai a comparative shallow bank was found all round, and there were few deep soundings.

Current observations were made at eight localities distributed over the whole region with an average of 43 hourly observations in each locality. A 20-foot current pole was used, with a log line and pelorus. Moderately strong and well defined currents were found, with a strength as great as $1\frac{1}{2}$ knots. All of the currents are branches of the continuous ocean current which flows from southeast to northwest through the Hawaiian Islands, and which is modified by the



coasts of the islands, by changes in the barometer and the corresponding winds, and only slightly by the tides. The currents are only moderately important to navigation, as they generally run in the direction of usual vessel tracks. Tidal reducers for the soundings were obtained from the automatic gauge operated by the Corps of Engineers, United States Army, at Hilo, Hawaii, where an excellent record is obtained continuously. The tides at Hilo agree in time and range with the whole region where soundings were made, and the range of tide in the Hawaiian Islands is always small.

A small amount of work was done on the coast of Oahu Island, requiring five days in all, at the request of the commandant of the naval station, and by authority from the superintendent.

A small amount of sounding was done in Mala Bay, near Lahaina, Maui Island, to develop the proposed location for a new Territorial wharf. This was at the request of the superintendent of public works of the Territory, and copies of the results were furnished to him.

The magnetic instruments on board the ship were standardized at the Honolulu Magnetic Observatory of the Coast and Geodetic Survey. No other magnetic observations were taken in the field during the season. The routine meteorological observations for the use of the Weather Bureau were made throughout the season and were forwarded to that Bureau on the forms provided by it for that purpose.

The Hawaiian Islands lie in the track of the northeast trade winds, and much of the coast is exposed to the heavy ocean swell and is unprotected from the wind, and there are no harbors. During the last two seasons it has been found possible to work on such coasts in a moderate trade wind, however, and by exercising some care, even to anchor the ship there when it is desirable. The wear and tear on ship and outfit is greater than in many other circumstances, but is not unreasonable, and many precautions are necessary in working with launches and small boats. On these coasts commercial steamers handle cargo and passengers in ordinary weather, but it is done with considerable risk to them and to the vessels themselves, much more than in many other regions. However, during the winter 1912-13, and 1913-14, this party was favored with some intervals of variable weather, when it was quite safe and convenient to work on such coasts. The past winter was especially unusual, and several heavy storms passed over, which prevented work altogether, when at their height. Much of the most difficult part of the exposed coast is now completed, and such localities were given the preference the past season, whenever it could be done.

SPECIAL DUTY.

OCEANOGRAPHIC WORK AND CURRENT OBSERVATIONS IN GULF STREAM.

OCEANOGRAPHIC WORK.

[CHARLES C. YATES, Commanding Steamer *Bache*.]

The oceanographic cruise of the steamer *Bache* in the Atlantic Ocean and Gulf Stream from Chesapeake Bay to Bermuda and the West Indies was undertaken in cooperation with the United States

Bureau of Fisheries in accordance with the plans of the Permanent International Council for the Exploration of the Sea.

While the work was primarily suggested by the Bureau of Fisheries for obtaining information as to the ocean conditions governing the fisheries on the coasts of the United States, the physical data obtained relating to depths, currents, temperatures, and densities in the Gulf Stream and adjacent waters are of equal interest and value to the Coast and Geodetic Survey as affecting navigation and the charting of the coasts.

The *Bache* had her usual complement of officers and crew, and two officers of the Bureau of Fisheries were detailed to conduct the special studies relating to the fisheries. The work of these experts was facilitated by construction of a laboratory for their use and the addition or modification of a number of appliances required for the fishing operations.

While waiting at Norfolk for the arrival of a supply of wire for deep-sea work ordered from abroad, the *Bache* made two preliminary cruises for the purpose of adjusting compasses and testing apparatus. Some defects were developed which were corrected as far as possible before the final departure of the ship.

The special wire having arrived the *Bache* sailed from Hampton Roads on January 26. This portion of the cruise ended at Bermuda on February 7 after a stormy passage which greatly interfered with oceanographic work. During the period of 12 days occupied in the voyage to Bermuda the vessel made an average of only 67 miles a day. During an average of 15 hours per day she was either lying in the trough of the sea and drifting while making physical hydrographic observations, or going ahead dead slow, also usually in the trough, towing deep-sea fishing nets.

Owing to the rough weather the Sigsbee sounding machine on the platform overhanging the stern could not be used a greater part of the time and the drum of the Lucas sounding machine forward gave way under the accumulated pressure of wire and in doing so carried away the driving wheel.

A new sounding machine of a new type was improvised, however, from parts of other machines on board which proved extremely efficient in deep-sea work. At Bermuda the new sounding machine was reconstructed in a more permanent form, and some necessary modifications were made to the reeling machine used in deep-sea fishing.

The governor general of the islands paid a visit to the *Bache*, as did some hundreds of others, the greatest interest being taken by all in the apparatus and specimens of deep-sea fish collected.

Between February 17 and March 4 the *Bache* was making the voyage from Bermuda to Nassau, Bahamas. By request of the colonial secretary of Bermuda the first part of this voyage was devoted to a search for a reported shoal located about 20 miles to the southeastward. It was not found, and the examination made indicates that it does not exist.

The weather on this portion of the trip was more unfavorable than that from the United States to Bermuda. On February 22 and 23 the vessel was hove to in a storm about 250 miles southeast of Bermuda, and again on the 26th and 27th about 250 miles northeast of the

Bahamas. On the evening of February 28 there commenced the most severe of all the storms experienced. This culminated on the morning of March 2, when a big sea was shipped which carried away two whaleboats, smashed the starboard launch, started the coaming of one of the skylights, flooded the ship, and damaged many other parts. Fortunately no one was on deck at the time except the officers on the bridge. The wreckage was quickly chopped away without fouling the propeller.

Upon arrival at Nassau on March 4 a small supply of coal was obtained sufficient to carry the vessel to Key West, at which place she arrived March 11. No oceanographic work was done during this part of the trip.

On March 13 the *Bache* proceeded from Key West to Habana, making the regular oceanographic observations across this section of the Gulf Stream. The remainder of the cruise took the ship up the Gulf Stream in the Florida Straits to Gun Key and then across to Fowey Rocks. From there the *Bache* cruised to Jupiter Inlet, then across the Gulf Stream again and on north of Great Araco Island of the Bahamas to a final oceanographic station about 200 miles north of Hole in the Wall.

On March 23 the vessel returned to Key West, where the officials of the Bureau of Fisheries packed and shipped to Washington their specimens and outfit, and the ship took on coal and supplies.

From their nature, the results of an oceanograph expedition are not subject to a summary statistical analysis and can only be properly covered by a separate report. The following extracts from a letter of the Commissioner of Fisheries to the Superintendent of the Coast and Geodetic Survey give testimony to the value of the work accomplished:

The successful conclusion of the oceanograph cruise of the *Bache* and the value of the collections obtained impels me to express to you my appreciation of the zealous and skillful execution of the investigation.

A preliminary examination of the material collected indicates that it will throw much light on biological and physical conditions in the Gulf Stream and the western Atlantic, particularly when it is considered in connection with the investigations which this Bureau is conducting along the coast as far as the Grand Banks. The region covered by the *Bache* is vital to our general inquiry and it could not have been investigated without the invaluable cooperation of the Coast and Geodetic Survey.

I request that you convey to * * * the officers and men of the *Bache* my thanks and congratulations for the success with which the expedition has been conducted under circumstances which well might have discouraged men less zealous and conscientious.

CURRENT OBSERVATIONS IN GULF STREAM.

After the completion of the oceanographic work in cooperation with the Bureau of Fisheries, the steamer *Bache* left Key West on March 31 to occupy a station in the Gulf Stream about midway between Cuba and the Florida coast. This work was undertaken primarily to investigate a new method of measuring deep-sea currents.

An attempt was made to anchor with wire in about 600 fathoms of water a moderate-sized nun buoy provided by the Bureau of Light-houses. The operation was not successful, as the location of the buoy was lost at night by reason of failure of the searchlight of the ship.

In the morning the buoy could not be found, and presumably it was carried away by the 3-knot current.

As it was most desirable that this method of current observations, depending on the successful anchoring of a buoy in the deep sea, should be tried out, the operations were transferred to more protected waters in the vicinity of Cay Sal Bank between Cuba and the Great Bahama Bank. Here buoys or markers constructed on the ship were successfully anchored on four sides of the Cay Sal Bank, one in Florida Straits, one in Nicholas Channel, and one in the Old Bahama Channel.

At these four stations current observations were successfully made in deep water out of sight of land, and at the same time observations of deep-sea temperatures and sea-water densities were obtained.

The observations in Old Bahama Channel developed the interesting fact of the existence of two distinct ocean streams or rivers superimposed one above the other, one flowing at the rate of nearly a knot an hour away from the Gulf Stream in the Straits of Florida and extending down to a depth of about 100 fathoms, and the other at the bottom flowing in the opposite direction at nearly as great a speed.

EXHIBIT OF COAST AND GEODETIC SURVEY AT THE NATIONAL MOTOR-BOAT SHOW, NEW YORK CITY.

[W. E. PARKER.]

Arrangements were made in January for installing an exhibit of the work of the Coast and Geodetic Survey at the national motor-boat show in Madison Square Garden, New York City, and an officer was assigned to the charge of it. The Coast and Geodetic Survey exhibit was placed in the auditorium, a small room opening directly off the balcony of the main space, reserved for the educational features of the show. The exhibit occupied a favorable position in the auditorium close to the main entrance from the large hall and at a place where it was plainly visible to everyone passing into the lecture hall. It attracted much attention and was favorably commented upon. The exhibit consisted principally of sailing and general coast charts of the Atlantic and Gulf coasts, Coast Pilots, Tide Tables, Table of Depths, and Chart Catalogues. A few navigational instruments, such as a sextant, three-arm protractor, parallel ruler, etc., were included to show methods of working positions on charts. About 12 charts covering Long Island and Sound, and Hudson River and New York Harbor, were hung upon the walls. The charts were consulted quite freely by people of varied interests.

TIDE INDICATOR, NEW YORK.

[W. R. WHITMAN.]

In July an examination was made of the tide indicator at the Maritime Exchange, New York City, which was not working satisfactorily.

The apparatus was overhauled and the indicator put in good working order.

TRIANGULATION, DISTRICT OF COLUMBIA.

[O. B. FRENCH.]

SUMMARY OF RESULTS.—Reconnaissance: 16 square miles of area covered, 62 points selected for scheme. Triangulation: 16 square miles of area covered, 23 signal poles erected, 38 stations occupied for horizontal measures, 62 geographic positions determined.

After July 1 the triangulation of the Potomac River between the harbor of Washington and Little Falls, for which a reconnaissance had been made and signals erected, was continued.

The scheme selected extends from Georgetown, where it connects with the triangulation executed during the previous fiscal year, to Little Falls just above Chain Bridge. The stations on the south side are very near the south bank of the river, whereas those on the north are on the tops of the hills along the north side of the river.

Below Georgetown a scheme was carried along the banks of the river, the stations having been selected and marked and signals erected by the United States Engineers in charge of the district. The observations were made by the Coast and Geodetic Survey officer. This triangulation connects with the District of Columbia scheme and that up the river at its western end, and near the other end with the Potomac Park base.

The triangulation along the upper part of Potomac Park is composed of short lines owing to the curvature of the river and to the growth of vegetation along the shore, but good triangle closures were obtained.

The primary object of this work being to furnish points for use in a hydrographic survey of the Potomac River, and such points being numerous enough below Washington harbor and the entrance to the Eastern Branch, the triangulation was not extended farther down the river.

Field work was completed on July 19.

PRECISE LEVELS, DISTRICT OF COLUMBIA.

[GEORGE D. COWIE.]

In March, at the request of the District Engineer, Corps of Engineers, U. S. A., Washington, D. C., a line of precise levels was run between the Capitol bench mark and bench mark XI on the Aqueduct Bridge. Connection was made with various other bench marks in the District of Columbia.

TOPOGRAPHIC SURVEY OF GROUNDS OF BUREAU OF STANDARDS, DISTRICT OF COLUMBIA.

[C. L. GARNER.]

SUMMARY OF RESULTS.—Topography: 0.01 square miles of area surveyed, 0.5 mile of roads surveyed, 1 topographic sheet finished.

A special topographic survey of the grounds of the National Bureau of Standards, in the District of Columbia, was begun June 19 and completed a few days after the close of the fiscal year. The object of the survey was to revise the old map where changes had taken place, and to lay out sites for three proposed buildings to the

northward of the original grounds. After the elevations of a sufficient number of bench marks were determined by leveling a considerable amount of detail topography was done with the plane table. A special descriptive report was made on this work.

SURVEY BETWEEN PENNSYLVANIA AVENUE AND UNION STATION PLAZA,
WASHINGTON, D. C.

[W. E. PARKER.]

At the request of the Attorney General, made through the Secretary of Commerce, a survey was made to determine whether or not an avenue 150 feet wide from the junction of Pennsylvania Avenue and First Street NW., to the Union Station Plaza, the center line of said avenue to be located on the axis of the Peace Monument and the site of the westerly fountain of the plaza will overlap that portion of square 633 which is west of Arthur Place.

Field work was begun August 8 and completed August 20.

The Survey shows that an avenue 150 feet in width, with its center line located on the axis of the Peace Monument and the western fountain at the Union Station will pass 2 feet eastward of the southeast corner of that portion of square 633 which lies west of Arthur Place and will nowhere overlap said square.

The objects which define the axis of this avenue not being inter-visible or visible from any point within a convenient distance from both, triangulation was used only to get an approximate check on the direct measurements.

A traverse was carried from the Peace Monument along the west sidewalk of C Street to the southwest corner of New Jersey Avenue, and thence across open lots to the west fountain of the Union Station. All lines were measured twice with steel tapes 100 feet long.

A plat was made of the southern portion of the proposed avenue, showing its intersection with all improved property and extending from the Peace Monument to north of the intersection of C Street and New Jersey Avenue.

COMPARISON OF PENDULUMS FOR GRAVITY WORK, DISTRICT OF COLUMBIA.

[C. H. SWICK.]

In July and August two independent determinations were made of the periods of each of three pendulums for gravity observations, constructed by an American manufacturer for the Mexican Government.

Observations were begun on July 23 and were continued until August 3. The results of the separate determinations were found to agree closely and to be well within the limits of accuracy required for gravity work.

