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ANNUAL REPORT

OF THE

SUPERINTENDENT, COAST AND GEODETIC SURVEY

TO THE

SECRETARY OF COMMERCE AND LABOR

FOR THE

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FISCAL YEAR ENDED JUNE 30, 1912

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National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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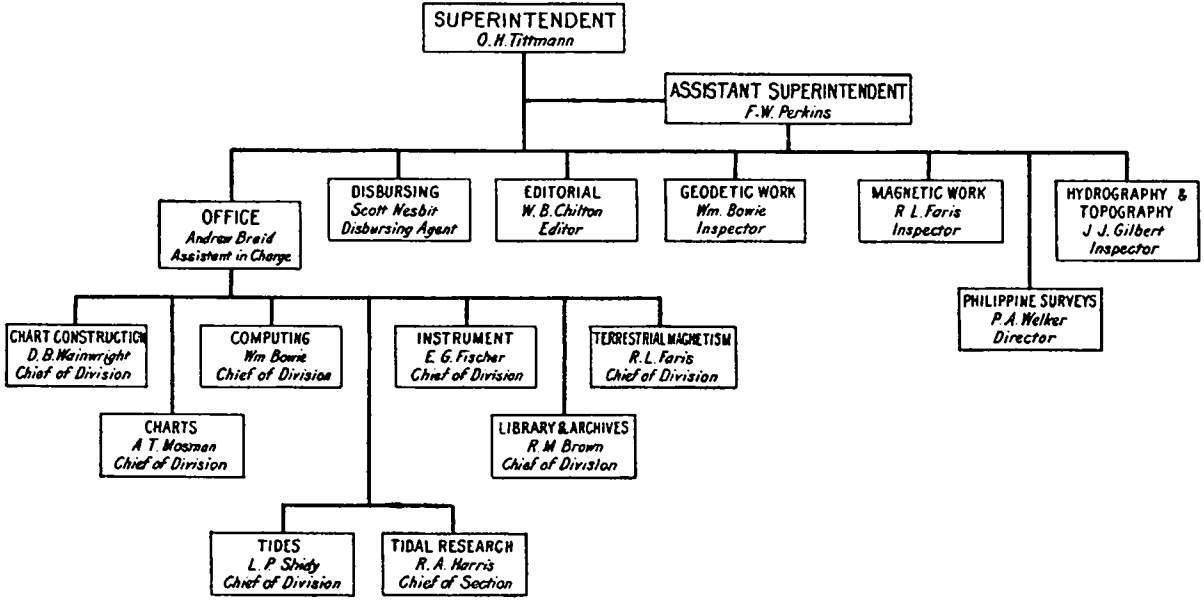
CHART SHOWING ORGANIZATION OF THE

COAST AND GEODETIC SURVEY

1912



REPORT

OF THE

SUPERINTENDENT, COAST AND GEODETIC SURVEY.

DEPARTMENT OF COMMERCE AND LABOR,
COAST AND GEODETIC SURVEY,
Washington, August 13, 1912.

SIR: I have the honor to submit the annual report of progress in the Coast and Geodetic Survey for the fiscal year ended June 30, 1912. It is accompanied by maps illustrating the general advance in the field work of the Survey up to that date.

GENERAL STATEMENTS OF PROGRESS.

The work of the Coast and Geodetic Survey during the fiscal year was continued in accordance with the general plan adopted of first completing the original surveys of portions of the coasts not yet adequately charted, giving particular attention to localities where the interests of commerce are more important, and next making resurveys of localities where changes are found to have taken place in natural or artificial features or where the original surveys were not sufficiently extensive or in sufficient detail to meet modern requirements.

HYDROGRAPHIC WORK.

The investigation by means of the wire drag of hidden dangers previously undiscovered is probably one of the most important developments of modern hydrographic surveying, and the systematic examination of the principal harbors and channels by this means will afford an additional safeguard to navigation and an assurance of the correctness of the minimum depths given on the charts. During the past year wire-drag examinations were made on the coast of Maine, in Block Island Sound, in the approaches to the Panama Canal, and in San Luis Obispo Bay, Cal.

ATLANTIC COAST.

In the regular hydrographic work two steamers and one schooner were employed on the Atlantic coast, besides one steamer employed for a portion of the year in gathering information along the southern coast for the correction of the Coast Pilots and charts.

Another party was engaged in making an examination of the inland waterways between the capes of the Chesapeake and Key West with

a view to the publication of detailed sailing directions and the correction of the charts of the inland passages, which are being improved by the United States Engineers and are now much frequented by small vessels.

Several land parties have been engaged in surveys and examinations for the revision of charts of the Atlantic and Gulf coasts.

PACIFIC COAST.

On the Pacific coast the fleet of four steamers and two launches was employed during the summer season in surveys on the coast of Alaska, and during the following winter months on the coast of Washington. One steamer was engaged during the winter in a survey of the entrance to the Panama Canal. Several parties were also engaged in surveys for the revision of charts on the Pacific coast.

GEODETIC, MAGNETIC, AND TIDAL WORK.

INTERIOR STATES AND TERRITORIES.

In the interior States and Territories, four parties were engaged in work of reconnoissance and primary triangulation, one on secondary triangulation, and two in revision of triangulation, two in running lines of precise levels, one in determining latitude and longitude, and one in determinations of the force of gravity.

Magnetic observations were made at five regular observatories and by six parties engaged in magnetic observations on land. Magnetic observations at sea were made by vessels of the Survey incidentally while engaged in their regular work.

Tides were observed at 10 permanent stations and temporarily at many other points in connection with hydrographic surveys. Current observations were made at various points along the coast. In this work the Bureau of Lighthouses cooperated.

Observations to determine the variation of latitude made under the direction of the Superintendent for the International Geodetic Association were continued at two stations in the United States.

OUTLYING TERRITORY.

Hawaiian Islands.—The survey of the island of Maui was nearly completed. Tidal observations made by the Territorial government are furnished to the Coast and Geodetic Survey through the courtesy of the Surveyor General of Hawaii.

A permanent magnetic observatory is maintained by the Coast and Geodetic Survey at Honolulu.

Porto Rico.—A permanent magnetic observatory is maintained by the Coast and Geodetic Survey at Vieques, P. R., and some field magnetic observations were made. No other work was done on this island.

Philippine Islands.—In the Philippine Islands surveys were continued by one vessel of the Coast and Geodetic Survey and four vessels assigned for the purpose by the insular government, and by parties working on shore. The usual operations were conducted by the suboffice of the Survey at Manila.

The steamer *Pathfinder* was engaged in surveys on the southeast coast of Negros and on the east and southeast coast of Mindanao.

The steamer *Fathomer* was engaged in work in the area between Tablas, Panay, Masbate, and between Romblon and Masbate Islands; also between Panay and Mindoro and the Calimanes and Palawan Islands.

The steamer *Romblon* made surveys in the area bounded by the islands of Luzon, Burias, Masbate, Sibuyan, and Tablas.

The steamer *Marinduque* was employed in Basilan Strait, Iligan Bay, and Ragay Gulf, southwestern Luzon.

The steamer *Research* surveyed in the area bounded by Samar, Leyte, Bilaran, and Masbate Islands.

One party was engaged in triangulation work on the island of Mindanao and another in magnetic observations on the island of Luzon.

INTERNATIONAL BOUNDARIES.

The survey and marking of the northern boundary line between the United States and Canada, and of the boundary between Alaska and Canada on Portland Canal and on the one hundred and forty-first meridian, are carried on by parties in the field under the direction of the Superintendent, as commissioner representing the United States, and Mr. W. F. King, as commissioner representing Great Britain, the American and Canadian parties either working together or on alternate sections of the line. In the latter case it has been arranged that each Government shall be represented in the party of the other by officers detailed for the purpose by the commissioner of each Government, respectively, in order to have an independent check on the work done.

UNITED STATES AND CANADA BOUNDARY.

In the survey of the boundary line between the United States and Canada the following progress was made:

The party employed on the boundary between Maine and New Brunswick continued work in the region between Woodland and Vanceboro, and from the lower end of Grand Lake to the mouth of Monument Stream. Some triangulation was also done in North Lake. In the meanwhile a Canadian party was at work on Mud Lake and Chiputneticook Lake.

On the same boundary a second party completed the survey in the valley of the St. Francis River, about 18 miles of the boundary, not including work by the Canadian party in the field at the same time, and made about 4 miles of line measurement to the southward and westward of Lake Pohenegamook.

In the section of the boundary between Pigeon River and Lake of the Woods, separating the State of Minnesota from the Province of Ontario, surveys were completed from Pine Lake to Sagagana Lake, a distance of approximately 30 miles.

A Canadian party, to which an American surveyor was detailed, operating on the boundary between North Dakota and Manitoba and Minnesota and Ontario, made about 120 miles of progress, from monument No. 170 on Turtle Mountain to monument No. 70 west of and near Red River, and from the Northwest Angle Inlet, Lake of the Woods, to below the mouth of the inlet, a distance of about 3 miles.

One party engaged in triangulation and monument setting on the boundary line between Manitoba and Montana, North Dakota, and Minnesota, began work about 40 miles east of the east branch of Poplar River and closed operations in the neighborhood of Short Creek, a distance of approximately 100 miles; work was carried on also from the vicinity of Emerson, Manitoba, west of the Red River, eastward to monument No. 47, a distance of about 25 miles. Another party engaged in the topography and vista cutting of the same section of the boundary line completed the work from the east fork of Poplar River to monument No. 29, a distance of about 124 miles, and from the vicinity of Emerson, Manitoba, to monument No. 31, a distance of 34 miles.

ALASKA BOUNDARY.

A Canadian party, to which an American surveyor was attached, engaged in the survey and marking of the boundary line on Portland Canal, separating Alaska from British Columbia, placed in position 22 reference monuments, the sites of which were determined by triangulation. A topographic survey of the region adjacent was begun.

Two parties have been at work on the Alaska boundary in the Mount St. Elias and Mount Natazhat region, one engaged in triangulation and the other in topography. This portion of the one hundred and forty-first meridian boundary survey remains to be done.

On the northern part of the one hundred and forty-first meridian boundary between Alaska and the Yukon Territory, about 164 miles of the boundary were surveyed and monumented. The line projection was carried from station "P" of the boundary to station "Y," on the last high ridge overlooking the Arctic Ocean.

SPECIAL SURVEYS.