PHYSICAL HYDROGRAPHY, DISTRICT OF COLUMBIA, MARYLAND, AND VIRGINIA.

[H. P. RITTER.]

SUMMARY OF RESULTS.—Physical hydrography: Days on which current floats were run, 125; miles of current lines run, 723; stations used for locating current lines, 2,185; days observations of the extent and movement of muddy water, ice, etc., 201; miles, 3,670; observations, 1,428; observations of density of water, 958; days, 55; observations of temperature of water, 1,351; observations of temperature of air, 776; days, 136; tide stations established, 3; directions of currents observed at Alexandria, Va.,; number of days and parts of days, 121; number of observations, 3,415; locality of work, Potomac River, Chain Bridge to Colonial Beach; results to be shown by charts, plats, tables, etc.

In cooperation with the United States Public Health Service a party was organized for a special examination in the Potomac River to determine to what extent the tides affect and how far the currents carry the sewage from the vicinity of Washington toward the oyster beds in the lower Potomac and the amount of dilution the waters of the river undergo from the fresh-water streams or influx of salt water from Chesapeake Bay, etc.

The Coast and Geodetic Survey launch *Inspector* was assigned for use in this work.

An automatic tide gauge was erected at Alexandria, Va., on July 1, and kept in continuous operation throughout the year. Current observations were begun on August 4 and were in progress at the close of the fiscal year.

In addition to the launch, two rowboats and a small motor boat were used in following the current floats.

The observations of currents during the year had in view the determination, by means of floats, of the actual current paths in different parts of the river with special reference to the movement of the water in the vicinity of the Washington sewer outlet (1½ miles below the junction of the Georgetown, Washington, and Anacostia Channels) and to ascertain the rate and extent of the probable down-stream movement of the sewage discharge.

The method pursued in making the float observations was to follow the float with a rowboat in which were two observers with sextants. When the float was set adrift the time was noted and sextant observations were taken by the observers in the boat to fixed objects on shore or located buoys in the river. At the same time the boatman took a sounding. At frequent intervals the boat was rowed close to the float and its position again determined. These observations, together with the state of the weather, condition of the water surface, direction and force of the wind, direction of current, etc., were recorded and constitute the field record. Whenever practicable the observations were started a short time before the beginning of the ebb or flood current and continued throughout that tide.

At first all of the observations were made during daylight hours. Later on, at the end of the day's observations, the float was left to run unattended during the night and if found still floating on the following morning the observations were continued. This plan not proving satisfactory, the floats were followed continuously day and

night until the observations had to be discontinued on account of stormy weather. During the night the path of the float was located by noting the time of passing buoys, wharves, lighthouses, beacons, and other objects, estimating the distance from shore and taking soundings at the same time.

At the beginning current observations were made with a pole 15 feet long weighted so as to float a foot and a half out of water. An improved form of pole was afterwards substituted, and proved satisfactory.

The places from which the current observations were begun at various times during the season were Chain Bridge, Aqueduct Bridge, Georgetown sewer outlet, north of Highway Bridge, south end of Georgetown Channel, and south shore of Anacostia River.

In addition to the current work observations bearing on the physical condition of the river were taken at various times and places. They consisted of specific gravity determinations, water and air temperatures, color, turbidity, ice, wind, and weather conditions. The 39 localities at which observations of this kind were taken are distributed along the river from Chain Bridge to Nomini, Va., and cover about 87 miles of the river. They were taken on various dates between August 6, 1913, and June 30, 1914.

Turbidity observations which consisted principally in noting the color of the water and specific gravity observations were also made and temperatures of the air and of the water at various depths were taken.

Observations to determine the change in the direction of the current with reference to the stage of the tide were made at Alexandria, Va.

The stage of the Potomac River at Chain Bridge and of the Anacostia at Bennings Bridge was frequently determined by tide-staff readings made in connection with current work near those localities and at other times.

NORTH CAROLINA FISHING GROUNDS.

[CLEM. L. GABNER.]

SUMMARY OF RESULTS.—Base lines: 2,500 meters in length. Triangulation: 6 signal poles erected. Hydrography: 65 positions determined, 2 hydrographic sheets finished.

At the request of the North Carolina Fish Commission an officer was assigned in September to replace the buoys marking the fishing limits of Albermarle, Croatan, and Pamlico sounds, as prescribed by acts of the General Assembly of North Carolina in 1909. The buoys remaining in position were relocated when there was in any case evidence that they were not where originally placed.

Preliminary arrangements for the work were made by J. H. Leroy, fish commissioner of North Carolina.

Work was begun October 9 north of Durants Island, where the marks had partly disappeared. Progress was much retarded by unfavorable weather. On October 30 four buoys were placed in Croatan Sound marking the area limited to Dutch or pound net fishing. From this time the work was directed to the vicinity of

Durants Island and then carried southward. Buoys Nos. 6 to 11, 13 to 23, 32, 36, 37, 38, 40 to 43, 45, 48, 50, 150, 157, 158 and 160 were replaced; buoys Nos. 151 to 155, 159 and 47 were relocated, and Nos. 161 and 162 were newly established.

Positions of Nos. 33, 34, 35, 39 and 49 were marked by stakes, the water being very shallow and not suitable for buoys. Position No. 39 was left to be marked by the fish commissioner.

All of the marks placed during this survey show the limits as prescribed by law for Dutch or pound net fishing. Those placed to mark the restricted area or Oregon Inlet also mark the area in which any kind of fishing is prohibited. The laws most violated are those covering the Dutch or pound net fishing, and consequently those areas were of the first importance.

A comparatively small number of buoys that were previously placed were found. All of these were relocated and examined as to their condition and when defective new ones were placed in position. Only in a few instances were the buoys found to have been moved, and this seems to have been caused by ice during the winter season. It is found that these buoys made of juniper wood are destroyed by the teredo in from one and a half to three years.

Several old signals were found standing to the northward of Roanoke Marshes Lighthouse but none to the southward of that point.

On November 20 the work was brought to a close, 34 buoys having been placed, 7 buoys relocated, 5 stakes placed, and a number of signals repaired.

MISSISSIPPI RIVER COMMISSION.

[H. P. RITTER.]

In accordance with law an officer of the Coast and Geodetic Survey has continued to serve as a member of the Mississippi River Commission in addition to his other duties, and attended the meeting of that commission held at St. Louis, Mo., in July, the annual low-water inspection from Rock Island, Ill., to New Orleans, La., in November, and the annual high-water inspection from St. Louis, Mo., to New Orleans, La., in April.

DELEGATE TO MEETING OF AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE.

[WILLIAM BOWIE.]

In December the inspector of geodetic work as a representative of the Department of Commerce attended the meeting of the American Association for the Advancement of Science, held at Atlanta, Ga., and read before the association two papers based on the scientific work of the Coast and Geodetic Survey. One of these papers read before the section of engineering and mechanical science was entitled "The substitution of metal tapes and wires for bars in base measurement," and the other, read before the section of physics, was entitled, "Isostasy and the shape and size of the earth."

INTERNATIONAL BOUNDARIES.

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

UNITED STATES AND CANADA BOUNDARY.

[F. D. GRANGER.]

The survey and demarcation of the boundary between the United States and Canada through the Lake of the Woods from Northwest Angle was continued after the beginning of the fiscal year by a joint party under the charge of J. J. McArthur, D. L. S., and F. D. Granger, assistant, United States Coast and Geodetic Survey, respectively.

The Canadian party carried two schemes of triangulation across the lake, one following the boundary and the other expanding from the vicinity of American Point to cover the main portion of the lake and connect with the scheme of work brought from the west by C. H. Sinclair, of the United States Coast and Geodetic Survey. This was effected by connection with the following-named points of Mr. Sinclair's scheme, viz, Driftwood Point, Buffalo Point, Long Point, Big Point, Burton, and Oak, the last two being at the extreme southern part of the lake near Rainy River. A small scheme of triangulation was carried up Rainy River for a distance of about 12 miles to Baudette. This scheme was confined to the river banks, the average length of the triangle sides being about one-half mile. As soon as the small scheme was completed a larger scheme with sides of about 3 miles in length was begun with the line Oak-Burton for a base. This work involved the erection of high tripods and the opening of vistas through heavy timbers, as was also the case with the smaller scheme. One of the stations in the larger river scheme "Willow" was built on muskeg ground, and although given a good foundation, it was so unstable that in its occupation with a theodolite satisfactory results could not be obtained, the closure of the triangles with which it was involved proving excessive. Finally it was decided to conclude the angles at this station, as it appeared that no perceptible change in the centering of the signal occurred except when bearing the weight of the observer. The rest of the signals in this scheme were built on more stable ground and the triangle closures were satisfactory.

Fifty reference monuments were set in the Lake of the Woods to indicate the position of the boundary line and 25 in Rainy River. These reference monuments consist of a shaft of solid wrought steel, 45 inches long, 2 inches in diameter, and having a sharp pyramidal top. They were set in a bed of concrete 2 feet square and about 2½ feet deep, and wherever possible in solid rock blasted out for the purpose. Along the Rainy River, the ground being free from rock, the monuments were set in concrete as described.

With regard to the hydrography soundings were taken along the boundary line through the Lake of the Woods and up the Rainy River as far as Baudette. In the river the sounding lines were carried from shore to shore wherever it was possible to do so, and a single line was run in midstream from the mouth up.

[C. H. SINCLAIR.]

SUMMARY OF RESULTS.—Triangulation: 310 square miles of area covered, length of scheme along its axis 111 miles, 280 signal poles erected, 23 observing tripods built (heights 30 to 90 feet), 249 stations occupied for horizontal and vertical measures, 280 geographic positions determined. Azimuth: 1 station occupied for observation of azimuth. Leveling: 6 elevations (tidal bench marks) determined by leveling, 5 miles of levels run.

During the latter part of June the party that had been engaged upon the triangulation of the forty-ninth parallel and the Lake of the Woods was transferred to the vicinity of Fort Frances, Ontario, and International Falls, Minn., to take up the triangulation of Rainy River. A base had been measured near Fort Frances on June 25 and towers had been erected at East Base (87 feet in height), Squall (40 feet), and Birch (75 feet), the line between the last two furnishing a base for the triangulation of Rainy Lake by E. C. Barnard. The base near Fort Frances is 8,061.52 meters in length. Base tower was rebuilt in June after having been destroyed by a severe storm in May. The tower at East Base was blown down afterwards on August 15 but was not rebuilt, being no longer needed.

The survey of Rainy River required two schemes of triangulation: (1) A main scheme with sides from 3 to 10 miles in length of sufficient strength for bringing the work from the Warroad base and the west; (2) a subordinate scheme following the banks of the stream to locate permanent reference marks on both sides of the boundary and for the topography.

The subordinate scheme was begun by building small signals along the river below International Falls and Fort Frances, using as a base the line East Base to Digestor, 849.6 meters in length; the station Digestor being a point on the paper mill at International Falls. The main difficulty in this work was due to the necessity of confining the triangulation to the edge of the scheme as the banks are wooded except for small clearings chiefly on the Canadian side. As a rule the width of the stream determined the length of the triangle sides, but in the direction of the stream the lines were made as long as possible and the scheme was strengthened by measuring bases and connecting them with the triangulation about every 10 miles. Motor skiffs and a barge were used for transportation. In the 44 miles of river triangulation 255 stations were established. The stations were marked with bronze disks set in concrete or in holes drilled in the rocks. The work of the season terminated at Birchdale.

The main scheme of triangulation was begun near Fort Frances and International Falls, so as to give a base for the triangulation of Rainy Lake.

The reconnoissance was confined to the Canadian side where the roads were fairly good. No scaffold signals were considered necessary, as tripods properly guyed had proved successful in previous work.

When the points had been selected for a sufficient distance ahead and the towers were erected observing was begun and continued as the work progressed. Eleven signals were blown down by the storms in August, causing delay, as most of them had to be replaced.

All of the observations in the main scheme were completed by November 13, and a remeasurement was then made on November 14

and 15 to test the accuracy of the base at Warroad. The second measurement agreed closely with the first.

In the main triangulation 25 stations were used, of which 20 were towers (tripods), ranging in height from 30 to 90 feet, and one pole at Big Fork, 102 feet.

Between July 16 and August 3 an azimuth was determined at Fort Frances East Base.

[E. C. BARNARD.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 39 miles, 22 points selected for scheme. Triangulation: 15 observing tripods and scaffolds built with heights from 18 to 70 feet, 23 reference and triangulation signals built, 35 stations in main scheme occupied for horizontal measures, 117 stations in secondary scheme occupied for horizontal measures and 52 with plane table, 89 geographic positions determined. Leveling: 6 miles of levels run. Azimuth: 1 station occupied. Topography: 83.8 square miles of area surveyed, 550.60 miles of shore line run, 45 miles of boundary mapped. Monumenting: 86 reference points set.

Work on the survey and marking of the international boundary in the region of the Lake of the Woods, Rainy Lake, and Rainy River was in progress at the beginning of the fiscal year.

By July 1 all work had been completed on the Lake of the Woods, the triangulation on Rainy Lake was well under way, the reconnaissance having been complete as far as Brulé Narrows, half way up the lake, the large scale mapping on Rainy River was one-half completed, and the topographic work on Rainy Lake was well under way.

On August 7 the large scale work on Rainy Lake being completed work was begun in Black Bay. The necessary triangulation was done in advance of the topography. On August 15 a hurricane swept over Rainy Lake and vicinity blowing down several of the triangulation signals and very nearly wrecking the launch *Amrita* used by the party.

In this month a trip was made by the chief of party through Brulé Narrows, some ranges were erected, soundings taken, and the channel followed out. On August 26 an officer of the survey took up the observation of horizontal angles for the location of boundary reference marks, relieving the Canadian surveyor who had been engaged on that work.

On September 24 an American surveyor was detailed to cooperate with a Canadian party in making a reconnaissance on Lake Namakan.

With the exception of the detail map of Four-Mile Bay and the mouth of Rainy River, the topography of the Lake of the Woods, completed before the beginning of the fiscal year, was done on a scale of 1:45,000 with 10-foot contours and extending back 1 mile from the shore. The shore line was run out with much detail. A plane-table triangulation was executed on Lake of the Woods for the location of additional signals for the topography. The topography of Black Bay was executed on a scale of 1:20,000 with a contour interval of 10 feet. This bay has an area of 8 or 9 square miles and is on the south side of Rainy Lake with a narrow entrance situated about 10 miles east of the mouth of Rainy Lake. Triangulation was carried up the bay from two stations established on opposite shores of the entrance. Reference points were set at each station and their elevations determined by stadia lines from the water level of the lake, which was known, this being the base used for the ver-

tical control of the topography. This work was completed in 9 days by one observer and two assistants. During this time 8 stations were rebuilt, 5 towers and 7 topographic stations were occupied and 10 other signals and points were cut in and checked by intersection, making in all a total of 21 checked locations.

A detail map of Four-Mile Bay and the mouth of Rainy River was made on a scale of 1:20,000 with 5-foot contours; it extended back 1 mile from the shore and included the mouth of Rainy River, the islands to the northward and westward of the mouth of the river, and all of Four-Mile Bay. When this work was begun the triangulation of the lake was not completed and it was necessary to measure a base from which to develop the control for the three field sheets on which the topography was executed. This base was measured with a 100-foot steel tape along a straight sandy beach on the north side of Pine Island. Eleven signals were erected in such positions that the base could be expanded by good intersections into a small scheme of control that located the two lighthouses and tied everything to the main triangulation station Oak and the subsidiary station Perk, which, together with Zipple and Lude, were occupied with a transit instrument and the whole tied into the main scheme triangulation.

The topography of Rainy Lake from its outlet at Rainer to the eastern end of Brule Narrows, a distance of 24 miles along the boundary, was executed on a scale of 1:20,000 with a contour interval of 10 feet. Reference points were set and determined in position by a subsidiary triangulation. The marks used were bronze tablets wedged and cemented into holes drilled in the rocks. In placing the reference marks the general practice observed was to establish them on points projecting toward and nearest to the boundary and as far above the water as possible. The observing was done with a 7-inch Berger transit with the same degree of precision as in the main scheme work. During the season on Rainy Lake 68 reference marks were placed and the same number of signals erected. The number of stations occupied was 65.

In the western portion of Rainy Lake, which extends for 23 miles along the boundary, 1,200 islands were located and mapped with a total shore line, including islands and mainland, of 402 miles.

A large scale survey was made of Rainy River and adjacent towns from a point about one-half mile below the dam at International Falls to the mouth of Rainy Lake, including the towns of International Falls and Ranier on the American side and Fort Frances on the Canadian side of the boundary. The scale adopted was 1:5,000 with 5-foot contours. Vertical control was furnished by level lines which were run on both sides of the river, based on the United States Geological Survey bench mark at International Falls. A 1,100-meter base was measured with invar steel tape along the Canadian Northern Railroad in Fort Frances. A small scheme of triangulation was carried up the river and closed on two stations of the main scheme next east of the Fort Frances base. Reference marks were set on both banks of the river in such position as to control the changes in the course of the boundary. The elevations of the reference marks were determined by closed level lines. Prominent points were cut in to aid in the control of the topography. A dam built at International Falls some years previously had caused considerable areas of land to be overflowed. This made it neces-

sary to run out two shore lines, the outer or brush and marsh line and the actual water line which is often far back in the timber, the region being densely wooded.

The reconnoissance for triangulation was extended through Rainy Lake and Lake Namakan, a distance of 60 miles along the boundary, but bad weather compelled the party to leave the field before the last two towers on Lake Namakan could be constructed. The observing was completed for 30 miles. Twenty-four triangles were closed with an average closure error of 4.8 seconds.

Work was closed for the season at the end of October.

The party engaged in the survey of the international boundary line through Rainy Lake eastward from Brule Narrows and through Rainy River westward from International Falls resumed work in May, 1914. The operation of the party included also the erection of observing tripods in the scheme of triangulation laid out during the previous season to the head of Lake Namakan, with the necessary topography, establishment of boundary reference marks, and the necessary triangulation for determining the position of the reference marks.

Arrangements had been made in the latter part of April for putting the motor launches and boats used in this work in condition for service.

On May 3 a level line was run from the Canadian geodetic bench mark at Sprague to a temporary bench mark of the United States and Canada boundary survey at Sprague's lumber camp, in order to check the levels along the boundary line from Red River to the Lake of the Woods.

The completion of the topographic work in Black Bay was next taken up.

Subparties for the triangulation, signal building, topography, and location of reference marks were organized during the latter part of May.

The elevations used in the topography of Rainy Lake were taken directly from the water surface, the elevation of which was read each day on a water gauge. The zero of this gauge was determined from bench marks established on the lake during the winter of 1912-13. From May 18 to June 30 the elevation of the water of the lake increased from 1,105.3 to 1,108.1 feet.

Two members of the Canadian party at work on Lake Namakan visited the American party on Rainy Lake from June 6 to 12, inclusive, to examine the methods used in the topographic work.

I. R. Pounder, representing the Canadian commissioner, was attached to the triangulation party on Rainy Lake from June 2 and rendered valuable assistance in the subsidiary triangulation.

An azimuth was observed on the terminal line of the triangulation of Lake Namakan. Time was obtained by transportation of chronometers.

The topographic map of Rainy Lake was completed from Brule Narrows to Deers Horn Point, a distance of 7 miles along the boundary, on a scale of 1:20,000, with 10-foot contours.

The topographic map of Rainy River, on the same scale, was completed from International Falls to the mouth of Little Fork, a distance of 14 miles.

Work was in progress at the close of the fiscal year.

[W. B. FAIRFIELD.]

SUMMARY OF RESULTS.—Reconnaissance: 97 points selected for scheme. Base lines: Tertiary, 1, 1,117 meters in length. Triangulation: 17.2 square miles of area covered, 103 signal poles erected, 97 stations in main scheme occupied for horizontal measures, 73 stations occupied for vertical measures, 94 geographic positions determined, 93 elevations determined trigonometrically. Leveling: 5 miles of levels run. Azimuth: 3 azimuth stations occupied. Topography: 114 square miles of area surveyed, 337 miles of shore line of lakes and rivers run, 12 topographic sheets finished. Distance along boundary 28 miles.

Work on the survey of the portion of the international boundary line from the mouth of Pigeon River to the Lake of the Woods was begun on May 22.

The reconnaissance was extended from the line Faith-Enough of the previous season's work, just below Knife Lake Dam, to the westward covering Birch Lake. Field work was carried on continuously and as rapidly as the weather conditions would permit up to November 20, on which day the party was disbanded at Winton, Minn.

During the season between May 13 and November 4 rain fell on 57 days which kept the water in the lakes at a fair stage and prevented forest fires.

The triangulation was taken up at Knife Dam at the west end of Knife Lake, starting from the line Faith-Enough and was extended to the westward, covering Carp, Birch, and Basswood Lakes and the river below to the east end of Crooked Lake.

The topography consisting of the shore line of all the lakes, islands, rivers, and connecting streams, together with the topography of all the portages along the line, was carried along at the same time with the triangulation. The scale was 1:20,000, but all of the narrow places, rivers, small lakes, connecting streams, and portages were on a scale of 1:5,000. In all of the topography done this season 20-foot contours were run. Cache Bay, entirely in Canada and some distance from the line, had not been surveyed during the previous season, but later the shore line of this lake was run in.

The shore line of Basswood Lake was completed, including the large bays Bayley, Merriam, and North in Canada, and Wind, Hoist, and Jackfish, in Minnesota. The last extends south into Minnesota for 10 miles below the boundary and contains numerous islands.

Double zenith distances were observed at enough triangulation stations to give the elevations of nearly all stations determined.

Levels were run over the portages between Carp and Birch Lakes, Birch and Basswood, and Basswood and Fall Lakes, the last over the $4\frac{1}{2}$ mile portage from Hoist camp to Fall Lake on the railroad of the St. Croix Lumber Co.

The difference in elevation of Fall Lake and two of the bench marks of the Duluth and Iron Range Railway at Winton was also determined by leveling.

Observations for azimuth were made on two nights at each of three triangulation stations—Garb, Gyp, and Hoist.

A base line 1,117 meters in length was measured in November near Hoist Portage, between the triangulation stations Hoist and North Base. The measurement was made on the ice with an invar tape.

The triangulation stations were permanently marked with brass plates or drill holes in the rocks.

During the greater part of the season canoes were used for the transportation of the party and equipment. A motor boat was used on two occasions in moving camp, and the final move in November from Hoist Portage to Winton was made by team.

A number of soundings were made in Basswood Lake along the general position of the line as shown on the old map, the deepest was 77 feet, found in the upper part of the straight north stretch, east of United States Point. The next deepest part was at the eastern end of the lake along the line south of Bayley Bay, where the average depth was about 60 feet just west of triangulation station Had. Up to and around the turn to the north stretch the average depth is about 30 feet.

The field report of this work contains a description of the region adjacent to the boundary, the lakes, rivers, islands, rapids, falls, dams, portages, and other natural and artificial features.

Work was resumed in May on the survey of this section of the boundary beginning at Birchwood Lake, the work being extended to the westward from the work of 1913. By June 30th eight new stations had been located in the triangulation scheme, the necessary signals erected and lines cut to all other stations. Six stations had been occupied and the work was being extended toward Crooked Lake.

[J. B. BAYLOB.]

SUMMARY OF RESULTS.—Boundary measurement: 35 miles, 2,545 feet of boundary measured twice with invar tapes, 20 miles of vista 30 feet wide cut through the forest. Triangulation: 2,338 feet of boundary triangulated, 6 stations occupied for horizontal measures. Leveling: 35 miles, 4,833 feet of levels run. Azimuth work: 13 azimuth stations occupied. Topography: 42.5 square miles of area covered. These statistics include work done in the spring of 1913.

Field work was resumed in May, 1913, on the Maine-Quebec boundary by the American and Canadian parties. The American party began work from the termination of the work of the previous season, west of St. Pamphile, Quebec, while the Canadian party took up the survey of the southwest branch of the St. John River, where this branch forms the international boundary line near St. Sabine, Quebec. The Canadian party undertook to continue the monumenting of the international boundary where their work of the previous season had closed, a short distance east of St. Pamphile. The American party undertook to open up and clear a 30-foot lane through the forest along the boundary from a point just west of English Lake to the point on the southwest branch of the St. John River where this branch becomes the international boundary. Work was begun on May 23 and was continued until the international boundary line was opened up, surveyed, and monumented to the southwest branch of the St. John River, connecting with the work of the Canadian party at this point. This vista-cutting party closed work on September 6 and the surveying party on September 10 excepting the measurement of some horizontal angles required west of St. Pamphile, which was completed by September 25.

During the season 35 miles, 2,545 feet, of boundary line were twice measured with invar tapes in opposite directions. The end stakes were braced in four directions owing to the marshy nature of the ground. A double line of levels was run over the tops of these stakes.

Two thousand three hundred and thirty-eight feet of boundary line were triangulated, across water areas, on the boundary line. Three invar tapes were supplied to the party, of which two were used for measuring and one was kept as a standard. Comparisons were made with the standard for about every 5 miles of the boundary. The spring balance used for measuring was compared with a spare balance kept for that purpose, before and after use, and the balance was tested while in use whenever it was thought desirable to do so.

Angles were observed for azimuth at the summits of convenient hills or ridges, pointings being made upon tripod signals upon the next hills north and south of the point occupied. Angles were measured for azimuth at 13 triangulation stations, and 6 stations were occupied in triangulation across the North West Branch.

The Canadian Government is connecting in their scheme of triangulation along the St. Lawrence Valley and around the dense forests the extreme ends of the straight lines which have been measured through the forest for about 80 miles, with invar tapes and horizontal deflection angles, by the American and Canadian parties. This triangulation, when completed, will furnish a check on the tape measurements.

A topographic survey on a scale of 1:20,000 was made of the territory immediately adjacent to the boundary.

Ten cement and 59 cast-iron monuments of the commission of 1842 were reset by the Canadian party along a portion of the international boundary line surveyed by the American party.

About 20 miles of 30-foot lane along the boundary was opened up through the forest by the American party. All trees were cut close to the ground and removed from the lane.

[JOHN E. McGRATH.]

SUMMARY OF RESULTS.—Reconnaissance: Length of scheme 13 statute miles, 15 square miles of area covered, 201 lines of intervisibility determined, 60 points selected for scheme. Base lines: 1, secondary, 612.7 meters in length. Triangulation: 15 square miles of area covered, 35 signal poles erected, 37 stations in main scheme occupied for horizontal measures, 8 stations in supplemental schemes occupied for horizontal measures, 74 geographic positions determined, 41 elevations determined trigonometrically. Topography: 3½ square miles of area surveyed, 14 miles of shore line of rivers surveyed, 1 mile of shore line of creeks surveyed, 1 topographic sheet finished.

Work was begun in June at Calais, Me., where it was intended to make arrangements with the mill operators to permit such a flow of the water impounded by dams at Woodland and Calais as would enable the commissioners to obtain conditions favorable for studying the channel surroundings about the islands between Milltown, Me., and Milltown, New Brunswick, during the period for the annual shutdown, which occurs about July 4. Owing to the unusually high stage of the river it was found however that the desired condition of the river bed could not be expected during that season.

A topographic survey on a scale of 1:10,000 was made of the valley of the St. Croix River extending from the vicinity of the large iron monument at the head of the river to station Avernus at the northern end of the survey executed by this party in the field season of 1912. This survey was controlled by the turning points in the traverse

survey executed by a Canadian party in 1912. The survey was made in such detail as to include all characteristic features of the stream necessary for definitely locating the boundary, and reference marks were placed in all localities where necessary. In addition to the survey of Monument Brook, the valley of Clendenning Brook, the principal affluent of Monument Brook, is shown for a distance of about a mile above the junction of the two streams.

The section through which the work was carried is an unbroken wilderness except for a few lumbering trails long since disused.

The permanent station marks now in position between the original iron monument at the head of the river and station Avernus are 16 in number. Eight of these are brass boundary marks set in bowlders, and 8 are granite posts 3 feet in length and 8 by 8 inches square, set in concrete. The iron monument which was originally erected at the head of the St. Croix River by the commissioners appointed under the provisions of the Treaty of Washington, 1842, and which was readjusted in position and strengthened and improved by a solid and substantial concrete base in 1908, was found to be in excellent condition. A small amount of triangulation was executed for the purpose of redetermining the geographic position of this monument.

On the completion of this work the party was transferred to Eastport, Me., to locate and establish range marks in the sections of the international boundary included between the center of Grand Manan channel and the mouth of the St. Croix River. The work to be done was divided between the American party and a Canadian party. In the section assigned to the American party from Grand Manan channel to a line joining Buckman Head and Friars Head, were seven links of the boundary line beginning with boundary point No. 7 and ending with boundary point No. 14.