Requests were received during the year for special surveys in many localities, including among others the following: Alaska: Landlocked Bay, Kuskokwim Bay, Kasaan Bay, Culross and Esther Islands, Prince William Sound, and Sheep, Simpson, and Gravina Bays. California: San Luis Obispo Bay and Alameda Creek to Roberts Landing. District of Columbia: Levels around Washington Monument and line of Florida Avenue. Georgia: Ossabaw and St. Simons Sounds. Maryland: Trial course at Cambridge. New York: East end of Long Island Sound, Davids Island, and Manhasset Bay. Massachusetts: Essex River. North Carolina: Meridian lines at various county seats; fishing grounds, Currituck and Albemarle Sounds; and Davidson Creek. Rhode Island: Coasters Island and Narragansett Bay. Washington: Seattle Harbor, and trial course at Port Townsend. Virginia: Mattaponi and Pamunkey Rivers, and Thimble Shoals.

DANGERS TO NAVIGATION.

Some of the dangers to navigation that were discovered, located, or investigated during the year are as follows:

Alaska: Determination of dangers in Kasaan Bay; location of rock off Cape Hinchinbrook on which the lighthouse steamer *Armeria* was wrecked; examination for a rock reported between Naked and

Smith Island in Prince William Sound; development of foul ground 1½ miles northwest of Little Smith Islands; search for a rock off Copper Mountain Point in Landlocked Bay; development of a reported shoal in Fritz Cove; a kelp patch with a least depth of 4 fathoms found between Aleks and Omida rocks; examination of the localities of the reported Leonard and Anderson rocks; search for a reported rock and shoal near Cape Pankof and for a reef reported at the entrance to West Anchor Cove; location and development of a shoal reported on a line between Acherk Harbor and Amugat Island; discovery of several submerged rocks off the northeast point of Kalgin Island; discovery of a 4-fathom patch near the southwestern point of Point Alexander; discovery of a shoal or rock about halfway between Scotch Cap Lighthouse and Middle Point.

California: Location with wire drag of dangerous pinnacle rocks in San Luis Obispo Bay, upon which several large vessels had struck; location of rock at Port Harford.

Canal Zone: Location of rocks in approaches to Panama Canal.

Florida: Location of wreck of schooner *Wm. R. Wilson*, steamer *Hannah M. Bell*, and an unknown schooner on Florida Reefs. Discovery of a rock in main ship channel, Key West Harbor. Changes in channels and depths determined in Nassau Bay.

Maine: About 300 rocks or shoals found by wire drag on the coast of Maine, including a number of important shoals in West Penobscot Bay between the two lines of islands extending north from Robinson's rock and Mark Island, respectively; location of the position of a wreck southeast of Goose Island and of numerous pinnacle rocks between Compass Island and Mark Island; verification of soundings on Bass Island; determination of a ledge and rocks off Yarmouth Island.

New York: Location of several rocks adjacent to Fort Slocum, Davids Island.

Virginia: Revision of depths in North Channel, entrance to Chesapeake Bay, showing important changes, the extension of Nautilus Shoal, and the disappearance of a 17-foot spot previously existing; verification of soundings on the Tail of the Horseshoe Shoal.

Washington: Survey of the bar and entrance to Willapa Bay, showing extensive changes in shore line, depths, location of channels and shoals.

OFFICE WORK.

The work of the 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, 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 $14,315.82, and miscellaneous receipts (work done for outside parties, sale of property, etc.) to $1,190.76, making a total of $15,506.58, which was duly covered into the Treasury.

OFFICE OF INSPECTOR OF HYDROGRAPHY AND TOPOGRAPHY.

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

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

VESSELS AND PARTIES.

Atlantic coast.—The steamer *Bache* was engaged in hydrography in the vicinity of New Ground Shoals and The Quicksands and Rebecca Shoal on the coast of Florida; search for reported shoals off Brunswick, Ga., in vicinity of Diamond Shoals Light Vessel, and off Hunting Island and Cape Romain; offshore hydrography between Delaware Bay entrance and Chesapeake Bay entrance; hydrography of entrance to Winyah Bay, S. C.; hydrography of entrances to Doboy and St. Simons Sounds. The *Bache* was undergoing repairs from August 29 to September 3.

The steamer *Endeavor* was engaged on hydrographic work in Chesapeake Bay in the vicinity of Tangier Island and Kedges Strait; off Cape Charles; Tail of the Horseshoe Shoal; and resurvey of Elizabeth River from Norfolk to the entrance to the canals. Repairs were made between August 29 and September 5.

The steamer *Hydrographer* was laid up at Curtis Bay, Md., during the greater part of the year. On April 13 she was taken to Baltimore for minor repairs, and on April 26 sailed from Baltimore for Key West, Fla., via the inland route from Norfolk to Beaufort, N. C., to take up the field revision of Coast Pilot, Volume VII, which work was in progress at the close of the year.

The schooner *Matchless* has been employed on the revision of the survey of the York River, Va., and of its tributaries, the Pamunkey and Mattaponi. The survey of the Mattaponi River was completed June 10 and the vessel proceeded to Baltimore for repairs, which began June 27. The *Matchless* was under repairs at Baltimore also from July 1 to August 7, 1911.

A wire-drag party was engaged during the summer in work in the vicinity of East Penobscot Bay, Me., and during the winter in the approaches to the Panama canal. In the spring work was begun in the channel between Montauk Point and Block Island, N. Y.

A revision was made of the triangulation of Casco Bay, Me., and the positions of aids to navigation determined.

Revision of triangulation, topography, and hydrography was continued at Cape Neddick Road, Me., southward to include York Harbor, and on the coast of Massachusetts north of Cape Ann.

An officer stationed at New York City has been engaged in the inspection of the coast in the district from New London, Conn., to Philadelphia, Pa.

The revision of surveys between Cape Charles and Cape Henlopen, in progress at the beginning of the fiscal year, was completed on August 8, and work was begun on the revision of the triangulation and topography of the Delaware River from Bridesburg to Trenton.

Except when detailed to duty with the Mississippi River Commission or other special duty, an officer of the Survey has been engaged throughout the year on the chart revision of Greater New York. This officer was also designated by the Department of Commerce and Labor to serve as a delegate to the meeting of the International Congress of Navigation at Philadelphia in May, 1912.

An examination to obtain data for sailing directions and to supplement the information on the charts was made of the inland waterways between the Capes of the Chesapeake and Key West, Fla.

At the request of the North Carolina Fish Commission, an officer was detailed to replace the buoys and beacons marking the limits of fishing grounds in Croatan and Pamlico Sounds.

An officer of the Survey has continued on duty in cooperation with the Maryland Shell Fish Commission, in the preparation of reports, charts, and other data for publication. Some assistance was also rendered to the Fish Commission of the State of Delaware.

A resurvey of the shore line and adjacent hydrography at Davids Island, N. Y., was made at the request of the officer in command at Fort Slocum.

Pacific coast.—The steamer *Explorer* was employed on a survey of the Kuskokwim River, Alaska, during the season of 1911 and again in 1912. This vessel was undergoing repairs from July 1 to 5, 1911, and in February, 1912.

The steamer *Gedney* made a survey of Willapa Bay entrance, Wash., and was engaged on the survey of Wrangell Strait and Tongass Narrows, Alaska. Some minor repairs were made during the year. The steamer *Cosmos* and launch *No. 117* were employed in connection with the *Gedney*.

The steamer *McArthur* was employed in surveys on the west side of Cook Inlet, Alaska. During the spring the vessel was repaired at Seattle and Winslow. A speed trial course in Port Townsend Bay was measured in compliance with a request from the Navy Department. In June, 1912, a survey was made of the water front of Douglas and Treadwell, Gastineau Channel, Alaska. Work was afterwards begun between Resurrection Bay and Cook Inlet.

During the season of 1911 the steamer *Patterson* was at work in the vicinity of Dolgoi and Sannak Islands, Alaska. A search was made for the Leonard and Anderson rocks. The vessel was afterwards employed on a survey of the approaches to the Panama Canal. The *Patterson* was undergoing extensive repairs from June 4 to the close of the fiscal year.

The steamer *Taku* completed the surveys in the vicinity of Naked, Peak, and Storey Islands, Prince William Sound, Alaska, made a search for a reported rock and developed a shoal near Little Smith Island. Work was also done at Green Island and in Landlocked Bay. In June, 1912, the position of the wreck of the lighthouse steamer *Armeria*, near Cape Hinchinbrook, Alaska, was determined. Regular surveying work in Prince William Sound was in progress at the close of the year.

The steamer *Yukon* was engaged in the survey of Cook Inlet, Alaska, south of the West Foreland. Work was resumed in Alaska in May, 1912, and was in progress at the close of the fiscal year.

A wire-drag examination was made in San Luis Obispo Bay, Cal.

Chart-revision work was done at Los Angeles Harbor and Port Harford, Cal.

In October, 1911, a party was sent to the Hawaiian Islands to continue the revision of the triangulation and topography. Work on the island of Maui was in progress and nearing completion at the close of the fiscal year.

The collection of Coast Pilot Notes for the Hawaiian Islands was completed, and the notes have been published.

An officer stationed at San Francisco has served as inspector for the coast of California and has also had charge of the San Francisco suboffice. An officer stationed at Seattle has performed similar duty for the coasts of Oregon and Washington and has supervised the repairs and outfitting of the vessels of the Survey employed in Alaska.

Philippine Islands.—An officer of the Survey detailed to duty as director of surveys, with headquarters at Manila, has direction of all field work in the Philippine Islands. The details of this work will be given elsewhere in this report.

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

OFFICE OF INSPECTOR OF GEODETIC WORK.

The duties of the Inspector are largely performed at the office. He prepares plans and instructions for field work, drafts correspondence with chiefs of field parties, examines records, computations and reports, and scientific discussions based upon the results of the field operations. He also aids the Commissioner in some of the details relating to the surveys of the boundaries between the United States and Canada and Alaska and Canada, and inspects the records and reports of the officers engaged in that work. One month during the fiscal year was given to the inspection of parties in the field.

Remarkably rapid progress was made in the work of reconnoissance for primary triangulation of the arc extending along the one hundred and fourth meridian from Denver, Colo., to the Canadian

boundary. This work was begun May 2, 1911, and closed August 10, 1911, during which period 720 miles of reconnoissance were completed, 300 miles of which was done after June 30. In the main scheme there are 74 stations and in the supplementary scheme 23. Provision was made for the usual connection with other systems of triangulation and with State boundaries.

Following this work a reconnoissance was made for primary triangulation to extend from the transcontinental triangulation in Utah to the Texas-California arc of primary triangulation in the vicinity of Needles, Cal., a distance of 310 miles. Provision was made for connection with stations and monuments of existing surveys. The time occupied in this work was one month and six days.

A reconnoissance was then made for a scheme of primary triangulation to extend from the oblique arc in the vicinity of Huntsville, Ala., to Memphis, Tenn., a distance of 232 miles; following which a reconnoisance was made for a primary traverse from Memphis to Little Rock, Ark. The length of this reconnoissance is 123 miles. The reconnoissance from Huntsville to Little Rock was made between November 8, 1911, and February 29, 1912, a period of 3 months and 22 days. The total length of reconnoissance was 965 miles.