The work included the determination by triangulation of a large number of points which would be useful to navigators, surveyors, public officers, or others interested in ascertaining the location of the boundary. The position of at least one point on each range line was determined and marked. On four sections of the line, because of local obstructions, but one range on shore (for each) was marked, but by placing can buoys, which can be readily done, at two of the turning points of the line, the number of sections not marked by ranges will be reduced to one, and each end of this last section is on the intersection of marked cross ranges.

The range points were marked with stone cairns set in cement with the exception of three, viz, the range mark on the Lubec breakwater; the front range mark on the range line Boundary Point No. 12, Front Range, Duck triangulation station, and the range mark on prolongation of the sections Boundary Point No. 13, Boundary Point No. 12. These three points are marked by round iron rods to which vanes have been riveted. Two of the rods are set in holes drilled in rocks and the third is set in a bed of concrete.

Most of the range marks established by Commissioners Mendenhall and King were found to have been destroyed.

Field work closed on October 28.

ALASKA BOUNDARY.

[THOMAS RIGGS, JR.]

SUMMARY OF RESULTS.—Boundary work: 210 miles of boundary covered, 35 stations occupied, 3 monuments repaired, 84 monuments inspected and numbered, 8 new monuments interpolated. Triangulation: 7 stations occupied for horizontal measures, 7 stations occupied for vertical measures, 22 monuments occupied for horizontal measures, 28 monuments occupied for vertical measures.

The operations of this party during the field season of 1913 included the inspection and numbering of the monuments between the Yukon River and Mount Natazhat; the strengthening of the positions of various monuments, and the interpolation of monuments in stretches where the distances between the existing monuments seemed too great. This work was done by a joint American and Canadian party, the British surveyor being J. D. Craig.

The party arrived at the boundary crossing of the Yukon River on June 27. Work was begun with the occupation of monument No. 111 on the north bank of the Yukon River. Until July 15 progress was much delayed by the smoky condition of the atmosphere. Heavy rains then put out most of the forest fires and laid the smoke. By that time about 40 miles of line had been gone over to Poker Creek, a tributary of Walkers Fork of Forty-Mile River and 6 monuments had been interpolated. On the 18th of July camp was moved to Sixty-Mile River. Here the pack train was divided, part going back to Glacier Creek for the remainder of the supplies which had been freighted by wagon to that point. The remaining horses freighted a full load across the high divide to the south, into the head of the North Fork of the Ladue River. Grain caches had been established during the winter on the Ladue and at Canyon City on the White River, so that it was now possible to transport almost everything without relaying except during the first week after leaving Sixty-Mile River.

While in camp on the Ladue River the first news was received of the new Chisana gold strike. Two prospectors had taken out 200 ounces of dust in a few hours on Cathenda or Johnson Creek, which is a tributary of the Chisana or Shushanna River. The result was a rush of prospectors to that region, many of them inadequately equipped. Frequent appeals for food and other necessaries were made to the boundary party, and two men who had lost their way on the Jenerk and were in a starving condition were rescued by the Canadian surveyors. Many of the prospectors used the vista cut along the boundary as a trail.

From Ladue River to Scottie Creek the party traveled almost continuously through a region which had been burned over subsequent to the survey of the line. Where in previous years barely enough grass had been found to keep the horses from starving, now the hills and valleys were covered with a luxuriant growth of grass, frequently reaching as high as a horse's back.

Snag River was crossed on August 8 and the valley of the Beaver was ascended. Here much damage had been done to the trail by recent floods. Near the mouth of Baultoff Creek there was a delay of two days before the Beaver could be crossed and the monuments on the east side inspected and numbered.

On August 17 the White River was crossed and on August 19 the party moved to the head of Kletsan Creek.

On August 21 the last monument on this stretch of the work was set and numbered. This is No. 187A, which is on the last ridge of Mount Natazhat to the north crossed by the boundary. The higher ridge on which point Z of the boundary is located was so deeply covered with snow as to make the setting of a monument impracticable. The party moved back to the White River on the same day, and on August 22 concluded the field work by repairing the large monument No. 182 on the north bank of the White River. This monument had been set on frozen ground the thawing of which had partly overturned the monument.

Floods in the White River on August 23 made the return crossing dangerous, the water reaching the backs of the horses and the current being very rapid. The same night the water made a further rise of 8 feet, owing to the overflow of a lake in the Russell Glacier.

Information was received from Mr. Lambart, one of the Canadian surveyors, that all of the field work south of Mount Natazhat and as far as Mount Constantine ridge had been completed. The triangulation had been extended for two quadrilaterals beyond Mount Natazhat and the necessary data had been obtained for the plotting of phototopography. This work when finished will connect with that of the American party to the south under D. W. Eaton. After repeated attempts an ascent had been made of Mount Natazhat. Unfortunately no observations were obtained as a storm arose shortly after the summit was reached.

With the object of visiting the parties of D. W. Eaton and Asa C. Baldwin who had been surveying between the Chitina River and Mount St. Elias, Scolai Pass was crossed on August 25, but information was then received that these parties had been withdrawn and disbanded.

The trail over Scolai Pass is on the route from McCarthy, at the end of the Copper River and Northwestern Railway, to the Chisana country. The trail was thronged with prospectors, many ill-supplied with provisions and other necessaries and inexperienced in camping and mountain travel. Four men had been drowned in the Nizina and Chitistone rivers. The trail was found to be dangerous in places but no more so than others encountered along the boundary.

The party left McCarthy on August 31, arriving at Cordova the same day.

The time spent in the field was 65 days, during which time 210 miles of boundary were covered, 35 stations occupied, 3 monuments repaired, 84 monuments inspected and numbered, 8 new monuments interpolated, and 9 stations occupied for magnetic declination.

The general condition of the monuments was found to be most satisfactory. A few had slipped slightly but not enough to get out of the allowable error 1 foot from the straight line between main-line points. The settings were in excellent condition and can not be moved by any ordinary means. The base of the small cone weighs about 1,500 pounds while the base of the large monument will weigh nearly twice this amount. As it now stands every monument between the Arctic coast and Mount St. Elias has a well-determined geodetic position and an elevation trigonometrically computed which

is sufficiently accurate for any engineering purpose. The numbers drilled into the metal of the monuments will positively identify them for use in connection with any future surveys, governmental or private, that may be connected with them.

The triangulation done during the season was merely to tie in the new monuments interpolated with the main scheme and to strengthen the connections at some of the existing monuments.

The party left Cordova on September 5 and arrived at Seattle on the 11th.

[D. W. EATON.]

SUMMARY OF RESULTS.—Topography: 305 square miles of area surveyed (with plane table), 600 square miles of area surveyed (by phototopographic method), 6 plane-table sheets finished.

During the season of 1913 the topography of the Chitina Valley and along the one hundred and forty-first meridian between Mount Natazhat and Mount St. Elias was completed excepting the portion from the summit between Mount Anderson and Mount Natazhat to Mount Natazhat.

The party arrived at Cordova, Alaska, on March 7, and at McCarthy on the 11, where preparations were immediately made for forwarding freight to the first camp. Field work was begun on April 25. A subparty consisting of C. V. Guerin, a cook, and two men was detailed to complete the plane-table work along the boundary across, and on either side of the Logan Glacier, and as far toward Mount St. Elias as possible. The plane-table work had been carried during the previous season as far toward Mount Natazhat as it was practicable to go. L. L. Summerlin was equipped with a phototopographic camera and detailed to accompany the party of Asa C. Baldwin to the snow fields toward Mount St. Elias. In the latter part of May D. W. Eaton began phototopographic work around the edges of the plane-table sheet worked upon by Mr. Guerin during the previous season, and extended the survey toward Mount Natazhat to connect if possible with the work of a Canadian party working in the vicinity of that mountain. He was assisted by two men. The trails that had been built along the rock slides on the sides of the mountains during the previous season had to be partly rebuilt, and it took the party until June 10 to reach the point where the Anderson Glacier enters into the Chitina Glacier. From this point the glacier could be traversed and was used as a highway until finally it also became impracticable.

The photographic work was carried up the glacier toward Mount Natazhat until further progress was prevented by the crevassed and broken condition of the glacier and the precipitous sides of the mountain. A return was then made to the foot of the glacier which was reached on July 8.

On the 11th arrangements were made for taking out the party and outfit. Mr. Guerin and Mr. Summerlin were then in the vicinity of the Logan Glacier, and reported that they would not be ready to leave for two weeks. On July 15 the journey was begun to McCarthy, distant about 100 miles, over a difficult trail. McCarthy was reached on the evening of July 25, and on the 31st the pack train was sent back for Mr. Baldwin's party and the remainder of the other

party. These arriving on August 25, the instruments and equipment worth preserving were shipped by freight to Seattle and the remainder sold, and shortly afterward both parties returned to Seattle.

During the season of 1912 a plane-table triangulation had been carried up the Anderson Glacier and a plane-table sheet completed of the glacier and of the adjacent mountain sides. In 1913 triangulation with the small phototheodolite was carried up this valley as far as Mount Anderson for the control of the phototopographic work. An attempt was made to photograph the country not already included in the plane-table work so as to extend these sheets northward toward Mount Natazhat. As further progress up the Anderson Glacier was impracticable, it was necessary to ascend peaks farther to the south and the view from these toward Mount Natazhat was cut off by an intervening ridge.

The upper Chitina Glacier was too much broken to use as a highway, and a trail had to be made along the mountain side to reach the boundary line. It was found impracticable to get to the southern side of this glacier. A station was occupied about half a mile below the boundary on the northern margin of this glacier.

Of the Logan Glacier and on Boundary Ridge along and in the vicinity of the one hundred and forty-first meridian a plane-table sheet was made on a scale of 1:45,000. This sheet was extended in the direction of the upper end of Logan Glacier as far as the control from the triangulation stations would permit. It was not found practicable to extend the plane-table work for any great distance north and south. The area between the plane-table sheets and Mount St. Elias was covered by phototopographic work done in cooperation with a Canadian party, and depending on the triangulation toward Mount St. Elias.

Results obtained with the plane table and camera will be plotted from Mount St. Elias northward to latitude 61 degrees 15 minutes north, or to the summit between Mount Anderson and Mount Natazhat.

[ASA C. BALDWIN.]

SUMMARY OF RESULTS.—Triangulation: 200 square miles of area covered. Length of triangulation along axis of main scheme, 35 miles, 1 base line measured, 22 signals built, 24 stations occupied for horizontal and vertical measures, 3 camera stations occupied, 30 secondary points determined. Azimuth: 1 azimuth measured. Monuments: 3 monuments set.

During the field season of 1912 the triangulation of the region north of Mount St. Elias had been extended from the head of White River to the Chitina River. Instructions for the season of 1913 directed that the triangulation should be carried from the Chitina River to the one hundred and forty-first meridian, and that a base should be measured at some point as near the boundary as possible and connected with the triangulation.

It was arranged that a representative of the British commissioner should cooperate with the American party in the location of such monuments as should be established on the boundary. It was directed that upon the establishment of a point on the boundary a meridian should be determined by the azimuth carried forward through the triangulation, and also that the astronomic azimuth of some line of the triangulation near the boundary should be deter-

mined as a check upon any large error that might occur in the triangulation or computations. It was also planned that Mount St. Elias should be connected by triangulation with the boundary as located, and that if practicable an ascent should be made of Mount St. Elias from the north for the purpose of laying off topographically a suitable course for the boundary line from the summit to its intersection with the one hundred and forty-first meridian.

Field work was begun on April 24. The triangulation was taken up where it ended in 1912 in the Chitina Valley about 30 miles west of the one hundred and forty-first meridian, and was extended up the river to and across the Chitina Glacier and up the Logan Glacier as far as the boundary line.

A base line 1,799.3852 meters in length was measured on the gravel bar near the foot of the Chitina Glacier, and the triangulation was connected with it.

The azimuth of the line Terminus to Finis was determined, and observations were also made for astronomic azimuth. In establishing the one hundred and forty-first meridian the azimuth carried through the triangulation was used, not the astronomic azimuth.

Three 30-inch cone-shaped monuments were set during the season. No. 189 is located at an elevation of 8,900 feet on the mountain between the Logan and Walsh Glaciers; No. 190 on the north side of the Logan Glacier and about 1,000 feet above it; and No. 191, the last and most southerly permanent mark on the one hundred and forty-first meridian, is on the south side of the Logan Glacier. Nos. 189 and 191 were well set in protected positions. No. 190 could not be satisfactorily set on account of the steepness of the slopes and the crumbly character of the rock. No other sites than the above could be located.

Three stations near Mount St. Elias were occupied with the phototopographic camera.

Mount St. Elias was connected with the triangulation. As compared with former determinations from the coast, there was a difference of 7.29 seconds in latitude and 2.21 seconds in longitude, and the computed elevation of the mountain was 18,008 feet, or 16 feet lower than the previous determination of 18,024 feet.

The party crossed the snow fields north of Mount St. Elias and reached an elevation of 16,400 feet on the shoulder of that mountain. The further ascent of the mountain offered no difficulty, and would in all probability have been accomplished but for a storm which lasted three days and made further progress impracticable.

From the valley of the Chitina Mount Logan appeared as a massive mountain with three domes. These domes were several miles broad, and no definite point could be sighted from the triangulation station. The observed elevation of this mountain was more than 1,000 feet less than that determined from the coast. It is probable, however, that the summit was not visible from the position occupied.

A few miles west of Mount Logan is a high isolated peak which was first discovered by the survey party in 1912. At the suggestion of the United States commissioner this mountain was called Mount King, in honor of the British commissioner, Dr. W. F. King.

Expedition to Mount St. Elias.—Mount St. Elias was discovered and named July 20, 1741, by Vitus Bering, a Russian navigator.

Its geographical position and elevation have been determined on various occasions with more or less accuracy, but the ascent to the summit has been made but once, by the party of the Duke D'Abruzzi in 1897.

Over the region to the northward of this mountain passes the one hundred and forty-first meridian from Mount Natazhat. It strikes the St. Elias range west of the summit. According to the treaty the line from the summit to the one hundred and forty-first meridian shall be parallel to the coast line. It was for the purpose of determining the topography of the St. Elias range so that this line could be laid off topographically that the survey party entered the St. Elias region.

The party consisted of the American surveyor and four men and the Canadian surveyor with one man, making a total of seven. Four additional men accompanied the party to the first divide, and then returned to the vicinity of the Logan Glacier, two of them to build the remainder of the triangulation signals and place the monuments, cement, and sand at the monument sites. The other two men also turned back after reaching the first divide, having occupied camera stations on the way.

The equipment and instruments were selected to meet the conditions of glacier travel and were of the least possible weight. Provisions for one month were carried. For transportation two 7-foot Yukon sleds, drawn by the men, were used. An average load of 100 pounds to the man was carried on the sleds.

On June 14 the summit of the intervening ridge, a 10,000-foot peak, was reached, from which Mount St. Elias could be plainly distinguished towering nearly 11,000 feet above the level of a valley to the southwestward.

The original plan had been to ascend the mountain from the northeast, but upon examination the route from the westward was found to be the shortest and only slightly steeper than that from the north, and it was therefore adopted. On June 17 the summit of the divide between the Logan and Columbus glaciers was crossed at an elevation of 9,000 feet, and a descent was made into the snow fields north of St. Elias. By June 22 the base of Mount St. Elias was reached, and the weather, which had previously been clear, became less favorable and a thick fog settled over the peaks. Camp was now at an elevation of 7,500 feet. The west face of Mount St. Elias proving impracticable, an examination was made on June 23 of a steep glacier that led to a saddle 12,000 feet high. From this saddle a south slope was discovered by which the ascent to the high shoulder appeared practicable. On June 28 camp was pitched at an elevation of 13,500 feet. From this camp looking to the southward could be seen the great Malaspina Glacier and beyond it the Pacific.

To the northeastward the west shoulder of Mount St. Elias rose abruptly for 3,000 feet, while a short distance to the westward stood the terminal cone of Mount St. Elias, 1,000 feet higher and distant 3 miles.

The final ascent was begun at midnight on June 29. Snow begun to fall almost immediately, and it was midnight of the next day

before the sky cleared. The ascent was begun at about 1 a. m. on June 30, each man carrying a pack weighing about 20 pounds, consisting of the instruments, food, and necessary clothing.

After nine hours of difficult climbing, and when within a few hundred feet of the top of the west shoulder, from which to the summit of the mountain was a gradual slope presenting no obstacles, a heavy storm set in which would have prevented instrumental work even if the summit had been reached, and very reluctantly the party turned back when at an elevation of a little over 16,000 feet. Camp was reached on the return at 5 o'clock in the afternoon, and as the provisions were becoming low, three men were sent back to the base camp. On July 3 snow was still falling and the provisions were almost exhausted and all idea of a further ascent of the mountain was abandoned. About 3 a. m. the clouds lifted sufficiently to permit the occupation of a camera station, after which preparations were made for the return journey.

In going down it was found necessary to jump over a deep crevasse 8 feet in width. On July 4 the return was continued from the base camp toward the timber line and the main cache. A thick fog was hanging over the snow fields on July 5, but it was necessary to continue. On the fourth day the Logan Glacier was reached, and a wood fire was made for the first time in 30 days. On that evening some of the party started for the main camp across the Logan Glacier and the remainder followed the next day.

The return journey to the coast was made without special incident, and after attending to necessary details and making proper disposition of the instruments and equipment the party sailed from Cordova, Alaska, for Seattle, Wash., on September 28, arriving at the latter place on October 3.

[FREMONT MORSE.]

In April an officer of the Coast and Geodetic Survey was instructed to join the Canadian party under N. J. Ogilvie to act as a representative of the United States commissioner in the marking of the boundary in Portland Canal and Dixon Entrance.

Field work was begun in May in the vicinity of Wales Island and from a camp in Sitklan Island.

The plan of operations for the season included first, the continuation of the triangulation down Pearse Canal from the termination of the work of the previous season to a junction with the Coast and Geodetic Survey triangulation at the east end of Dixon Entrance; second, a primary scheme of triangulation through Dixon Entrance to Cape Muzon and North Island; third, the reoccupation for phototopography of some of the stations of the preceding year, at which the photographs taken were not successful; fourth, a visit to the site of Monument D on the ridge between the Bear River and Salmon River valleys, to see if the monument was still in position; fifth, a test of the alignment of the first monument up the ridge between Eagle Point Monument and Monument D; and, sixth, the establishment of a monument on the boundary line on the south bank of the Stikine River.

At the close of the season's work of 1912 the triangulation of Pearse Canal had terminated at the quadrilateral Twenty-Eight, Twenty-Nine, Thirty, and Thirty-One. The first two of these sta-

tions had been occupied and on the others signals had been erected and observed upon.

For carrying the work to a connection with the Coast and Geodetic Survey triangulation a new station, Mount Des Brisay, on Wales Island, was taken into the scheme to form a quadrilateral with Twenty-Eight, Thirty, and Thirty-One. Through a chain of four quadrilaterals a connection was made with the old Coast and Geodetic Survey stations Boston, Garnet, and Whitley. From the stations of this triangulation, together with one or two subsidiary stations, reference marks were located at U. S. 5, C. 5, U. S. 4, C. 4, U. S. 3, C. 3, U. S. 1 and 2, C. 2 and C. 1. These names indicate the approximate location of the monuments. Monuments of concrete identical in size and shape with those placed during the season of 1912 were established at the above-named points.

For the primary triangulation of Dixon Entrance an observing party was sent to Cape Muzon to begin work near the ocean and proceed to the eastward. The weather was extremely unfavorable for observing and during the season from May to September only two stations were completed, Cape Muzon and North Island. The observations at Cape Chacon were partly completed when there occurred on the night of Sept. 7-8 an unfortunate accident which resulted in the death of two signal men at the Cape Muzon station. A heavy storm and rainfall came on at night and an immense land slide overwhelmed and buried the camp in which the men were located.

In June a joint examination by the American and the Canadian officers was made of the islets off Cape Muzon and the passages between them for the purpose of securing data from which the commissioners could decide on the location for the initial monument "A" of the boundary. Sounding and photographs were obtained and a joint report was submitted.

Photographs were taken at the stations on the canal at which the pictures taken the year before had proved unsatisfactory.

Monument "D" was visited and found to be undisturbed. Photographs were taken of it from different viewpoints.

The alignment of the first monument up the ridge between Eagle Point Monument and Monument D was tested and found to be correct.

A monument was set on the south bank of the Stikine River, a short distance from the shore in line with two monuments on the opposite shore established by the American surveyor in 1904.

Work was closed for the season on September 26.

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 most important work completed or in progress in the computing division during the fiscal year is as follows:

The preparation for publication of the results of the fourth general adjustment of the precise level net of the United States; the

preparation for publication of the results of the one hundred and fourth meridian and thirty-ninth parallel triangulations; the preparation for publication of the results of a line of levels between San Francisco and Brigham, Utah; proof reading of special publications Nos. 16, 17, and 18; the computation and adjustment of the triangulation on the one hundred and fourth meridian and that part of the thirty-ninth parallel in Colorado, Utah, and Nevada; the computation and adjustment of triangulation on the coast of North Carolina and in Pamlico and Albemarle Sounds; the computation and adjustment of the primary triangulation which extends from Alice, Tex., southward to the Rio Grande; the computation and adjustment of the triangulation on the one hundred and forty-first meridian boundary of Alaska; the computation and adjustment of the triangulation on the international boundary along the forty-ninth parallel between the summit of the Rocky Mountains and Lake of the Woods; the computation and adjustment of the triangulation on the water boundary between the United States and Canada to the eastward of the Lake of the Woods; the computations and adjustment of the observations made for the determination of the astronomic latitude at a number of points on the one hundred and fourth meridian.

The completion of the triangulation extending to the Canadian boundary along the one hundred and fourth meridian made it possible to place the geographic positions of the triangulation stations along the forty-ninth parallel, which control the boundary surveys, on the North American datum.

A number of other pieces of work were completed or in progress during the year.

The use of the photostat was continued for copying information from the files for the use of field parties of the Survey, other bureaus and departments, private individuals, and corporations. The amount of photostat work was very much greater than for any previous year. The use of the photostat has saved much clerical work, besides the advantage of greater rapidity and absolute accuracy.

Three publications giving results of triangulation and leveling were received from the printer during the year. These are listed under the head of "Publications," in another part of this report. Manuscript has been prepared for two other publications, one giving triangulation results and the other the results of precise leveling.

DIVISION OF TERRESTRIAL MAGNETISM.

The chief of this division prepared programmes and instructions for all magnetic work and attended to the correspondence of the division. He reviewed the estimates for magnetic work and directed the preparation of the results for publication. He also at times acted as assistant in charge of the office and as inspector of hydrography and topography during temporary absences of those officers.

The statistics of correspondence during the year show that the demand for information, especially concerning magnetic declination, was greater than for any previous year except 1912.

The revision of field observations on land and sea was kept up to date, including the field work in the Philippines, Hawaii, and Alaska.

The results of field observations on land and sea in the United States and outlying territories for the calendar year 1913 were prepared for publication as Special Publication No. 20. In this publication, as with the preceding one, the method of publishing the field results by the calendar year instead of the fiscal year has been followed advantageously.

Manuscripts were prepared and submitted for publication of observatory results at Honolulu, Hawaii; Sitka, Alaska; Vieques, P. R.; and Tucson, Ariz., and proof was read of four publications.

Magnetic information was furnished to Dr. van Everdingen, De Bilt, Netherlands, in accordance with a request from the International Commission for Terrestrial Magnetism, and to Dr. G. Angenheister, of Gottingen, Germany.

Copies of the tabulation of earthquakes recorded at the five magnetic observatories of the Survey were furnished for the use of the International Seismological Association, and to the Dominion Observatory, Ottawa, Canada. A copy of the Honolulu register was sent to the secretary of the seismological committee of the British Association.

Material was collected, tabulated and reduced for an isogonic chart of the West Indies, and the chart was prepared and published.

The work of tabulating the magnetic results has been much facilitated by the introduction of a specially constructed motor-driven adding machine, which not only performs the required summations but also, by an automatic change, enables figures to be printed on the tabulation sheets that heretofore required to be typewritten.

With a view to making special magnetic observations at the time of the solar eclipse of August 21, 1914, the times of beginning and ending of the eclipse were computed for Cheltenham, Md., and Bangor, Me.

The reduction of observations at the magnetic observatories was continued.

Quarterly reports of magnetic storms were supplied to the Journal of Terrestrial Magnetism for publication.

TIDAL DIVISION.

The work of the tidal division during the year includes the preparation for annual publication of the general tide tables, with separate reprints of the portions relating to the Atlantic and Pacific coasts, the preparation of information relating to the time and height of tides, in reply to a large number of requests from field offices of the Survey, other officers of the Government, and from individuals; the preparation of descriptions of bench marks, furnishing data for planes of reference, tide reducers and reduced soundings, and tide notes for charts and original sheets. Harmonic analyses were completed for two stations, for one year each, and summations were made for an analysis of two other stations. Nonharmonic reductions were made for 135 stations, with a combined length of 39 years and 5 months; mean sea level was computed for 56 stations, with a combined length of 18 years and 6 months; tabulations of high and low waters and hourly heights of the sea were made for 278 stations, with a combined length of 47 years, 10 months, and 13

days; monthly means and extremes were tabulated for 19 stations, with a combined length of 63 years and 6 months; 344 volumes of soundings, involving the computation of the plane of reference for 120 stations were reduced, and the many thousand of tide reducers were entered; and the registering, indexing, and filing of tidal records, tabulations, and reductions, and the necessary correspondence were attended to.

Additional observations of tides have been received from the Corps of Engineers, United States Army, the Hawaiian government survey, and from the Government of Cuba.

Tidal information was exchanged with the Imperial Hydrographic Office at Wilhelmshaven, Germany, and at the request of the Government of Western Australia copies of tidal predictions were furnished for Fremantle, Australia, for the year 1914.

TIDE STATIONS IN THE UNITED STATES AND INSULAR POSSESSIONS, ALASKA, CANAL ZONE, MEXICO, AND WEST INDIES FOR WHICH THE COAST AND GEODETIC SURVEY HAS ONE YEAR OR MORE OF CONTINUOUS RECORD.

	Years.		Years.
Eastport, Me.....	2	Key West, Fla.....	* 1
Portland, Me.....	* 2	Tortugas, Fla.....	2
Pulpit Harbor, Me.....	3	Charlotte Harbor, Fla.....	1
Boston, Mass.....	* 3	Egmont Keys, Fla.....	1
Newport, R. I.....	* 1	Cedar Keys, Fla.....	1
Bristol, R. I.....	1	St. Marks, Fla.....	1
Providence, R. I.....	2	St. Vincent Island, Fla.....	1
Block Island, R. I.....	1	Pensacola, Fla.....	1
New London, Conn.....	* 1	Mobile Point, Ala.....	2
Willetts Point, N. Y.....	* 2	Biloxi, Miss.....	1
Fort Hamilton, N. Y.....	3	Cat Island, Miss.....	1
Governors Island, N. Y.....	* 3	Port Eads, La.....	1
Sandy Hook, N. J.....	* 3	Weeks Island, La.....	2
Atlantic City, N. J.....	1	Galveston, Tex.....	* 2
Reedy Island, Del.....	2	Fort Point, Tex.....	2
Philadelphia, Pa.....	* 3	Morgans Point, Tex.....	1
Fort Carroll, Md.....	2	Nassau, New Providence.....	1
Baltimore, Md.....	* 3	Havana, Cuba.....	1
Washington, D. C.....	* 3	Colon, Canal Zone.....	2
Colonial Beach, Va.....	2	Balboa, Canal Zone.....	2
Alexandria, Va.....	1	Naos Island, Canal Zone.....	2
Tappahannock, Va.....	1	San Diego, Cal.....	* 3
Old Point Comfort, Va.....	* 3	San Francisco, Cal.....	* 3
Richmond, Va.....	1	Sausalito, Cal.....	3
Wilmington, N. C.....	2	Astoria, Ore.....	* 3
North Island Light, Winyah Bay, S. C.....	2	Port Townsend, Wash.....	* 2
Fort Sumter, S. C.....	3	Bremerton, Wash.....	1
Charleston, S. C.....	* 3	Seattle, Wash.....	3
Port Royal, S. C.....	1	Juneau, Alaska.....	1
Tybee Island, Savannah Entrance, Ga.....	1	Skagway, Alaska.....	2
Fort Clinch, Fla.....	1	Sitka, Alaska.....	* 1
Fernandina, Fla.....	* 3	Kodiak, Alaska.....	* 2
Mayport, St. Johns River, Fla.....	2	Hilo, P. I.....	2
St. Augustine, Fla.....	1	Cebu, P. I.....	2
Cape Florida, Fla.....	1	Corregidor Island, P. I.....	1
Indian Key, Fla.....	1	Manila, P. I.....	* 3
		Grande Island, P. I.....	1
		Honolulu, Hawaii.....	* 3

* Daily predictions for port given in annual Tide Tables.