In May, 1912, observations were begun on the primary triangulation near the one hundred and fourth meridian by two parties working from the northern and southern ends of the arc, respectively. A signal building party preceded the observing parties.

An event of the year was the completion of the scheme of secondary triangulation from Tacoma, by way of Grays Harbor, to Willapa Bay, Wash. The area covered has long been in need of an adequate control for surveys and maps. This chain of triangulation is 140 miles in length, and all of the observing was done during the fiscal year. This was a difficult piece of work, owing to the very high timber, fog, rain, and the great amount of smoke from forest fires.

The triangulation was completed on the Neuse River, N. C., which was necessary to connect the work of the United States engineers affecting navigation with that of the Coast and Geodetic Survey.

Two parties were engaged in the revision of triangulation on the coast of Texas during a portion of the year. Several parties engaged on chart revision and hydrography also did some work of triangulation.

At the request of the General Land Office, the latitude and longitude of a point near Copper Center, Alaska, were determined by two cooperating observers. Longitudes were determined telegraphically by the same parties at stations in Fort Stevens, Oreg.; Jarilla, Boracho, Stanton, Matagorda, and Sabine, Tex.; and the astronomic latitude was determined at six stations of the Texas-California arc of the primary triangulation.

An important event of the year was the completion of a three years' campaign of gravity determinations, during which 77 stations were established in the United States. Previous to 1909, when the recent gravity work was begun, only 47 stations in this country had been occupied with the invariable pendulums. During the fiscal year 1912 gravity determinations were made at 18 stations.

The line of precise levels from El Reno, Okla., to Goffs, Cal., was completed during the year. It furnishes a second and almost independent connection between the Gulf of Mexico and the Pacific Ocean.

Excellent progress was made on the line of precise levels from Brigham, Utah, toward San Francisco, Cal. Work on this line was begun in July, 1911, and by the close of the season 302 miles of levels between Brigham, Utah, and Beowawe, Nev., had been completed. Work on this line was resumed from the San Francisco end in March, 1912, working eastward, and by the end of the year about 300 miles of leveling had been run.

The Survey has made a contribution to geodesy in the publication entitled "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity" (Special Publication No. 10), which was available for distribution in May, 1912. A preliminary report on this subject was submitted to the International Geodetic Association at its meeting in 1909. In Special Publication No. 10, the new method of making gravity reductions (in which topography and isostatic compensation are considered) is explained at length and the necessary reduction tables are given in detail. The results of this investigation supplement and agree with the results obtained from the investigations by this Survey of the deflections of the vertical, which were published as "The Figure of the Earth and Isostasy, from Measurements in the United States," and "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy." A second investigation of the effect of topography and isostatic compensation has been made by this Survey, using all of the 124 stations now available in the United States. The results obtained from this investigation are in close agreement with those of the first investigation, where only 89 stations were used. The most important result given in the latest publication is the derived value of the flattening of the earth when the new method is used. The value agrees remarkably well with the generally accepted best values of the flattening, although in the present case the number of gravity stations used is small and the range of the latitudes of these stations is only about 24°. The manuscript of a report on this latest investigation is now in press.

There is also in the hands of the printer the manuscript of the following publications: "The Texas-California Arc of the Primary Triangulation," "Geodetic Operations in the United States, 1909–1912," and "A Manual on the Determination of Time, Longitude, Latitude, and Azimuth."

Three appendixes relating to the triangulation were published in the Superintendent's annual report for the fiscal year 1911, viz, "Triangulation along the Ninety-eighth Meridian, Nebraska to Canada, with Connection with the Great Lakes," "Triangulation along the Ninety-eighth Meridian, Seguin to Point Isabel, Texas," and "Triangulation along the East Coast of Florida and on the Florida Keys."

An enlarged edition of the "Formulæ and Tables for the Computation of Geodetic Positions" was prepared and published during the year.

OFFICE OF INSPECTOR OF MAGNETIC WORK.

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

It was not found necessary to make any inspection trips into the field or to any of the magnetic observatories during the year, except to the Cheltenham Magnetic Observatory, which was visited and inspected twice during the year. All other inspection work during the year was performed at the office through the current examination of records and reports from chiefs of magnetic parties and others engaged in magnetic work. The necessary instructions and detailed information were given magnetic observers for their guidance in the proper execution of the field and observatory work and computations.

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

Special rapid-rate registration was carried out on specified term days each month in conformity with requests for international cooperation in connection with the English Antarctic Expedition and with the Australasian Antarctic Expedition, both of which were still engaged in magnetic observational work in the antarctic regions at the close of the fiscal year.

Instruction in magnetic work was given at Cheltenham to Mr. Lincoln Ellsworth, who is preparing for the Crocker Land Arctic Expedition to be sent out next summer. At the same observatory a number of magnetic instruments were standardized for the use of the Survey.

MAGNETIC WORK ON LAND.

The magnetic elements (declination, dip, and horizontal intensity) were determined at over 300 stations. The stations were distributed in accordance with present needs over 32 States and Territories, and outlying islands under the jurisdiction of the United States, as shown in the following table. About 60 stations were reoccupied during the year for the purpose of obtaining data for maintaining an adequate knowledge of the secular change of the magnetic elements, especially of the magnetic declination. Special parties worked in Porto Rico and the Philippines for this purpose.

SUMMARY OF RESULTS OF MAGNETIC WORK ON LAND.

States.	Localities.	Stations.	Old localities reoccupied.	Declination results.	Dip results.	Intensity results.
Alabama	16	16	1	16	16	16
Alaska	30	30	4	32	5	5
Arkansas	1	1	1	1	1	1
California	2	2	2	3	3	3
Florida	3	4	3	4	4	4
Georgia	52	54	6	53	54	53
Hawaii	1	1	1	1	1	1
Illinois	10	10	2	10	10	10
Indiana	14	14	1	14	14	14
Iowa	4	4	0	4	4	4
Kansas	1	1	1	1	1	1
Kentucky	9	9	0	9	9	9
Maryland	4	4	1	9	8	6
Minnesota	12	12	1	12	12	12
Mississippi	13	13	0	13	13	13
Nebraska	8	8	0	8	8	8
New York	6	6	1	6	6	6
North Carolina	5	8	4	8	8	8
North Dakota	7	7	1	7	7	7
Ohio	1	1	1	1	1	1
Oklahoma	9	9	1	9	9	9
Pennsylvania	3	3	1	3	3	3
Philippine Islands	15	15	10	15	15	15
Porto Rico	7	7	7	7	7	7
South Carolina	14	15	1	15	15	15
South Dakota	5	5	1	5	5	5
Tennessee	18	19	3	19	18	18
Texas	21	22	2	22	21	21
Virginia	7	7	0	7	7	7
Washington	1	1	0	1	0	0
West Virginia	1	1	0	1	1	1
Foreign countries	5	8	4	9	10	10
Total	305	319	61	325	296	293

MAGNETIC WORK AT SEA.

The magnetic work done at sea during the year by the vessels of the Survey was, as in past years, incidental to the regular work upon which they were engaged, and the magnetic observations were made when the vessels were cruising to and from their working grounds, or where opportunity offered on their working grounds. The following table shows the amount of magnetic work carried out on board the vessels of the Survey during the year:

SUMMARY OF RESULTS OF MAGNETIC WORK AT SEA.

Vessels.	General region.	Results from swings.			Results from course observations.
		Declination.	Dip.	Intensity.	
Bache	Atlantic Ocean	8	7	7	
Hydrographer	do	15			
Patterson	Pacific Ocean	33	33	33	
Explorer	do	9	9	9	
Gedney	do	4	0	0	
McArthur	do	3			2
Fathomer	Philippine Islands	2			
Total		74	49	49	2

All of the vessels in the service which are suitable for it are instructed during each season's work to make such magnetic observations, especially of the magnetic declination, as there is opportunity for doing, either at sea or on land, where the weather conditions and the requirements of their survey duties permit. The *Bache* on the Atlantic coast and the *Patterson* and *Explorer* on the Pacific coast are supplied with ship dip circles for the determination of dip and total intensity at sea. The two latter ships are also equipped with magnetometers for magnetic work on land. During the last few years many declination observations have been secured in the inland passages through British Columbia and southeastern Alaska. A valuable series of results at sea were also obtained on the recent trip of the *Patterson* to and from her season's work at Panama. Several shore stations were made at Panama, and two swings of the ship were made in Panama Road and vicinity.

The results of magnetic observations made by the Coast and Geodetic Survey at the time of the solar eclipse of April 28, 1911, were prepared and published in the Journal of Terrestrial Magnetism for March, 1912, as was also the list of principal magnetic storms which were recorded at the Cheltenham Magnetic Observatory.

The inspector of Magnetic Work was on special duty representing the Department as a member of a committee, appointed at the request of the President's Commission on Economy and Efficiency, to examine into the duties and organization of the Life-Saving Service and the Bureau of Lighthouses. He also represented the Department as a member of a joint board recommended by the Secretary of the Navy to consider the question of uniform dimensions for the National Ensign and Union Jack. By direction of the Superintendent he consulted with the authorities of the New York Shipbuilding Co. for the purpose of obtaining information of the location of the obstruction which the *Arkansas* struck in Two-Bush Channel, Me., when proceeding to the builders' speed trial.

APPROPRIATIONS AND DISBURSEMENTS.

The appropriation for the Coast and Geodetic Survey for the fiscal year ended June 30, 1912, was $1,005,120, divided as follows:

Field expenses	$317,400
Repairs and maintenance of vessels	40,000
Officers and men, vessels	245,000
Salaries:	
Superintendent and field force	160,200
Office force	192,520
Office expenses	50,000

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

The Disbursing Agent of the Survey also disburses the greater portion of the appropriations made to the Department of State for the

survey of the Alaska boundary and of the boundary line between the United States and Canada.

PUBLICATIONS.

The following publications of the Coast and Geodetic Survey were received from the printer during the fiscal year 1912:

Report of Superintendent, showing progress of work, July 1, 1910, to June 30, 1911. 52 maps (9 in pocket), 38 p. of maps, 3 l. 589 pp.

Results of magnetic observations made by Survey between July [1], 1910, and June [30], 1911; by R. L. Faris. [App. 3, Report 1911.] 84 pp.

Triangulation along 98th meridian, Nebraska to Canada, and connection with Great Lakes; by William Bowie. 12 maps. [App. 4, Report 1911.] 186 pp.

Same, Seguin to Point Isabel, Tex.; by A. L. Baldwin. 8 maps. [App. 5, Report 1911.] 74 pp.

Triangulation along east coast of Florida and on Florida Keys; by Hugh C. Mitchell. 23 maps, 3 l. [App. 6, Report 1911.] 172 pp.

Tide tables, [calendar] year 1912 [with list of references]. 2d edition. il. 538 pp.