CHART CONSTRUCTION DIVISION.

The principal feature of the work of the year in the drawing section has been the increase in the quantity of original hydrographic work of a complex character to be plotted. The plotting of the wire-drag field sheets, on account of their intricacy, is particularly slow, and the hydrographic work of the past two seasons in Alaska has been of such a detailed character that progress in plotting was likewise slow.

To meet the demand for immediate results from late surveys in Alaska, preliminary charts have been prepared on vellum, printed by the Vandyke paper process, and the requisite number of copies issued to the inspector at Seattle for distribution.

In the engraving section, besides the new charts on scales of 1:400,000 and 1:200,000 which are being engraved, the 1:80,000 charts of the coast of Maine will be engraved. The greater number of ledges and details along this coast are best represented by the sharper prints from an engraved copper plate.

In order to make an advance both in quality of prints and in rapidity of printing, new offset presses are needed in the printing section.

The "direct process," by which a photoprint is made on a sensitized aluminum plate from the chart drawing, replacing the glass negatives and prints on transfer paper, promises to be the sole method employed in the future. To carry on this method conveniently a pneumatic printing frame should be provided, and to be independent of the sun an additional open arc electric lamp will be required.

The photograph section is in need of a new floor surface and ventilating fans in the bromide enlargement dark room.

The statistics for the year are as follows:

CHART PREPARATION.

Schemes approved for new charts.....	20
Approved schemes on hand, charts not started.....	4
Drawings for new charts finished.....	18
Drawings for new charts in hand.....	16
New drawings for new editions finished.....	7
Extensive corrections finished.....	87
Extensive corrections in hand.....	9
Chart drawings from Manila for new charts finished.....	8
Chart drawings from Manila for new editions finished.....	10
Various miscellaneous drawings and tracings.....	

ENGRAVING.

New plates for new charts finished.....	6
New plates for new charts in hand.....	7
New bassos for new editions finished.....	18
New bassos for new editions in hand.....	13
New bassos for reissues finished.....	16
New bassos for reissues in hand.....	15
New editions using current plate finished.....	14
New editions using current plate in hand.....	6
Extensive corrections applied to plates.....	239
Extensive corrections in hand.....	9
Miscellaneous plates engraved or corrected.....	11
Minor corrections applied to plates.....	1,198
Charts in engraving section, engraving not started.....	2

PRINTING.

New subjects' printed from aluminum plates.....	90
Reprints printed from aluminum plates.....	93
Reprints printed from stones.....	2
Total number of different lithograph charts printed.....	185
Different engraved charts printed.....	778
Miscellaneous lithographic publications.....	12
Copies of lithograph charts printed and delivered.....	62, 856
Copies of engraved charts printed and delivered.....	80, 812
Miscellaneous lithographic prints.....	30, 962
Total	174, 630
Lithographic impressions (all work).....	213, 573
Engraved impressions (all work).....	88, 107
Total	301, 680

ELECTROTYPING.

Altos completed.....	60
Bassos completed	45
Total	105
Number of pounds of copper deposited.....	3, 936

PHOTOGRAPHING.

Glass negatives made.....	1, 184
Paper negatives made.....	30
Velox prints made.....	1, 903
Vandyke prints made.....	244
Bromide prints made.....	317
Blue prints made.....	1, 937
Photostat prints made.....	11, 381
Lantern slides made.....	11
Matrices made.....	101
Prints mounted.....	19
Negatives developed.....	0
Photolithographic negatives, number of charts.....	52

CHART DIVISION.

The regular work of this division has been kept up during the year. Seven employees from other divisions have been detailed at different times during the year to aid in the work of the chart division, amounting in the aggregate to the services of two additional employees for the year. Without such aid the force attached to this division would be unable to keep the work up to date.

The total issue of charts for the year was 117,492, or a decrease of 26,202 from the previous year. The issue of Coast Pilots was 5,374 and of Tide Tables, Atlantic Coast, 2,150, Pacific Coast, 11,693, general, 1,388. The issue of the Tide Tables does not represent the demand, as, owing to the early exhaustion of the editions published, the office was unable to supply all orders during a portion of the year.

In addition to the Charts, Coast Pilots, and Tide Tables, the following publications were received during the year:

Index maps, Maryland oyster charts.....	216	Supplement to Coast Pilot, Part IV, for 1915.....	700
Isogonic Chart of West Indies..	226	Philippine Island maps.....	236

The following Coast Pilots were issued during the year :

Part I-II -----	272	California, Oregon, and Wash-	
Part III -----	369	ington -----	407
Part IV -----	573	Alaska -----	413
Part V -----	370	California, Oregon, and Wash-	
Part VI -----	582	ington, 1889 -----	1
Section D -----	786	Alaska, one each 1869, 1883,	
Part VIII -----	330	1891, and 1901 -----	4
Inside Route Pilot -----	1, 221		
Porto Rico -----	46	Total -----	5, 374

The following Tide Tables were issued during the year :

Atlantic coast :		Pacific coast :		General : ^a	
1908 -----	1	1907 -----	1	1910 -----	1
1909 -----	1	1909 -----	1	1911 -----	1
1910 -----	1	1910 -----	1	1912 -----	3
1911 -----	2	1911 -----	1	1913 -----	38
1912 -----	8	1912 -----	3	1914 -----	1, 125
1913 -----	145	1913 -----	682	1915 -----	220
1914 -----	1, 898	1914 -----	10, 668		
1915 -----	94	1915 -----	336	Total -----	1, 388
Total -----	2, 150	Total -----	11, 693		

Charts were issued as follows :

Sales agents -----	53, 139	Suboffice, Manila, P. I. -----	7, 460
Sales by office and chart divi-		Executive departments -----	7, 486
sion -----	3, 085	Foreign governments -----	1, 521
Congressional account -----	3, 720	Miscellaneous -----	1, 702
Hydrographic Office -----	29, 343		
Bureau of Lighthouses -----	4, 344	Total -----	117, 492
Coast and Geodetic Survey ---	5, 692		

Charts were issued at the suboffice, Manila, P. I., as follows :

Sales agents -----	1, 237	Executive departments (other	
Sales by office -----	1, 527	than above) -----	1, 164
Hydrographic Office, Navy -----	485	Miscellaneous -----	127
Coast and Geodetic Survey of			
office, Manila, and Survey ves-		Total -----	5, 371
sels -----	301		

There were issued of the Catalogue of Charts, Coast Pilots, and Tide Tables, 735 copies; of the Maryland oyster charts, 7,067 copies; of the index to Maryland oyster charts, 60 copies; and of the Philippine maps, 368 copies.

INSTRUMENT DIVISION.

The annual report of the chief of the instrument division gives details of work accomplished in that division during the year, including the general office work, the instrument shop and the carpenter shop.

The work of accounting for instruments, general property, and furniture has been attended to as heretofore, and in addition, the necessary correspondence of the division has been kept up.

The scientific part of the work in designing and constructing new instruments, apparatus, and various kinds of special experiments, with a view to improving apparatus or methods of construction, has been conducted as usual.

^a The title "General Tide Tables" was adopted with the 1915 edition.

The making and repairing of furniture, repairs to office buildings, packing and unpacking instruments and general property issued or received, and other special duties in connection therewith have been carefully attended to.

A general inventory of stock was taken prior to the sale of old instruments and material on October 31, 1913.

LIBRARY AND ARCHIVES.

The chief of the division of library and archives has charge of the general reference library maintained by the Survey and also the custody of the original sheets and field records.

During the year 700 books and pamphlets of no further use to the Survey were sent to the Library of Congress or to bureaus of the Department of Commerce. Fifteen hundred books and pamphlets were turned over to the Superintendent of Documents. The maps and charts were examined with a view to the elimination of useless items and 3,000 items were discarded. The maps were turned over to the Library of Congress and the charts sold as waste paper. The card catalogue of maps was revised.

The library contains a large collection of maps of the principal countries of the world. The collection of maps of Alaska is large, being particularly strong in chart and boundary material. There is a good collection of Philippine and Hawaiian maps.

STATISTICS OF ACCESSIONS.

Classification.	Purchased.	Donated.	Exchanged.	Total.
Books and pamphlets.....	161		531	692
Maps, charts, and blue prints.....			982	982

ARCHIVES ACCESSIONS.

Subject.	Volumes.	Cahiers.	Sheets.	Miscellaneous.
Astronomy:				
Observations.....	8	9		1
Computations—				
Field.....	6	27		
Office.....		3		
Geodesy:				
Observations.....	121	74		
Computations—				
Field.....	11	99		
Office.....		18		
Hypsometry:				
Observations.....	11	20		
Computations—				
Field.....		1		
Office.....	5			
Surveys:				
Soundings.....	693			
Sheets—				
Hydrographic.....			127	
Topographic.....			48	
Tides.....	177	21		175
Currents.....	39	7		
Levels.....	7			
Topographic miscellany.....	7	1		
Hydrographic miscellany.....	194			
Views: Negatives and prints.....				199
Total.....	1,279	280	175	375

TIDAL RESEARCH SECTION.

The reduction and tabulation of current observations taken on board light vessels of the third lighthouse district were continued.

The analysis of tides at Gauss Station, Antarctic Continent, extending from June 27 to December 26, 1892, was completed, the period analyzed being 162½ days. A first reduction of high and low waters was also made.

A harmonic analysis was made of tides observed at Campbell Island, South Pacific Ocean, in 1874, and a first reduction of high and low waters covering a period of 80 days was also made. A harmonic analysis was made for St. Paul Island, Indian Ocean, from observations in 1874, and other work was done in connection with tides in the Southern Hemisphere.

Examination was made of tidal and tidal-current observations for the Gulf of Mexico eastward of the Mississippi Delta.

Current predictions were made for Seymour Narrows, British Columbia, and Sergius Narrows, Alaska, for publication in the annual Tide Tables for 1915. In connection with the Seymour Narrows predictions, the harmonic constants for Port Simpson, British Columbia were examined, and tide predictions were made from them for the year 1915.

Some work was done upon the tidal currents in the Gulf of Panama and around the Hawaiian Islands.

The annual fluctuations in the sea level along the South Atlantic Gulf and Caribbean coasts were considered in reference to their bearing upon the flow of the Gulf Stream, and a memorandum was prepared in regard to the proposed determination of difference of level between St. Augustine and Cedar Keys, Fla.

Information was furnished in reply to many requests from sources outside the Survey on technical subjects relating to the tides, currents, effect of winds, height of waves, temperatures, densities, and similar matters.

MISCELLANEOUS SECTION.

During the year the chief of this section represented the Department of Commerce on the General Supply Committee, a duty which occupied about half his time.

This section attends to the purchase and distribution of supplies and keeps 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.

Respectfully,

O. H. TITTMANN,
Superintendent.

To Hon. WILLIAM C. REDFIELD,
Secretary of Commerce.

INDEX.

	Page.		Page.
Abagadassit Light, Kennebec River, Me	28	Beaufort, N. C.	39
Adams, F. L., magnetic observer	71	Bellingham, Wash	58
Aids to navigation	7, 27, 29, 57	Bench marks	50
Alabama, Coast Pilot work	44	Benton, J. R., magnetic observer	35
magnetic observations	45	Bering, Vitus	114
reconnoissance	47	Bermuda, Island of	91, 92
Alaska	5	Bilby, J. S., signalman	47, 52
general surveys	59, 62, 63, 65, 66, 67, 68, 69, 71	Birch Lake	105
Alaska boundary	10, 109	Birchwood Lake	106
Alaska Peninsula	65	Black Bay	102
Alaskan Engineering Commission	63	Black Rock Pass, P. I.	76
Albay Gulf, P. I.	70	Blanche, barge	69
Albemarle Sound, N. C.	39, 98	Block Island Sound, N. Y.	32
Alligator River, N. C.	40	Board on life-saving appliances	24
Alpha, launch	64	Board of rate regulations, P. I.	73
American Association for the Advancement of Science	15, 25, 99	Bongo Island, P. I.	75
Ames Ledge Light, Kennebec River, Me	28	Boundary Ridge, Alaska	112
Amrita, launch	102	Boutelle, J. B., assistant	31, 42
Anchorage Bay, Alaska	64	Bowie, William, assistant	99
Anclote River, Fla.	44	Brule Narrows, Rainy Lake	102, 104
Anderson Glacier, Alaska	112	Buildings, Coast and Geodetic Survey	5
Apo Reef, P. I.	84, 86	Bureau of Fisheries	91, 93
Appropriations and disbursements	23	Bureau of Lighthouses	8, 40
Arizona, latitude observations	52	Bureau of Standards	25, 95
magnetic observations	52	Bustamente, steamer	77
Arkansas, reconnoissance	47	Busuanga Island, P. I.	84, 85, 86
magnetic observations	51	Butte, Mont.	49, 50
Ashpoo River, S. C.	42	Buzzards Bay, Mass.	26, 29
Assateague anchorage	35	Cache Bay, Canada	105
Assistance rendered	41, 69, 78	Cade, C. M., assistant	50
Atlantic coast	25	Calamianes Islands, P. I.	78, 84
Attorney General, United States	96	Calantas Rock, P. I.	78
Augusta, Me.	28	California, triangulation	55, 58
Augustine Island, Alaska	68	hydrography	58
Azimuth observations	10, 38, 52, 62, 68, 101, 102, 105, 112	California-Nevada boundary	52
Bache, steamer	38, 41, 45, 91, 92, 93	Caloosahatchee River, Fla.	44
Baldwin, Asa C., surveyor	110, 111, 112	Cape Chacon, Alaska	116
Baralof Bay, Alaska	66	Cape Charles, Va.	37
Barnard, E. C., chief topographer	101, 102	Cape Cod Canal, Mass.	29
Base lines	7, 17, 33, 34, 36, 38, 39, 40, 46, 47, 49, 52, 59, 75, 98, 102, 103, 105, 107, 112	Cape Fear River, N. C.	40, 43
Basswood Lake	105	Cape Henry, Va.	38
Batas Island, P. I.	80	Cape Lynch, Alaska	70
Bath, Me.	28	Cape May, N. J.	31
Bay Point, Palawan Island, P. I.	82	Cape May Channel, N. J.	31
Baylor, J. B., assistant	104	Cape Muzon, Alaska	70, 116
Beal, A. F., magnetic observer	52	Cape Newenham, Alaska	62, 67
		Cape Parida, Alaska	70
		Cape Suspiro, Alaska	70
		Capul Island, P. I.	77
		Carabao Island, P. I.	75
		Caraga Bay, P. I.	74
		Carnegie Institution	22

	Page.		Page.
Carolina Shoal Beach, N. C.-----	43	Daluptri Island, P. I.-----	77
Carp Lake-----	105	Dangers to Navigation-----	11, 31, 32, 45 64, 65, 68, 72, 77, 80, 82, 84, 85, 91
Carter Spit, Alaska-----	62	Deep-sea soundings-----	65, 75
Casian Island, P. I.-----	80	Deer Island, Me-----	27
Catalogue of charts-----	122	Deers Horn Point, Rainy Lake-----	104
Cay Sal Bank-----	94	Delarof Harbor, Alaska-----	66
Chamberlain Bay, Alaska-----	61	Delaware, inspection duty-----	30
Charts-----	74	Coast Pilot work-----	34
Chart preparation-----	120	hydrography-----	35
Chart Construction Division-----	120	magnetic observations-----	35
Chart Division-----	121	Delaware Bay-----	35
Chesapeake Bay-----	35, 38, 91	Delaware Breakwater-----	35
Cheyenne, Wyo-----	48	Denson, H. C., assistant-----	32, 74
Cheyenne, base line-----	52	Derickson, R. B., assistant-----	69, 75
Chinitna Point, Alaska-----	68	Destacado Island, P. I.-----	76
Chitina Glacier, Alaska-----	111, 113	Details of field operations-----	25
Chitina River, Alaska-----	112	Details of office operations-----	116
Chitina Valley, Alaska-----	111	Dickins, E. F., assistant-----	30
Choctank River, Va-----	35	Director of Coast Surveys, P. I.-----	73
Churruca, steamer-----	78	District of Columbia, triangulation-----	95, 96
Clallam Bay, Wash-----	56	topography-----	95
Clarence Strait, Alaska-----	71	gravity-----	96
Clendenning Brook-----	108	physical hydrography-----	97
Coaling and water supply station, in P. I.-----	73, 78	Division of Terrestrial Magnetism-----	117
Coast Pilots-----	12, 35, 121	Dixon Entrance, Alaska-----	115
Cocoro Island, P. I.-----	86	Dominion Astronomical Observatory-----	17
Cobasset, Mass-----	29	Duck Island Harbor of Refuge, Conn-----	26
Colbert, L. O., assistant-----	82	Dumaran Channel, P. I.-----	83, 84
Colorado, magnetic observations-----	46, 47	Dumaran Island, P. I.-----	82, 83
reconnoissance-----	47	Dumrug Point, P. I.-----	76
latitude observations-----	52	Durants Island, N. C.-----	99
Columbia River, Oreg-----	57	Eagle Point Monument, Alaska-----	115
Columbus Glacier, Alaska-----	114	Earthquakes-----	19, 71, 89
Combahee Bank, S. C.-----	42	East River, N. Y.-----	32
Commissioner of Fisheries-----	93	Eastport, Me-----	27
Companario Island, P. I.-----	75	Eaton, D. W., surveyor-----	110, 111
Computing Division-----	116	Eau Gallie, Fla-----	45
Connecticut, wire drag work-----	25	Egg Bank, S. C.-----	42
chart revision-----	30	Electrotyping-----	121
Coast Pilot work-----	31	El Paso base line-----	47, 52
Cook Inlet, Alaska-----	63, 68	Elizabeth River, Va-----	36
Coosaw River, S. C.-----	42	Elizabethport, N. J.-----	34
Corncake Inlet, N. C.-----	43	Endeavor, steamer-----	13, 26, 31, 42
Coron Bay, P. I.-----	84	Engineers, United States Army-----	41, 43, 57, 95
Coron Island, P. I.-----	84	Excursion Inlet, Alaska-----	63
Corregidor Island Lighthouse, P. I.-----	75	Exhibit of Coast and Geodetic Sur- vey at the National Motor-Boat Show, New York City-----	94
Cosmos, launch-----	14, 69	Explorer, steamer-----	14, 22, 62, 63
Cotabato River, Mindanao, P. I.-----	73, 75	Fairfield, W. B., assistant-----	105
Cowie, G. D.-----	27, 50, 71	Fajardo, P. R.-----	72
Craig, J. D., Canadian surveyor-----	109	Fall Lake-----	105
Croatan Sound, N. C.-----	98	Fathomer, steamer-----	15, 84
Crooked Lake-----	105	Ferguson, O. W., assistant-----	36
Crooked River, Fla-----	44	Fire Island Inlet, N. Y.-----	32
Crookston, Minn-----	49, 50	Fish commissioner of North Caro- lina-----	98
Cruz Bay, Alaska-----	70	Fishing grounds, North Carolina-----	98
Culebra Island, Alaska-----	70	Fishing rights-----	73
Cullion Islands, P. I.-----	80, 84, 85	Fishers Island Sound, Conn-----	28
Current observations-----	8, 13, 30, 37, 62, 63, 65, 67, 68, 77, 78, 84, 85, 86, 90, 91, 93, 97, 122		
Cuyos Islands, P. I.-----	82, 83, 84, 86		
D'Abruzzi, Duke-----	114		
Dall Island, Alaska-----	70		

	Page.		Page.
Fishermans Island, Va.....	37	Hill, W. M., magnetic observer.....	46, 51
Florida, wire drag work.....	43	Hilo, T. H.....	87, 91
Coast Pilot work.....	44	Hodgkins, W. C., assistant.....	38, 73
hydrography.....	45	Hodgson, C. V., assistant.....	48, 52
Florida Straits.....	93, 94	Hole in the Wall.....	93
Florida, State drainage canals.....	44	Ifooniab, Alaska.....	63
Foote, United States torpedo boat.....	41	Hudson River, N. Y.....	32
Forney, Stehman, assistant.....	33	Humboldt Harbor, Alaska.....	66
Fort Frances, Ontario.....	101, 103	Hydrographer, steamer.....	13, 31, 34, 41
Four-Mile Bay.....	102	Hydrography.....	6
Fortune Island, P. I.....	75	Alabama.....	44
Fowey Rocks.....	93	Alaska.....	59, 62, 63, 64, 65, 68, 69
Framjee Bank, P. I.....	85	California.....	58
French, O. B., assistant.....	27, 95	Connecticut.....	25, 31
		Delaware.....	35
Galoc Island, P. I.....	80	Florida.....	43, 44, 45
Gambler Bay, Alaska.....	70	Hawaiian Islands.....	89
Gardner's Bay, N. Y.....	32	Louisiana.....	44
Garner, C. L., assistant.....	39, 95, 98	Maine.....	25, 28
Gedney, steamer.....	14, 53, 69, 70, 71	Maryland.....	35
General statement of progress.....	6	Massachusetts.....	25
General Supply Committee.....	124	Mississippi.....	44
Geodetic work.....	7, 15, 18	North Carolina.....	41, 98
Geographic positions.....	17, 18	New Hampshire.....	28
Georgia magnetic observations.....	45	New Jersey.....	31, 33, 34, 35
Glacier Bay, Alaska.....	63	New York.....	31, 34
Glacier Island, Alaska.....	61	Philippine Islands.....	74,
Gold Beach, Cal.....	55	75, 76, 77, 78, 81, 82, 83, 84	
Goodnews Bay, Alaska.....	62	Porto Rico.....	72
Gouldsborough Bay, Me.....	27	Rhode Island.....	31
Grand Manan channel.....	108	South Carolina.....	40
Granger, F. D., assistant.....	100	Texas.....	45
Graves, H. C., nautical expert.....	31	United States and Canada bound- ary.....	100, 106
Gravity work.....	96	Virginia.....	36, 38
Grays Harbor, Wash.....	54	Washington.....	53
Great Araco Island, Bahamas.....	93	Icy Passage, Alaska.....	63
Great Bay, Me.....	28	Idaho.....	47
Great Harbor, Culebra Island, P. R.....	72	Idaho Inlet, Alaska.....	63
Great Machipongo Inlet, Va.....	35	Iliamna Bay, Alaska.....	68
Great Point, R. I.....	31	Iloc Island, P. I.....	81
Great Salt Pond, N. Y.....	32	Inland waterways.....	32
Great South Bay, N. Y.....	32	Inspection duty.....	14, 59
Green, J. W., magnetic observer.....	46, 71,	Inspector, launch.....	97
	87, 80	Inspector of geodetic work.....	15
Green Hill Life-Saving Station.....	28	Inspector of hydrography and topog- raphy.....	12
Guerin, C. V., surveyor.....	110	Inspector of magnetic work.....	18
Gulf Stream.....	90, 92	Instrument division.....	122
Gulf of Esquibel, Alaska.....	70	Instrument and chart-printing shops.....	5
Gun Key.....	93	Interior States.....	46
		International boundaries.....	8, 100, 102
Hackensack River, N. J.....	33	International Boundary Commissions.....	16
Haleamaumau, Hawaii.....	87, 88	International Falls, Minn.....	99, 100, 104
Hamorauan, P. I.....	78	International Geodetic Association.....	24
Hanamalo Point, Hawaii.....	86, 87	International Geographic Congress for an atlas of the world.....	74
Hand, B. R., assistant.....	86	Iowa.....	47
Harbor River, S. C.....	42	Ivanov Bay, Alaska.....	67
Hardy, F. H., assistant.....	53, 63, 69		
Hartnell, George, magnetic observer.....	36	Jack Smith Bay, Alaska.....	64
Hawaii, Island of.....	86, 87	Jackson Cove, Alaska.....	61
Hawaiian Government survey.....	86	Jaggar, Jr., Prof. T. A.....	89
Hawaiian Islands.....	10, 22, 86, 89, 91	Jamaica Bay, N. Y.....	31
Hawaiian Volcano Observatory.....	20, 22, 88	Jupiter Inlet, Fla.....	93
Hawley, J. H., assistant.....	29		
Heating, power and lighting plant.....	5		
Heck, N. H., assistant.....	25, 43		

Page.	Page.		
Ka Lae, Hawaii.....	87	Linapacan Island, P. I.....	79, 80, 81, 84
Kaea Point, Hawaii.....	90	Little Fork, Rainy River.....	104
Kaena Point, Hawaii.....	90	Logan Glacier, Alaska.....	111,
Kaiaika Bay, Oahu, Hawaii.....	90		112, 113, 114, 115
Kamishak Bay, Alaska.....	68	Long Island, N. Y.....	32
Kapoho, Hawaii.....	87	Long Island Sound.....	34
Kaual Island, Hawaii.....	87	Longitude, International.....	16
Kaupo Landing, Hawaii.....	90	Alaska.....	62, 67
Kawaihae, Hawaii.....	86	Louisiana, Coast Pilot work.....	44
Keauhou, Hawaii.....	87	magnetic observations.....	45
Kennebec River, Me.....	28	Luce, R. F., assistant.....	78
Key West, Fla.....	43, 93	Lukens, R. R., assistant.....	64
Kilauea, Hawaii.....	87, 88	Luzon Island, P. I.....	70
Kilauea Volcano.....	22		
King, W. F.....	108, 113	McArthur, steamer.....	14, 68, 69
Klawak Inlet, Alaska.....	70, 71	McArthur, J. J., D. L. S.....	100
Knife Lake.....	105	McComb, H. E., magnetic observer.....	47
Knik Arm, Alaska.....	63	McGrath, John E., assistant.....	107
Kukuihaele, Hawaii.....	90	Magallanes Bank, P. I.....	85
Kupreanof Harbor, Alaska.....	67	Magnetic observations.....	7, 8, 18
Kuskokwim River, Alaska.....	62, 64	Alabama.....	45
		Alaska.....	59, 67, 69, 70, 71
La Jolla, Cal.....	58	Arizona.....	52
La Perouse Bay, Hawaii.....	90	Arkansas.....	51
Lahaina, Hawaii.....	87, 91	Colorado.....	47
Lake of the Woods.....	100, 101, 102, 105	Delaware.....	35
Lake Namakan.....	102, 104	Florida.....	45
Lake Okechobee, Fla.....	44	Georgia.....	45
Lake Washington, Wash.....	53	Hawaiian Islands.....	87, 89
Lake Washington Canal.....	54	Idaho.....	47
Lanai Island, Hawaii.....	90	Iowa.....	47
Latham, E. B., assistant.....	27, 31, 34, 57	Maryland.....	36
Latitude, Alaska.....	62, 68	Massachusetts.....	30
Colorado, Wyoming, South Dakota,		Michigan.....	51
North Dakota, Arizona, and		Minnesota.....	51
Texas.....	52	Mississippi.....	45
Latitude determinations.....	7	Missouri.....	51
Leroy, J. H.....	98	Montana.....	47
Levelling.....	7, 16	Nebraska.....	47
Alaska.....	62, 69	New Hampshire.....	30
Connecticut.....	25	New Jersey.....	35
Delaware.....	35	New York.....	30
District of Columbia.....	95	North Carolina.....	35
Maine.....	25	Pennsylvania.....	35
Massachusetts.....	25	Philippine Islands.....	84, 85, 86
Minnesota.....	50	Porto Rico.....	72
Montana.....	49	Utah.....	47
North Carolina.....	39	Vermont.....	30
North Dakota.....	50	Virginia.....	35
New Jersey.....	31	Wisconsin.....	50
New York.....	32	Magnetic work, at sea.....	21, 38, 62, 65, 68, 78
Philippine Islands.....	75, 82	Magnetic work, on land.....	20, 69
Porto Rico.....	72	Maber, T. J., assistant.....	84
United States and Canada bound-		Maine, wire-drag work.....	25
ary.....	101, 102, 103, 104, 105, 106	revision work.....	27, 28
Virginia.....	36	hydrography.....	28
Lewes, Del.....	31	Maine-Quebec boundary.....	106
Linga Bay, P. I.....	74	Mattlagut Island, P. I.....	80
Library and archives.....	123	Mala Bay, Hawaii.....	90, 91
Life-saving stations, New Jersey.....	34	Malabuctun Island, P. I.....	80
Lighthouses, Hawaiian Islands.....	86	Malaspina Glacier, Alaska.....	114
Light vessels, Atlantic coast.....	30	Manila Bay, P. I.....	75
Linao Bay, P. I.....	76	Mare Island Straits, Cal.....	58
Linao Point, P. I.....	76	Marinduque, steamer.....	15, 82, 83, 84