Same, 1913. il. 542 pp.

Tide tables for Atlantic coast of United States, including Canada and West Indies; from Tide tables, [calendar year] 1912. il. 181 pp.

Same, 2d edition. il. 181 pp.

Same, 1913. il. 181 pp.

Tide tables for Pacific coast of United States, with foreign ports in Pacific Ocean; from Tide tables, [calendar year] 1912. 165 pp.

Same, 2d edition. 165 pp.

Same, 1913. 165 pp.

United States Coast Pilot, Atlantic coast: pts. 1, 2, St. Croix River to Cape Ann; [by S. M. Ackley, assisted by E. A. Anderson and John Ross]. 3d edition [revised by Herbert C. Graves, assisted by C. L. Warwick and E. Vance Miller]. 1911. il. 2 maps. 200 pp.

Same: pt. 3, Cape Ann to Point Judith; [by Edwin H. Tillman, assisted by John Ross]. 3d edition [revised by Herbert C. Graves, assisted by C. L. Warwick and E. Vance Miller]. il. 2 maps. 166 pp.

Same: pt. 4, Point Judith to New York [supplement to 5th edition]. Mar. 11, 1912. 7 pp.

Same: pt. 5, New York to Chesapeake Bay entrance [supplement to 4th edition]. Mar. 13, 1912. 7 pp.

Same: pt. 6, Chesapeake Bay and tributaries [supplement to 3d edition]. Aug. 10, 1911. 19 pp.

Same: pt. 7, Chesapeake Bay entrance to Key West [supplement to 3d edition]. Oct. 10, 1911. 30 pp.

Same: pt. 8, Gulf of Mexico from Key West to Rio Grande [supplement to 3d edition]. Oct. 12, 1911. 16 pp.

United States Coast Pilot, Pacific coast: California, Oregon, and Washington [supplement to 2d edition]. Mar. 12, 1912. 8 pp.

Same: Alaska, pt. 1 [supplement to 5th edition]. Mar. 20, 1912. 13 pp.

Coast pilot notes on Hawaiian Islands. Feb. 21, 1912. 57 pp.

Results of observations made at magnetic observatory at Cheltenham, Md., 1909–10; by Daniel L. Hazard. 11 pl. 93 pp.

Same, Baldwin, Kans., 1907–09; by Daniel L. Hazard. 15 pl. 114 pp.

Same, Vieques, P. R., 1907–08; by Daniel L. Hazard. 9 pl. 3 text fig. 98 pp.

Same, Honolulu, Hawaii, 1909–10; by Daniel L. Hazard. 11 pl. 95 pp.

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

- Baltimore County, Md. 42 pp.
- Kent County, Md. 130 pp.
- Queen Annes County, Md. 176 pp.
- St. Marys County, Md. 203 pp.

Supplement to chart catalogue. Nov. 15, 1911. 6 pp.

Formulæ and tables for computation of geodetic positions, 5th edition; with preface, by Charles R. Duvall. (Special publication No. 8.) 91 pp.

Distribution of magnetic declination in United States, Jan. 1, 1910, with isogonic chart and secular change tables; by R. L. Faris. Map. (Special publication No. 9.) 14 pp.

Effect of topography and isostatic compensation upon intensity of gravity; by John F. Hayford and William Bowie. 9 maps and charts (5 in pocket), 11 text fig. (Special publication No. 10.) 132 pp.
Inland waterway, Atlantic coast. [Dec. 15, 1911.] 2 pp.
Sailing directions, Philippine Islands, Sections VI–VII, 3d edition.
Sailing directions, Philippine Islands, Section III, 4th edition. 180 pp.
iling directions for Philippine Islands, Section IV, 4th edition. 201 pp.
Philippine Notices to Mariners, 1911, Nos. 4, 5, 6, 7, 1912, No. 1.

Several other publications were in press at the close of the year.

The total cost of printing and binding, including blank forms and miscellaneous job printing for the year, payable from the appropriation for printing and binding for the Department of Commerce and Labor, was $31,267.82.

The Annual Report of the Superintendent, beginning with the present report, will be restricted to matters of administration. The results and discussions of the work which formerly appeared as appendixes to the annual report will hereafter be published in separate form only.

ECONOMY AND EFFICIENCY.

Much time and labor were devoted to the preparation of information called for by the President's Commission on Economy and Efficiency. Several officers and employees served on joint committees composed of representatives of the Department and of members of the President's Commission, as the results of the work of which various changes in methods and processes have been recommended and carried into effect.

A revision of the regulations for the government of the Coast and Geodetic Survey has been nearly completed.

PERSONNEL.

The personnel of the service, particularly in the case of the younger officers and employees, is continually changing, owing to various causes, chief among which are the higher salaries offered in the entering grades by other Departments of the Government and by private employers. The frequent resignation or transfer of employees trained in the service and the substitution for them of persons educationally qualified but inexperienced is often the cause of considerable embarrassment and a distinct loss of efficiency, as much of the time of the experienced officers and employees is taken up in training new appointees. The remedy for this condition is to be found only in the establishment of a uniform system of compensation in the Government service for employees engaged in the same class of duties. The demands on the Survey are constantly increasing, the present force is inadequate for current requirements, and the salaries in many grades are below the rates paid for similar service elsewhere. Increases have been asked for in the estimates submitted for the next fiscal year and should be approved if it is desired that the service be maintained in the highest state of efficiency.

VESSELS.

Many of the vessels of the Survey are old, requiring frequent repairs in order to keep them in condition for service. The appropriation for repairs of vessels is barely sufficient to meet the current

requirements and is inadequate when extensive repairs are required. The steamer *Pathfinder*, of steel construction, employed for many years in the Philippines, has deteriorated to such an extent as to endanger her safety, and a special appropriation of $20,000 has been asked for repair of this vessel.

TRIANGULATION OF THE YUKON RIVER.

An addition to the item of appropriation for furnishing points for State surveys has been included in the estimates for several years past, for the triangulation of the Yukon River in Alaska as a permanent basis for topographical, geological, and land surveys in that region. Attention is again directed to this matter, the importance of which is such as to call for special action on the part of Congress.

DETAILS OF FIELD OPERATIONS.

UNITED STATES.

ILLINOIS, INDIANA, KENTUCKY, OHIO, AND WEST VIRGINIA.

[J. R. BENTON.]

STATIONS OCCUPIED.—*Illinois:* Belvidere, Cairo, Hennepin, Jacksonville, Morris, Pekin, Springfield, Virginia, and Wheaton. *Indiana:* Cannelton, Knox, La Grange, Logansport, Marion, Monticello, Muncie, Nashville, Rising Sun, Salem, Scottsburg, Tipton, Versailles, and Vevay. *Kentucky:* Carlisle, Henderson, and Paris. *Ohio:* Marietta. *West Virginia:* Elizabeth.

Between July 1 and September 11, inclusive, observations of the three magnetic elements—declination, dip, and horizontal intensity—were made at the stations named above.

ALABAMA, ARKANSAS, CALIFORNIA, COLORADO, MISSISSIPPI, NEVADA, TENNESSEE, UTAH, AND WYOMING.

[J. S. BILBY.]

SUMMARY OF RESULTS.—Reconnoissance: 39,540 square miles of area covered, 316 lines of intervisibility determined in main scheme, 101 lines of intervisibility determined in supplementary scheme, 133 points selected in main scheme, 43 points selected for supplementary scheme, length of main scheme 1,188 miles, 123 miles of reconnoissance for traverse line, 24 traverse stations selected. Base line prepared for measurement, 9,600 meters. Triangulation: 57 observing signals and scaffolds built and stations marked. These statistics include some work done in May and June, 1911.

The reconnoissance for primary triangulation along the thirty-ninth parallel from the vicinity of Denver, Colo., to the Canadian boundary, begun in the spring of 1911, was in progress at the beginning of the year.

This reconnoissance was executed by the chief of party, aided by one man, with an outfit consisting of a team and light wagon, one saddle mule, a tent and bedding, cooking outfit for open camp fire, the necessary tools, instruments, and personal baggage. The total weight of the camp outfit, tools, and instruments was about 400 pounds. Field work was completed to the Canadian boundary by August 10.

Pike's Peak-Bison, with Divide as the third point, were selected for the base, starting from the transcontinental triangulation. These stations are approximately in latitude 39°, longitude 105°. The two most northern points in the scheme, Boundary and Northeast Base, are practically on the United States and Canada boundary and between longitude 103½° and 104°. The distance from the thirty-ninth parallel base to the line Boundary-Northeast Base, as measured through the scheme, is 720 miles. The actual work, including field records, was completed in 3½ months, making an average of about 206 miles per month.

In all there are 73 stations in the main scheme of this reconnoissance, including base nets and Laplace stations. Only nine signals are required, viz, two 60-foot, three 30-foot, two 20-foot, and two 10-foot; of these, five signals are in the base nets and one signal is at a Laplace station, leaving but three signals necessary for the main scheme of 720 miles of trangulation.

Two base-line sites were selected, one in the vicinity of Provo, S. Dak., a station on the Chicago, Burlington & Quincy Railroad, and the other in the vicinity of Ambrose, N. Dak., near the boundary between the United States and Canada. Three Laplace stations were selected, one at Watkins, Colo.; one at Provo, S. Dak.; and one at Mondak, near the North Dakota-Montana line.

Connections were made with monuments on the State boundaries between Colorado and Wyoming, Wyoming and Nebraska, Nebraska and South Dakota, Wyoming and South Dakota, South Dakota and Montana, Wyoming and Montana, South Dakota and North Dakota, and North Dakota and Montana. Connections were made with Coast and Geodetic Survey bench marks at Watkins, Colo.; Brighton, Colo.; Dover, Colo.; and Provo, S. Dak., with two bench marks of the Chicago, Milwaukee & Puget Sound Railroad; and with three bench marks and four trangulation stations of the Missouri River Commission. Connections were made also with triangulation stations of the United States Geological Survey adjacent to the scheme, and several stations of the Geological Survey were used as points in the main scheme.

Upon the completion in August of the reconnoissance from the vicinity of Colorado Springs to the Canadian boundary, work was begun on the reconnoissance for the connection of the primary triangulation in Utah with the primary triangulation of the Texas-California line in the vicinity of Needles, Cal.

Field operations were begun near Milford, Utah, on August 23. In this work the observer carried only the necessary instruments and a few necessary articles of personal baggage, the total weight of which was about 135 pounds, and traveled by rail and stage. Teams or saddle horses were hired temporarily where it was necessary to depart from regular lines of transportation to visit the points selected for the scheme.

Starting from the transcontinental triangulation, with the line Pioche-Tushar as a base and Wheeler Peak as the third point, rapid progress was made, and the reconnoissance was completed on September 29. The scheme connects with the California triangulation on the line Pine-Chimehuevis, with Powell as the third point. The total length of the scheme, measured along its axis, is 310 miles. The time occupied in actual work was one month and seven days.

Beginning at stations Pioche-Tushar, the scheme was swung to the westward along the San Pedro, Los Angeles & Salt Lake Railroad and the stage lines connecting with that railroad. The stations, which are on the highest points of the mountains, can all be reached by pack horses. The scheme was carried along the route most convenient for the observing party, keeping in touch as far as possible with railroads, wagon roads, and towns from which supplies are obtainable.

There are 10 primary stations to be occupied in the main scheme, including the two stations on the transcontinental line and two stations on the Texas-California line.

A Laplace station was provided for at Moapa, Nev. Connections were made with Coast and Geodetic Survey bench marks at Lund, Utah, and Moapa, Nev., with monuments on the boundaries between Nevada and Utah, Nevada and Arizona, and Utah and Arizona, and with stations of the Geological Survey triangulation adjacent to the scheme.

In October the trangulation station on Pikes Peak was visited and the station mark recovered.

Between November 8 and February 6 a reconnoissance for primary triangulation was made between Huntsville, Ala., and Memphis, Tenn. Beginning at Huntsville, stations "Rowe Mt." and "Wilson Mt." of the oblique arc were recovered, and they form the base stations for the present work. "Smithers" and "Tanyard" stations were also recovered and are used in the main scheme. By December 31 the reconnoissance was extended to stations "Gordon" and "Hickory" in the vicinity of Grand Junction, Tenn.

A longitude station was provided for at Huntsville, Ala. Provision was also made for a connection with a precise level bench mark at Iuka, Miss.

Connection was made with the existing surveys of the Mississippi River Commission, the United States Engineers, and the triangulation of the Coast and Geodetic Survey in the vicinity of Memphis. A base was provided for in the vicinity of Capleville, Tenn., also a Laplace station near Germantown, Tenn., and connection was made with a precise level bench mark at Memphis. After completing the reconnoissance to Memphis, an examination was made of the country to the westward between Memphis and Little Rock, Ark. The country between these places is flat and covered with high timber, and there are but few wagon roads, which are very bad during the greater part of the year. To extend triangulation from Memphis to Little Rock would require signals 90 to 100 feet high for 10 to 12 mile lines, and the total cost would be about five times greater than that of a primary traverse. For this reason, a reconnoissance for primary traverse was made between Memphis and Little Rock.

The traverse starts from M. R. C. West Base triangulation station, 7 miles west of Memphis, on the Chicago, Rock Island & Pacific Railroad, and follows the above railroad track to Little Rock N. W. Base triangulation station, about 3 miles east of the city of Little Rock, Ark. Provision was made for a Laplace station at Forest City, Ark., Devall Bluff, Ark., and Little Rock N. W. Base, Ark. The length of the traverse is about 123 miles.

A base for primary triangulation was located to the eastward of Little Rock and a reconnoissance for primary triangulation extended westward to the line "Shinall" to "Reynolds." These stations are

15 miles west of Little Rock. Provision was made for connection with precise level bench mark at Little Rock, Ark., and a connection was made with United States Geological Survey triangulation stations "Shinall," "Mannella," and "Reynolds," in Pulaski County, Ark. Field work closed on February 29.

In April two signal-building parties were organized at Littleton, Colo., to build the signals and scaffolds and prepare base-line sites for the primary triangulation near the one hundred and fourth meridian from the vicinity of Denver, Colo., northward to the Canadian boundary. One party began work in the vicinity of Manville, Wyo., and the other at Crosby, N. Dak. At Ambrose, near Crosby, a base-line site was prepared and signals erected and the building party assisted in measuring the base. Signal building was then resumed southward from the United States and Canada boundary line, and by June 30 the northern party had marked stations and built signals at 34 points, completing the signal building as far south as Sentinel Butte, N. Dak., a distance of 140 miles. By June 25 the southern party had completed signal building from Manville, Wyo., southward to "Pikes Peak-Bison" in the vicinity of Colorado Springs, including 23 stations, a distance of 210 miles.

VIRGINIA.

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

SUMMARY OF RESULTS.—Triangulation: 70 square miles of area covered, 77 signals erected, 8 observing tripods built, 24 old stations recovered, 29 new stations determined, 84 stations occupied for horizontal measures, 87 geographic positions determined. Topography: 4 square miles of area surveyed, 43.2 miles of shore line run, 8 miles of creeks, 25 miles of railroads and other roads. Hydrography: 375.2 square miles of area covered, 12,202.4 miles run while sounding, 14,275 positions determined, 77,450 soundings, 1 tidal station established.

At the beginning of the year the steamer *Endeavor* was engaged in surveying operations in Chesapeake Bay, with headquarters at Crisfield, Md. This work was completed by August 25. The area covered being through the center of the bay at its widest part, the observing was difficult. Signals were built 50 to 60 feet in height and a crow's-nest for observing on the ship's foremast, 42 feet above the water, was constructed. Sounding could only be done in clear weather, as a very little mist or haze in the air would shut out the distant signals. The sunken battleship *Texas*, at the mouth of Pocomoke Sound, was utilized as a signal.

The soundings over nearly all of this area run very evenly, with no indication of the formation of lumps and generally little change from the published charts.

From July 17 to 22 the party made a hydrographic examination of North Channel, entrance to Chesapeake Bay, with results as follows: Red nun buoy No. 2 was found to be in a position ½ mile SE. of that shown on chart 131. Red nun buoy No. 4 was found to be ¼ mile SW. of the charted position, and the wreck buoy ⅜ mile SW. of the position shown on the chart.

Nautilus Shoal was found to have extended a point to the southwest, reaching to about one-quarter mile south of the line between buoys No. 2 and No. 4 and showing 10 feet of water. The 3-fathom curve between buoy No. 2 and the wreck buoy was found to have

moved three-fourths mile to the north. The 17-foot spot shown on chart 131 in the channel five-eighths mile southeast of the position of buoy No. 2 had apparently been washed away, and no depth of less than 35 feet was found in that vicinity. The least water found on Nautilus Shoal was 8 feet, about 100 meters northwest of buoy No. 2.

At the request of the Maryland Board of Pilots a hydrographic examination was made in the vicinity of Cape Henry to see if changes had taken place in the shoal known as the Tail of the Horseshoe. The soundings made showed that the published chart of the locality was substantially correct. This examination was made between September 7 and 11.

The next work of the vessel was in the vicinity of Tangier Island, in Chesapeake Bay. Signals were established from Tangier Island to Kedges Strait and the area from the 4-fathom curve to the shore line and connecting with the work of 1910 was sounded over. One sheet extending from Tangier Island to Kedges Strait was completed on December 20, and, as the weather was extremely unfavorable for work in the bay, the party was transferred to Norfolk, Va., to make a resurvey of the south branch of the Elizabeth River.

Two churches, old triangulation points, one in Norfolk and one in Portsmouth, were used as a base, and from these a tertiary triangulation was carried up the Elizabeth River to the locks of the Dismal Swamp Canal on Deep Creek. At the latter place one of the triangle sides was measured with a steel tape as a check on the triangulation, and showed a satisfactory agreement.

On the completion of the triangulation the topography of the river was taken up and carried from the canal locks to Norfolk and along the south shore of the eastern branch to the highway bridge, and the wharf line of Norfolk, Portsmouth, and Berkley was verified.

The hydrography of Deep Creek from the Elizabeth River to the canal locks was also completed. That of the south branch of Elizabeth River was omitted, owing to dredging operations soon to be commenced there by the United States Engineers.

Work in Elizabeth River was completed on April 23, and the party returned to the previous working ground in Chesapeake Bay, in the vicinity of Crisfield, Md.

From May 27 the party was engaged in searching for old stations and building signals over the area extending from Kedges Strait to Barren Island and in determining their positions. Sounding was begun May 27 and continued to the close of the year.

NORTH DAKOTA, NEW MEXICO, UTAH, AND WASHINGTON.

[Wm. Bowie.]

During the month of August an inspection was made in the field of the work of parties engaged in reconnoissance, triangulation, leveling, and gravity work, viz: One party engaged in reconnoissance for primary triangulation from Colorado Springs, Colo., to the Canadian boundary between the one hundred and third and one hundred and fifth meridians; one party engaged in the determination of the intensity of gravity in the State of Washington; one party engaged in triangulation from the mouth of the Columbia River to

Tacoma, Wash., by way of Willapa Bay and Grays Harbor; one party engaged in precise leveling in Utah; and one party engaged in precise leveling in New Mexico. Methods of work were examined and suggestions made as to instruments and other details relating to outfit and party organization where necessary.

MARYLAND.

[J. E. BURBANK, GEORGE HARTNELL, and S. G. TOWNSHEND, Jr.]

The magnetic observatory at Cheltenham, Md., was under the charge of Mr. J. E. Burkank from July 1 until September 7, 1911. From the latter date until the close of the year Mr. George Hartnell was in charge.

The Eschenhagen and Adie magnetograph and the Bosch-Omori seismographs were kept in operation without appreciable interruption, and the required absolute observations, scale value determinations, and daily meteorological observations were made and magnetograph and seismograph records obtained. The number of magnetic storms recorded was less than for the previous year. Reports of these storms have been furnished to the Journal of Terrestrial Magnetism for publication.

Special rapid-rate registration was carried out on specified term days in each month, in conformity with requests for international cooperation with the English Antarctic Expedition and with the Australasian Antarctic Expedition, both of which were still engaged in magnetic observational work in the antarctic regions at the close of the fiscal year.

About 45 earthquakes were recorded, mostly of distant origin, the motion at Cheltenham being very small. An observer preparing to accompany the Crocker Land Expedition to go north next summer was given instruction in magnetic work. A number of instruments were standardized for the use of the Survey. Certain alterations and improvements were made in the buildings.

TEXAS AND NEW MEXICO.

[C. M. CADE.]

SUMMARY OF RESULTS.—Leveling: 358.7 miles of line completed, 153 bench marks established.

The party organized in May, 1911, to carry on precise leveling between Jericho, Tex., and Albuquerque, N. Mex., had reached Canyon, Tex., by June 30. From that point the line of levels was continued to Albuquerque, where the work was closed on November 8.

At Jericho a satisfactory connection was made between bench mark B10 and bench mark A10, 3.5 miles east of Jericho. The line Jericho to Albuquerque follows the Chicago, Rock Island & Pacific Railway as far as Amarillo, Tex., and the lines of the Atchison, Topeka & Santa Fe Railway from that point to Isleta, N. Mex., where connection was made with Coast and Geodetic Survey bench mark N2. Permission for the use of velocipede cars by the leveling party was granted by the officials of both roads, and permission to use freight trains for the transportation of the party was granted by the officials of the Santa Fe road.