	Page.		Page.
Maryland, coast pilot work	35	New Hampshire, hydrography	28
magnetic work	36	magnetic observations	30
physical hydrography	97	New Jersey, magnetic observations	30
Maryland Shell Fish Commission	14, 24	coast pilot work	31, 35
Masbate, P. I.	76	triangulation, topography, and hydrography	33, 34
Massachusetts, wire-drag work	25	magnetic observations	35
revision work	28, 29	New Mexico, magnetic observations	46
triangulation	29	New River, N. C.	39
magnetic observations	30	New York, inspection duty	30
Matchless, schooner	13, 36	magnetic observations	30
Matinicus Harbor, Me.	26	topography	31
Matinicus Island, Me.	25	coast pilot work	31
Matunau Island, P. I.	84	revision work	32
Maui Island, Hawaii	87, 90	New York Bay, N. Y.	32, 34
Mauna Loa, Hawaii	89	Newport Bay, Cal.	58
Maupin, J. W., assistant	58	Nicholas Channel	94
Mendenhall, T. C.	108	Nichols Passage, Alaska	68, 71
Meridian lines	8, 23, 30, 46, 51	Ninety-eighth meridian	48
Merrymon, W. W., magnetic observer	52, 89	Noon signals	17
Meteorological observations	71, 72, 89, 91	North Carolina, magnetic observations	35
Mexican Government	98	triangulation	38, 40, 41
Michigan magnetic observations	51	hydrography	41
Miller, J. B., assistant	65, 89	fishing grounds	98
Milltown, Me.	107	Fish Commission	98
Mindanao Island, P. I.	74, 75	Fisheries	25
Mindoro Island, P. I.	84, 85	North Dakota, leveling	50
Minnesota, leveling	50	latitude observations	52
magnetic observations	51	North Edisto River, S. C.	40
Miscellaneous section	124	North Lubec, Me.	27
Mississippi, coast pilot work	44	Northwest Angle, Lake of the Woods	100
magnetic observations	45	Northwest Beacon Light, Key West, Fla.	44
triangulation	46	North West Branch, St. John River	107
Mississippi River	44, 45	Northwest Channel, Key West, Fla.	44
Mississippi River Commission	99	No. 117, launch	69
Missouri, magnetic observations	51	Oahu Island, Hawaii	90
Mobanen Island, P. I.	80	Oceanographic work	24, 90, 92
Mokuaweoweo, Hawaii	89	Ocklocknee Bay, Fla.	44
Molokai, Hawaii	90	Office work	12
Monja Rock, Manila Bay, P. I.	75	Ogilvie, N. L.	113
Montana, magnetic observations	47	Old Bahama Channel	93
reconnaissance	47	Olympic Peninsula, Wash.	56
levelling	49	Orca Bay, Alaska	59
Monument Brook	108	Oregon, magnetic observations	46
Morse, Fremont, assistant	58, 115	triangulation	55, 57
Motor truck	15, 52	Outlying territory	72
Motor velocipede cars	16, 50	Pacific coast	14, 53
Mount Anderson, Alaska	111, 112	Pagenbart, E. H., assistant	46, 54
Mount Constantine Ridge, Alaska	110	Palawan Island, P. I.	79, 80, 82, 83, 84
Mount King, Alaska	113	Pamlico River, N. C.	41
Mount Logan, Alaska	113	Pamlico Sound, N. C.	98
Mount Natashat, Alaska	110, 111, 112, 114	Panay Island, P. I.	84, 86
Mount St. Elias, Alaska	110, 111, 112, 113, 114	Panibatuhan Point, P. I.	75
Nagai Island, Alaska	67	Parang, P. I.	75
Naranjos group, P. I.	77	Parker, W. E., assistant	30, 44, 94, 96
Narvaez Bank, P. I.	85	Pasco, Wash.	50
Narragansett Bay, R. I.	28, 30	Passage Canal, Alaska	60, 61
Nassau, New Providence	92	Passaic River, N. J.	33, 34
Nassawadox Creek, Va.	37	Passamaquoddy Bay, Me.	27
Nebraska, magnetic observations	47	Pathfinder, steamer	15, 74, 75
Neumann, Frank, magnetic observer	30, 72	Patterson, steamer	14, 22, 65, 80
New Inlet, N. C.	43		
Newark Bay, N. J.	33		

Page.	Reconnoissance—Continued.	Page.
Patton, R. S., assistant.....	Idaho.....	47
Pease, H. W., magnetic observer....	Maine.....	27
Pearse Canal.....	Montana.....	47
Pelican Bank, S. C.....	New Jersey.....	33
Pendulum observations.....	Oregon.....	55, 57
Pennsylvania, magnetic observations..	Philippine Islands.....	75, 76, 77
Penobscot Bay, Me.....	Porto Rico.....	72
Permanent International Council for the Exploration of the Sea.....	Tennessee.....	47
Peters, John H., assistant.....	United States and Canada bound- ary.....	100, 102, 104
Pharsalia, steamer.....	Virginia.....	36
Philippine committee on geographic names.....	Washington.....	54, 55
Philippine Islands.....	Wyoming.....	47
Photographing.....	Red River.....	104
Physical hydrography.....	Reddings Rock, Cal.....	55
Pigeon River.....	Redfield, William C., Secretary of Commerce.....	124
Pinachinyan Island, P. I.....	Research, steamer.....	15, 76, 77
Pine Island Sound, Fla.....	Revision work.....	17, 27, 28, 29, 32, 44
Piscataqua River, Me.....	Rhode Island, revision work.....	28
Pleasant Point, Me.....	current observations.....	30
Popof Island, Alaska.....	inspection duty.....	30
Popototan Island, P. I.....	hydrography.....	31
Port Allen, Hawaii.....	Riggs, Thomas, jr., engineer.....	109
Port Cataingan, P. I.....	Ricord Channel, Del.....	31
Port Chester, Alaska.....	Ritter, H. P., assistant.....	97, 99
Port Cullon, P. I.....	Romblon, steamer.....	15, 78, 81, 84
Port Gravina, Alaska.....	Rose Inlet, Alaska.....	70
Port Lagumanoc, P. I.....	Rude, G. T., assistant.....	53, 59
Port Lebak, P. I.....	Sabine Bank, Tex.....	45
Port Usou, P. I.....	St. Croix River, Me.....	27, 106
Portage Glacier, Alaska.....	St. Helena Sound, S. C.....	42
Portland Harbor, Me.....	St. John River, Me.....	106
Porto Rico, triangulation.....	St. Pampille, Quebec.....	106
hydrography.....	Sakonnet River, R. I.....	28, 31
Potomac River.....	Samar Island, P. I.....	76
Potter, L. A., aid.....	Samar Sea, P. I.....	76
Pounder, I. R., Canadian surveyor....	San Alberto Bay, Alaska.....	70
Prince of Wales Island, Alaska.....	San Bernardino Strait, P. I.....	76
Prince William Sound, Alaska.....	San Cristoval Channel, Alaska.....	69
Printing and binding.....	San Juan Bautista Island.....	70
Prussian Royal Geodetic Institute....	San Miguel, P. I.....	78
Puako, Hawaii.....	Sangay Point, P. I.....	78
Public Health Service, United States..	Sannak Reefs, Alaska.....	65
Publications.....	Santa Cruz Point, P. I.....	82
Punaluu Landing, Hawaii.....	Scolai Pass, Alaska.....	110
Pungo River, N. C.....	Sea Otter Sound, Alaska.....	71
Quidapfl Point, P. I.....	Secretary of Commerce.....	96, 124
Quillian, C. G., assistant.....	Secretary of Commerce and Police, Philippine Government.....	73
Quluit, P. I.....	Seran, H. A., assistant.....	55
Quinhagamut, Alaska.....	Sharks Fin Bay, P. I.....	80
Quinluban Islands, P. I.....	Sheep Bay, Alaska.....	59, 61
Radio apparatus.....	Shelby, Mont.....	49
Rainy River.....	Shumagin Islands, Alaska.....	65, 66, 67
Rainy Lake.....	Sibugay Island, P. I.....	76
Rear Range Light, Kennebec River, Me.....	Siems, F. B. T., assistant.....	83
Reconnoissance.....	Signal building.....	54
Alaska.....	Silanga Bay, P. I.....	80
Arkansas.....	Simpson Bay, Alaska.....	59
California.....	Sinclair, C. H., assistant.....	29, 102
Colorado.....	Sister Rock, Cal.....	55
District of Columbia.....	Sitklan Island, Alaska.....	115
	Slades Creek, N. C.....	41

	Page.	Topography—Continued.	Page.
Sorsogon Bay, P. I.-----	78	District of Columbia-----	95
Sounding machine-----	92	Hawaiian Islands-----	86, 89
South Carolina, revision work-----	40, 41	Maine-----	27
triangulation and hydrography-----	41	New Jersey-----	31, 33, 34
South Dakota, latitude observations-----	52	New York-----	31, 32
South Inian Pass, Alaska-----	63	North Carolina-----	39, 41
Special duty-----	24, 91	Oregon-----	57, 58
Special surveys-----	10	Philippine Islands-----	74,
State of California, steamer-----	14, 70	75, 76, 77, 78, 81, 82, 83, 84	81
Steam sounding machine-----	70	Rhode Island-----	31
Steirnagle, W. M., assistant-----	76, 81	United States and Canada bound- ary-----	101, 103, 104, 105, 106, 107
Stikine River, Alaska-----	116	Virginia-----	36
Strait of Fuca, Wash-----	54	Washington-----	53
Strough, R. P., assistant-----	28, 38	Topsall Sound, N. C-----	39
Subic Bay, P. I.-----	75	Triangulation-----	6, 7, 15, 16, 17, 24
Suisin Bay, Cal-----	58	Alaska-----	59, 62, 63, 64, 65, 68, 69, 70, 71
Sulu Sea, P. I.-----	85	Alaska boundary-----	109, 112, 115
Sumnerlin, L. L.-----	111	Arizona-----	51
Swick, C. H.-----	96	Arkansas-----	47, 48
Table of distances-----	73	California-----	55, 57, 58
Tagapula Island, P. I.-----	77	Colorado-----	47, 52
Tagauayan Bay, P. I.-----	84	Connecticut-----	25
Tagauayan Island, P. I.-----	85, 86	District of Columbia-----	95
Taku, steamer-----	14, 59, 61	Idaho-----	47
Taytay Bay, P. I.-----	80	Hawaiian Islands-----	86, 89
Temperatures of sea water-----	67	Maine-----	25, 26, 27, 28
Tennessee, magnetic observations-----	46	Massachusetts-----	25, 27, 28, 29
triangulation-----	46	Mississippi-----	46
reconnoissance-----	47	Montana-----	47
Texas, hydrography-----	45	New Jersey-----	31, 33
magnetic observations-----	46	New York-----	32
latitude observations-----	52	North Carolina-----	38, 39, 40, 41, 42, 98
Texas-California arc-----	52	North Dakota-----	52
Ticao Island, P. I.-----	76, 77	Oregon-----	56, 56, 57
Ticao Pass, P. I.-----	77	Philippine Islands-----	74,
Tielin Strait, P. I.-----	78	75, 76, 77, 78, 79, 80, 81, 82, 83, 84	72
Tidal division-----	118	Porto Rico-----	28, 31
Tidal research section-----	124	Rhode Island-----	52
Tide indicator, New York-----	94	South Dakota-----	46, 47
Tide observations-----	7, 8	Tennessee-----	52
Alaska-----	59, 62, 63, 65, 68, 69	Texas-----	52
District of Columbia-----	97	United States and Canada bound- ary-----	100, 102, 103, 104, 105, 106
Hawaiian Islands-----	89, 91	Utah-----	47
Maine-----	25	Virginia-----	36, 37
Maryland-----	97	Washington-----	53, 54, 55, 56
Massachusetts-----	29	Wyoming-----	47
New Jersey-----	34	Trocadera Bay, Alaska-----	71
Philippine Islands-----	73,	Trout Light, Kennebec River, Me-----	28
74, 75, 76, 77, 78, 79,	80, 81, 82, 83, 84, 85	Trueblood, Paul M., assistant-----	77
Rhode Island-----	28	Tucson, Ariz-----	52
Virginia-----	36, 37, 97	Tugapangan Point, P. I.-----	75
Washington-----	53	Turnagain Arm, Alaska-----	60
Tide tables-----	121, 122	Unga Island, Alaska-----	66
Tittmann, O. H., superintendent-----	100, 124	Unimak Pass, Alaska-----	67
Tiverton, R. I.-----	28	Utah, magnetic observations-----	47
Tonawek Bay, Alaska-----	71	reconnoissance-----	47
Tongass Narrows, Alaska-----	69, 71	United States Naval Observatory-----	17
Topography:		United States and Canada bound- ary-----	8, 100
Alaska-----	59,	Vermont, magnetic observations-----	30
62, 63, 65, 67, 68, 69, 70, 71	110, 111	Vessels, new-----	5
Alaska boundary-----	110, 111		
California-----	58		

	Page.		Page.
Vessels and parties-----	12	Westdahl, F., assistant-----	59
Virginia, coast pilot work-----	35	White River, Alaska-----	112
magnetic observations-----	35	Whitman, W. R.-----	94
hydrography-----	36	Whitney, P. C., assistant-----	34, 35, 41
physical hydrography-----	97	Winds-----	90, 91
Wachapreague Inlet, Va-----	35	Wire drag-----	5, 6, 25, 26, 30, 43, 72
Waimoa, Hawaii-----	87	Wireless telegraph apparatus-----	74
Wales Island, Alaska-----	115	Winston, Isaac, assistant-----	28, 40
Walsh Glacier, Alaska-----	113	Wisconsin, magnetic observations---	51
Washington, magnetic observations-	46	Wrightsville, N. C.-----	39
triangulation-----	53, 54, 55	Wyoming, reconnoissance-----	47
topography-----	53	Yaquina Bay, Oreg-----	58
hydrography-----	53	Yates, Charles C., assistant-----	45, 91
Welker, P. A., assistant-----	73	Yukon, steamer-----	14, 62, 63, 64
West Indies-----	91	Yukon River, Alaska-----	109