For the establishment of permanent bench marks, bridge abutments, and buildings of masonry construction afforded convenient locations. Sufficient iron and stone posts were set to furnish a bench mark every 5 or 6 miles. Disks, bolts, and squares cut in masonry were used to bring the number of bench marks 25 per cent above the minimum of 20 bench marks per kilometer. At or near every railroad junction point not less than three permanent bench marks were established. Nine iron bolts set by the Santa Fe engineers were included in the line of levels, and copper disks and bolts, when set in the abutments, were placed near the railroad bench marks to afford means of comparison with their levels.

Connection was made with an iron pipe bench mark at Fort Summer on the Pecos River supposed to have been set by the United States Reclamation Service, and with five iron pipe bench marks of the United States Geological Survey between Belon and Isleta.

The largest amount of work done in any one day was 14.35 miles of single line, or 7.075 miles of completed line. This was accomplished in 7 hours and 30 minutes of actual leveling. The largest amount of work for any calendar month was done during September, 95.5 miles in 24 working days. From August 16 to September 16, 106.8 miles of line were completed in 25 working days.

WASHINGTON.

[R. B. DERICKSON, Commanding Steamers *Gedney* and *Explorer*, Dec. 7 to May. 3.]

SUMMARY OF RESULTS.—Triangulation: 8 signals erected, 1 station occupied for observations of horizontal angles, 8 geographical positions determined. Topography: 20.43 square miles of area covered, 34.31 miles of coast line surveyed, 4.80 miles of shore line of rivers, 13.96 miles of shore line or creeks, 9.75 miles of roads, 2 topographic sheets completed. Hydrography: 25.3 square miles of area sounded, 439.3 miles run while sounding, 4,202 angles measured, 20,710 soundings made, 2 tidal stations established, 5 current stations occupied, 3 hydrographic sheets finished Magnetic work: 1 station occupied for observations of magnetic declination.

The resurvey of the bar and entrance to Willapa Bay, Wash., which was in progress at the beginning of the year, was continued by the party on the steamer *Gedney* until completed on July 27.

Upon examination it was found that great changes had taken place since the original survey. The channel and bar crossing was found to be a mile north of its charted position, and the shoals and sand pits were either entirely gone or had shifted in position both inside and outside the entrance. It was only with local knowledge, aided by the buoys which had been changed in position from time to time, that vessels were able to enter the harbor.

In order to make the required changes to the chart, a considerable area had to be covered by hydrography, and the topography extended from the capes as far east as Toke Point.

A base line approximately a mile in length was measured on the beach with a 50-meter steel tape, and from this base the triangulation was extended to furnish points for the hydrography and topography. A search was made for triangulation points previously established, but only one station, "Goose Point," was recovered. This station was occupied and the line between it and the lighthouse on Cape Shoalwater connected with the local triangulation, giving an azimuth and an approximate check on the field computations.

Thirty-six points were located by triangulation and their geographical positions determined. Great care was given to the permanent marking of the triangulation stations. Subsurface marks were placed 4 feet below ground, with concrete and galvanized iron pipe to mark the points on the surface in most cases, and all signals were well secured and left standing.

Topography was begun at a point about 3 miles north of Cape Shoalwater and the shore line surveyed around North Bay to the wharf at Toke Point. As shown by the topographic sheet, the south point of Cape Shoalwater has receded nearly three-quarters of a mile, the whole south side having been washed away, with a slight filling in on the west side opposite the lighthouse. The shoals in North Bay are now dry at half tide and their area increased so that it appears that the entire bay will fill in in a short time. The next important change in the topography is the filling in of the large sand flats north of Leadbetter Point, which are awash at high tide. The high-water line at the extremity of Leadbetter Point has receded about one-quarter of a mile and extended approximately 1 mile in an easterly direction. The west side of the point is practically the same with the exception that the low-water line extends far to the westward. Inside the bay the area of the low-water flats is about the same as shown on the chart. The island known as Ellen Sands has extended to over 2 miles in length and shifted one-quarter of a mile to the eastward. No changes in the high-shore line bordering the bay were noted.

The most important part of the resurvey was the development of the navigable waters and outline of the breakers at the entrance to the bay. In connection with this, and in order that careful tidal observations might be taken, an automatic tide gauge was established at Toke Point, which recorded the tides continuously during the progress of the work.

Sounding lines were run in and out the main ship channel as marked by the buoys, and from these lines the work was extended to the northward and southward so as to include the whole of the entrance to the bay. The lines of soundings were carried from inside the bay to the 15-fathom curve outside the bar.

The hydrographic work shows that important changes have taken place outside and in the entrance. The 1 and 2 fathom curves extend from Leadbetter Point around the flats to the point marked by buoy No. 6. This flat or South Spit is approximately 2½ miles long and 1 mile wide, extending out from Leadbetter Point in a northerly direction and contracting the entrance to 1 mile. North Spit has shortened and now extends only 1¼ miles out from Cape Shoalwater in a southwesterly direction.

Middle Sands have entirely disappeared or washed in toward Leadbetter Point. The center of the sands is now covered by about 4 fathoms of water. From the north point of the Middle Sands, as shown on the present chart, the line of breakers extends continuously to the vicinity of buoy No. 6, and in a southerly direction to abreast of Leadbetter Point station. With a smooth sea the water breaks continuously along these lines, showing that Leadbetter Point itself practically extends up to the main ship channel.

The shoals showing 9 and 10 feet of water 2 miles northwest of Middle Sands have disappeared and are now covered by 4 fathoms of

water. The 3-fathom curve along the southwest extremity of North Spit is only 2 miles from Cape Shoalwater. The south end of the cape is now covered by 10 to 16 fathoms of water, the currents having washed out the sand for a distance of three-fourths of a mile. The North Spit is well defined in any weather by a continuous line of breakers inward from the 3-fathom curve.

Inside the entrance the changes are not so extensive, except that the two 18-foot spots, one-half mile south of Jenny Ford Spit, mark the northeast end of Leadbetter Point Spit. The south end of Jenny Ford Spit has receded about one-half mile. The main ship channel extends in an east-northeast direction. The fairway buoy marking the outer edge of the bar is 5 miles from the south end of Cape Shoalwater. At this place the bar has about 26 feet over it at mean low water, continuing for a half mile to the eastward, where the water begins to deepen. Between the extremity of Cape Shoalwater and the South Spit, the water deepens to 20 fathoms, and then shoals to 5 fathoms between buoys No. 3 and No. 8. Outside the fairway buoy the water deepens abruptly to 15 and 17 fathoms near the whistling buoy.

Observations made at 12 different positions where the ship was at anchor give an idea of the velocity and direction of the currents in the prevailing northwest winds. A maximum velocity of 5 knots was observed in the main channel. Very strong currents set over the South Spit. On an ebb tide, breakers and tide rips form between the fairway buoy and the end of North Spit and endanger small vessels. They disappear with the slacking of the current.

A complete set of magnetic observations with the compass declinometer was made at Toke Point, showing the declination to be 23° 41.8′ east.

The results of this survey will be of great value to masters of vessels entering the harbor, who have been obliged to depend upon local knowledge in piloting vessels in and out, the chart being more or less misleading, owing to the changes that have occurred since the former surveys. The chief industry of Willapa Bay is the export of lumber to foreign and domestic ports. During the year 1910, 391 steamships and 27 sailing vessels entered and departed laden with lumber from this harbor.

In March a hydrographic survey was made of the entrance to Eagle Harbor. Soundings were made in the customary way over an area extending from the 10 to 20 fathom curve, outside the entrance up to the shipyard dock. A topographic resurvey of the shore line was made to establish points for the hydrography. The sounding lines were afterwards plotted on the same topographic sheet. During the survey a tide staff was maintained at the wharf and comparative readings made with the automatic gauge at Seattle. Afterwards the hydrographic survey of the east and west waterways of Seattle Harbor was taken up. This survey work was carried on while the steamer *Gedney* was having repair work done, and the triangulation continued by the steamer *Explorer*, the command of which vessel had been assigned to Assistant R. M. Patton on May 3. The topography was brought to a close May 21.

The work of the *Gedney* in Alaska is noticed under another head.

NEW YORK.

[E. F. DICKINS.]

Inspection of the district from New London, Conn., to Philadelphia, Pa., was assigned early in October to the above-named officer. Through the courtesy of the collector of customs at New York a room in the customhouse was assigned to the representative of the Survey, who is furnished with a file of the latest charts, Coast Pilots, tide tables, notices to mariners, and other maritime publications for the inspection and use of those desiring to consult them, and is able to answer requests from the public for information regarding harbors, rivers, and inlets not only in that particular district but for the Pacific coast, Alaska, and the outlying possessions of the United States.

Through the courtesy of the New York Maritime Exchange he is enabled to receive the latest marine news, to keep in touch with navigators and others practically interested in the publications of the Survey and to obtain their views in regard to improvements desirable or errors to be corrected.

This officer has also attended to shipments of launch engines, boilers, supplies, and other material to field officers of the Survey in Alaska and the Philippine Islands and in the Canal Zone.

VIRGINIA.

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

SUMMARY OF RESULTS.—Base lines: 1 secondary. Triangulation: 69 square miles of area covered, 109 signal poles erected, 55 observing signals and scaffolds built, 103 stations occupied for horizontal measures, 107 geographic positions determined. Leveling: 16 elevations determined by leveling, 4.2 miles of levels run. Magnetic work: 3 land stations occupied for magnetic declination. Topography: 60 square miles of area covered, 193.2 miles of rivers surveyed, 100.3 miles of creeks surveyed, 151.6 miles of roads surveyed, 4 topographical sheets finished. Hydrography: 82.9 square miles of area covered, 770 miles run while sounding, 4,252 positions determined, 29,974 soundings, 6 tidal stations established, 8 current stations occupied, 4 hydrographic sheets finished.

During the period from August 11 to December 31 the party on the schooner *Matchless* was continuously engaged in the revisionary survey of the York River, Va., and the surveys of the Mattaponi and Pamunkey Rivers, tributaries of the York River, which unite to form that river, and which had not previously been surveyed by the Coast and Geodetic Survey. The work included triangulation, topography, and hydrography. By December 31 the survey of the York River was nearly completed. The triangulation had been carried 7 miles up the Pamunkey River and the topography about 6 miles, and on the Mattaponi River the triangulation had been extended about 4 miles and the topography 1 mile.

Only two of the triangulation stations of 1855 and 1856 on the York River were recovered. Tides were observed during the progress of the survey at Gloucester Point, Claybank, Allmondsville, and Westpoint.

Between January 1 and June 30 the survey of the Pamunkey River was completed to about 14 miles above Westpoint, and there suspended until the survey of the Mattaponi River could be completed.

The survey of the Mattaponi River was finished on June 10 and the vessel then proceeded to Baltimore for repairs.

The triangulation began at stations "York" and "Fort" of 1906 and was continued to Westpoint and thence up the Pamunkey River 14 miles and up the Mattaponi River 32 miles. The last 8 miles of the Mattaponi River was controlled by a meander line, carrying azimuth, latitude, and longitude. A side of the triangulation station "White" to station "Base," about 300 meters long, was measured near the end of the season and the measured length was found to agree well with the computed length. All stations were well marked and described.

The topography of the river shores was executed in sufficient detail to show all sloughs, creeks, roads, and other important features.

The hydrography of the York, Mattaponi, and Pamunkey Rivers was completely developed in the areas covered, and the tidal planes were well determined. Three tidal bench marks were established. Tidal currents were observed at eight stations. Observations were made for magnetic declination in three localities.

NEW YORK.

[E. G. FISCHER.]

In the latter part of November the electrical tidal indicators at the New York Maritime Exchange were examined, adjusted, and put in thorough working order. The float pipe on Pier A was removed from its previous location and remounted in a suitable room constructed for the purpose within the building on the pier. The sending part of the apparatus was repaired and the instrumental part remounted.

The electrical indicator at the Seamen's Friend Society's Institute was also overhauled and put in order, and electric current from the street mains was substituted for the battery current previously used.

VIRGINIA, PENNSYLVANIA, DELAWARE, AND NEW JERSEY.

[STEHMAN FORNEY.]

SUMMARY OF RESULTS.—Triangulation: 138 square miles of area covered, 57 signals erected, 65 stations occupied for horizontal measures, 119 geographic positions determined. Topography: 19 square miles of area surveyed, 40.5 miles of shore line run, 4 miles of marsh line, 57.5 miles of roads, 4.75 topographic sheets completed. Hydrography: 18 square miles of area covered, 128.86 miles run while sounding, 385 angles measured, 4,576 soundings, 2 tidal stations established, 2 hydrographic sheets completed.

After July 1 the party engaged in the resurvey of the eastern shore of the Virginia Peninsula completed the hydrographic examination of Wachapreague Inlet and approaches, revised the shore line at Fishing Point, and made a hydrographic examination of Assateague anchorage and Chincoteague Inlet.

Upon the completion of the latter work on August 7 the house boat *Comrade*, which provided accommodations for the party, was taken to Philadelphia, and preparations were begun for resurveying the upper portion of the Delaware River, commencing at Bridesburg. Satisfactory progress was made in the Delaware River work, and by December 31 the topographical resurvey of both shores of the river from the railroad bridge below Bridesburg to the House of Correction wharf at Holmesburg had been completed. The new triangulation up the river from the line "Frankford Pumping" to "Clark" (old

triangulation stations), to the line "Enterprise" to "Dromer," had also been completed, and triangulation stations had been marked and signals erected as far as Burlington, N. J.

A serious accident to the chief of party prevented his taking an active part in the field work from October 3 to December 31. He continued to direct the work of the party, however, and the work was carried on without interruption by other officers acting under his instructions.

Between January 1 and June 30 the shore line and interior topography was completed from Torresdale, Pa., to Beverly, N. J. Triangulation signals were built and stations marked with concrete piers as far up the river as Florence, N. J. The triangulation and plane table work are completed to Burlington, N. J., and Bristol, Pa.

GEORGIA AND SOUTH CAROLINA.

[OSCAR H. GAARDEN.]

STATIONS OCCUPIED.—*Georgia:* Augusta, Appling, Butler, Fayetteville, Forsyth, Gray, Griffin, Jonesboro, Knoxville, Lexington, Monticello, Perry, Talbotton, Vienna, and Zebulon. *South Carolina:* Abbeville, Bishopville, Chester, Chesterfield, Dillon, Edgefield, Florence, Gaffney, Greenville, Laurens, Lexington, St. Matthews, and Winnsboro.

Determinations of the value of the three magnetic elements were made by the above-named observer between February 19 and June 30. Meridian lines were established in 27 localities. Meridian marks were not set at Lexington, Winnsboro, and Chester, S. C., as the United States Geological Survey had established meridian lines at these places. Meridian marks were set only at the new stations, Florence, S. C., and Augusta, Ga. Special observations were made at 14 places in South Carolina with compass declinometer No. 2. At Florence, S. C., and Augusta, Ga., observations were made at both the old and new stations.

The Coast and Geodetic Survey brass station marks, securely embedded in suitable stones, were used to mark stations and bearings, and distances to near-by objects were determined at each station.

NEW YORK.

[JOHN C. GAUGER.]

SUMMARY OF RESULTS.—Triangulation: 15.1 square miles of area covered, 5 signals erected, 6 stations occupied for observations of horizontal angles, 28 geographic positions determined. Hydrography: 1.85 square miles of area covered, 9 miles run while sounding, 69 positions determined, 963 soundings, 1 tidal station established.

The revision of the triangulation at the eastern end of Long Island and hydrographic examination of Great Pond, in the vicinity of Montauk Point, Long Island, which had been begun by Assistant A. M. Sobieralski, were continued by Mr. Gauger from July 22 until August 10, when he was relieved by Mr. W. M. Steirnagle. The triangulation was connected with three stations of the old triangulation. Four of the seven stations of the original surveys of 1837 and 1882 were recovered and marked in a permanent manner. The length of the triangulation along its central axis is 6.5 statute miles.

The hydrographic examination of Great Pond was made merely for the purpose of determining its general depth. In order to establish a relation between the pond and mean low water, datum for

purposes of possible harbor development, a connection by leveling was made between the present water level of the pond and one observed low water in Long Island Sound.

Soundings were made in Great Pond at quarter-mile intervals, the greatest depth found being 12½ feet. The water level of the pond was found to be approximately 3½ feet above mean low water in Long Island Sound. No marked changes were found to have occurred in the shore line.

Notes concerning landmarks, other aids to navigation and topographical features were made with a view to the correction of the charts.

FLORIDA, GEORGIA, NORTH CAROLINA, SOUTH CAROLINA, AND VIRGINIA.

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

The party on the steamer *Hydrographer* was organized in April for the revision of the sailing directions and Coast Pilot volumes along the South Atlantic coast from Chesapeake Bay entrance to Key West, Fla.

On April 29 the vessel left Norfolk and proceeded through the inside passage to Beaufort, N. C., and then outside to Charleston, Port Royal Sound, Brunswick, Fernandina, and Key West, arriving at the latter place on May 17. After that date coast-pilot work was done on the coast from Key West to the St. Johns River, St. Johns River to Brunswick, Brunswick to Savannah, Savannah to Charleston, and Charleston to Georgetown, S. C.

Between Key West, Fla., and Georgetown, S. C., the principal harbors, rivers, and inland passages have been traversed and the buoyed channels over the bars at the entrances have been sounded. At all points visited masters, pilots, harbor masters, and others interested in navigation were interviewed. The vessel, with the aid of local pilots, was taken some distance up the principal rivers in order to learn by personal observation the extent of traffic, character of the channels, conditions for obtaining supplies, and other information relating to the navigable waters embraced within the limits of tide water. Valuable information was obtained from the United States Engineers engaged in river and harbor work in South Carolina, Georgia, and Florida.

The ship was swung on 32 headings to determine compass deviation at 14 places along the coast, these embracing the entrances to the principal harbors.

MAINE.

[N. H. HECK.]

SUMMARY OF RESULTS.—Triangulation: 250 square miles of area covered, 10 signals erected, 20 stations occupied for horizontal measures, 47 geographic positions determined. Leveling: 40 elevations of bench marks determined, 7 miles of levels run. Hydrography: 150 square miles of area covered, 591 miles run with wire drag, 23,452 angles measured, 377 soundings made, 3 tidal stations established, 5 hydrographic sheets completed, 57 tidal bench marks established.

Work on the coast of Maine was continued by the wire-drag party, which took the field in April, 1911, as long as weather conditions permitted field operations.

The instructions for the season included work in East Penobscot Bay, West Penobscot Bay, Jericho Bay, the channels south of Swans Island, Blue Hill Bay, and the approaches to Penobscot Bay between Metinic and Matinicus Islands.

By the close of the season on October 30, the work in East Penobscot Bay and West Penobscot Bay was completed and all work of pressing importance in Jericho Bay was finished. A portion of the work required in Blue Hill Bay was accomplished, but the work in the channels south of Swans Island and in the approaches to Penobscot Bay was not completed.

In addition to the hydrography, a large number of tidal bench marks were recovered, many new ones established, and 27 triangulation stations were occupied, including 12 new stations, and the latter were thoroughly marked. Forty-six old triangulation stations were recovered, 15 were not found, and 23 were re-marked.

A list of conspicuous objects useful for navigation, and also in locating buoys, was compiled and forwarded to the office. A complete description of the wire-drag work as now carried on was prepared and transmitted for the Superintendent.

The wire-drag work done during the season was planned with especial reference to the examination of important channels in such a way as to insure the safety of vessels using such channels at all points.

The total area covered with the drag during the season from April to October was 200 square miles, or nearly twice the area covered during the previous season. The number of soundings made, nearly 500, indicates the large number of uncharted shoals found, probably 300, representing either new shoals or less depths found on charted shoals.

A number of important shoals were found, especially in the channels between the two lines of islands and shoals in West Penobscot Bay extending north from Robinsons Rock and Mark Island, respectively. In the open water southeast of Goose Island a wreck was located and buoyed for the United States Engineers. The area surrounding the islands from Compass Island to Mark Island was found to contain numerous pinnacle rocks, which were located. Soundings made on Bass Harbor Bar disproved the report of greater depths than those indicated by the charts.

The cost of this work is $75 per square mile, the lowest cost yet attained.

From December 14 until May 7 the wire-drag party was engaged in a survey of the approaches to the Panama Canal, which work is noticed under the head of "Outlying territory."

In June the party was organized for wire-drag work in the approaches to Block Island Sound, between Block Island and Montauk Point, and by the close of the month everything was in readiness for beginning work on July 1.

GEORGIA AND NORTH CAROLINA.

[WALLACE M. HILL.]

STATIONS OCCUPIED.—*Georgia:* Abbeville, *Americus, *Ashburn, Bainbridge, Blakely, Carnesville, Cleveland, Colquitt, *Cordele, Covington, Crawfordsville, *Dahlonega, Danielsville, Dawsonville, Fitzgerald, *Greensboro, Hazlehurst, Irvington, Jasper, La Grange (old station), *La Grange (new station), Leesburg, *Louisville, *Lumpkin, McRae, Milledgeville, *Milton, Monroe, *Morgan, Nashville, *Preston, Quitman, Sparta, Sylvester, Thomson, Tifton, and *Tocoa. *North Carolina:* Lumberton (old station), and Lumberton (new station).

During the season from July 1 to November 30 magnetic observations were made at the stations listed above by the observer named. Meridian lines were established at the stations marked by an asterisk. By request of the State Geologist of North Carolina the meridian line at Lumberton, N. C., was moved to another location in the same town. Old stations were recovered at Bainbridge, Louisville, and Milledgeville, Ga. Stations were marked with stone posts 6 by 6 by 30 inches, with tops either lettered or marked with a brass plate set in the stone.

Owing to the cutting down of many of the blazed trees marking boundaries, property lines in Georgia are often uncertain, causing litigation in many instances. There were consequently many requests for the establishment of meridian lines for use in determining magnetic variation and the correction of compass errors.

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

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

SUMMARY OF RESULTS.—Triangulation: 10 square miles of area covered, 4 signal poles erected, 11 stations occupied for horizontal measures, 18 geographic positions determined. Magnetic work: 8 stations at sea occupied for magnetic observations. Topography: ½ square mile of area covered, 4 miles of general coast surveyed, 1 topographic sheet finished. Hydrography: 650 square miles of area covered, 4,476.07 miles of soundings, 76,243 soundings, 11,636 angles measured, 7 tidal stations established, 13 current stations occupied, 5 hydrographic sheets finished.

At the beginning of the fiscal year the *Bache* was engaged in hydrographic work in the vicinity of New Ground Shoal, Florida Reefs. The work in that general region, including Isaac and Rebecca Shoals, and Marquesas Rock was continued until July 11, on which day work was closed for the season. The *Bache* then proceeded via Key West to Norfolk, Va.

On July 29 the ship was swung in Hampton Roads for compass deviation and magnetic dip and intensity.

On August 2 the *Bache* left Norfolk to take up the offshore hydrography between the Chesapeake and the Delaware entrances, in connection with which tidal observations were made at Cape Charles Quarantine Station, Assateague Anchorage, and Delaware Breakwater.

The hydrography in that region included a general examination for the determination of possible changes by running lines due east from shoal water near the beach to a depth of 20 fathoms. The greater part of the work of the season was done in the region off Assateague and northward to Fenwick Island Shoal, that being the area within which the greatest changes were suspected. A number of lines of soundings were run, however, in other portions of the field of opera-

tions, usually in connection with the necessary passages to or from a harbor.

Between August 30 and September 25 the vessel was undergoing repairs at Baltimore, after the completion of which work was resumed on the coast of Virginia. In the latter part of November this work was suspended, and after some minor repairs in Baltimore the vessel sailed for the southern coast.

On December 4 and 5 determinations were made of the positions of the schooner *Joseph G. Ray*, wrecked on the Middle Ground, off Cape Charles, and of the naval collier *Sterling*, beached west of Cape Henry after being in collision.

From December 11 the vessel was engaged in hydrography off the entrance to Winyah Bay, S. C., between Cape Romain and Little River.

In January a search was made for a dangerous shoal reported to exist about 11 or 12 miles southeastward of Rebecca Shoal Lighthouse, in the vicinity of Key West, Fla. For the purpose of determining the position of the vessel while sounding, a number of buoys were moored and located by observations from station "Quick" and Rebecca Shoal Lighthouse. A tide staff was established at the lighthouse. When the weather prevented work being done from the ship, a close hydrographic development was made of the reef, and as some shoal areas were discovered this development was extended eastward as far as Glama Wreck Buoy. A development was also made of the western part of Rebecca Shoal and vicinity to complete the survey of that locality, the eastern part of it having been surveyed in 1911. Nothing was discovered corresponding to the reported danger, which was the original object of the season's work. The suspected area was pretty thoroughly covered by sweeping with a wire drag set to a depth of 24 and 27 feet. From the result of this examination and from information derived from the master of the schooner *Elisha Atkins*, who had reported striking in that region, the commanding officer of the *Bache* concludes that the object struck was a wreck which has since disappeared.

At times when the *Bache* was at Key West a topographic survey was made of the water front of that town.

The next work of the vessel was in the vicinity of Brunswick, Ga., and included the offshore hydrography between St. Marys entrance and Sapelo Sound, with special examinations at the entrances to St. Andrews and St. Simons Sounds and a close survey of Doboy Bar and approaches. At the end of the fiscal year the work at Doboy entrance had been completed.

WYOMING.

[C. V. HODGSON.]

SUMMARY OF RESULTS.—Reconnoissance: 1 point selected for scheme. Triangulation: 2,000 square miles of area covered, 11 stations occupied for horizontal measures, 11 stations occupied for vertical measures, 24 geographic positions determined.

In the latter part of April a party was organized for primary triangulation along the one hundred and fourth meridian to the northward of Pikes Peak. Work was begun in May in the vicinity of Guernsey, Wyo., and by the end of June the occupation of stations had been completed as far as Cheyenne, Wyo.

MAINE AND MASSACHUSETTS.

[E. B. LATHAM.]

SUMMARY OF RESULTS.—Triangulation: 26 old stations recovered, 3 old stations searched for and not found, 8 signal poles erected, 11 stations occupied for horizontal measures, 18 geographic positions determined. Topography: 61 square miles of area revised, 7.6 square miles of area surveyed, 21 miles of general coast line, 10 miles of rivers, 5 topographic sheets revised but not entirely completed. Hydrography: 1.2 square miles of area sounded, 591 miles run while sounding, 1,534 positions determined, 19,916 soundings, 5 tidal stations established, 5 hydrographic sheets finished.

In June work had been begun on the revision of the surveys in the vicinity of York, Me. This work was continued after July 1 and a topographical survey of York Beach and Cape Neddick on a scale of 1/2,500 was completed. A topographic revision of chart No. 328 of York Harbor, Me., extending from York Harbor to Cape Neddick, scale 1/20,000, was also completed. A hydrographic sheet on a scale of 1/2,500 of Cape Neddick Roads and approaches was finished and sent to the office. The additions to the hydrography on chart 328 were shown on a tracing.

On August 29 an inspection was made of the automatic tide gauge station at Portland, and the elevation of the gauge connected with several bench marks by leveling.

The next work taken up after the close of operations at York Harbor on August 30 was the continuation of revision work on the coast of Massachusetts northward from the work of the preceding season in the vicinity of Ipswich. Hydrographic surveys were made of the bars at the entrance to Annisquam and Essex Rivers and Plum Island Sound. Soundings were also made in Plum Island Sound and Merrimac River when the weather was suitable for the more exposed work on the bars.

The work of revising the topography northward from the limits of the surveys made in the previous season was begun October 12 and by December 31 had been completed as far as Newburyport. In the course of the work search was made for old triangulation stations needed for control purposes, and notes were made respecting the condition of the stations visited.

During the period from January 1 to June 30 chart revision was carried northward from Ipswich, Mass., to Hampton, N. H. The topography was revised to Newburyport, Mass., and the hydrographic sheets of Plum Island Sound and River were completed. A survey was made at the entrance to Hampton River, N. H. The positions of Ipswich front range light and of two beacons at the entrance to Essex Bay were determined by triangulation. Points at the entrance to Hampton River and the position of the standpipe at Boars Head were also trigonometrically determined.

KANSAS, NEBRASKA, OKLAHOMA, AND TEXAS.

[H. E. MCCOMB.]

STATIONS OCCUPIED.—*Kansas:* Winfield. *Nebraska:* Blair, Fullerton, Grand Island, Lexington, Loup City, Oshkosh, Seward, and Taylor. *Oklahoma:* Guthrie, Lehigh, Marietta, Okema, *Poteau, Salisaw, Tishomingo, and Westville. *Texas:* Carthage, Centerville, Crockett, Dallas, Denton, Fairfield, Gilmer, Groveton, McKinney, *Mt. Vernon, Nacogdoches, and Pittsburg.

Observations for the determination of the magnetic declination, dip, and intensity were made at the stations named during July and

August, 1911, and in June, 1912, stations were reoccupied at Winfield, Guthrie, and McKinney. Meridian lines were established at the stations marked with asterisks. The stations were marked by limestone posts 6 by 6 by 24 to 30 inches, with a brass plate in the top marked "U. S. C. & G. S." This method of marking was found more satisfactory than simply lettering the stone.

Much interest was shown in the magnetic work by local surveyors at the points visited, and many requests for copies of the results were received.

INSPECTION OF CHART AGENCY.

[J. E. McGrath.]

An inspection of the chart agency of the Survey at Eastport, Me., was made by the above-named officer after the close of field work on the survey of the northeastern boundary between the United States and Canada in October.

CALIFORNIA.

[Fremont Morse.]

In February a revision was made of the surveys at Los Angeles Harbor necessary to correct chart No. 5145. Blue prints were obtained from the United States Engineers showing the dredging which had been done, and also a pamphlet showing the location of the harbor lines and a list and description of triangulation points, together with their coordinates referred to Coast and Geodetic Survey station "Deadmans Islands." Mr. Hamlin, city engineer of Los Angeles, supplied a blue print of a map prepared by the bureau of harbor improvement showing improved harbor frontage and also proposed improvements. Blue prints showing completed or prospective improvements were furnished by several companies occupying wharf property on the harbor front. Three days were spent in field work around the harbor, locating improvements and changes in shore line, and running in the electric road and boulevard around the shore of the bay from Wilmington to San Pedro.

On February 15 an examination was made of a rock at Port Harford, on which the Union Oil Co.'s steamship *Lansing*, drawing 25 feet 2 inches, was reported to have struck on December 21. A minimum depth of 24.8 feet was found on this rock, which forms a ledge extending northwest and southeast with two summits on which the depth is less than 27 feet.

INSPECTION OF CHART AGENCIES.

[A. T. Mosman.]

Between August 23 and September 12 an inspection was made of the agencies for the sale of the publications of the Survey in the following places: Portland, Bath, Rockland, Belfast, and Bangor, Me.; Boston, Mass.; New London, Conn.; Newport, R. I.; and New York City, N.Y.

At all of the agencies visited the stock of publications on hand was carefully examined, the number checked, and the agent directed to turn in to the office all publications found to be obsolete. Notes were

made of the facilities for the display and sale of charts and other publications, the method of accounting for them, and the general condition of the various agencies.

ALABAMA, ARKANSAS, MISSISSIPPI, NORTH CAROLINA, TENNESSEE, TEXAS, AND VIRGINIA.

[FRANK NEUMANN.]

STATIONS OCCUPIED.—*Alabama:* Anniston, Ashland, *Athens, Brewton, *Camden, Courtland, *Elba, Elkmont, Hartselle, Lafayette, *Monroeville, *Moulton, Pell City, Selma, Tuscumbia, *Tuskegee, and Wetumpka. *Arkansas:* Little Rock. *Mississippi:* Brandon, *Coffeeville, *Columbus, *Decatur, Grenada, Houston, Lexington, Louisville, Philadelphia, *Pittsboro, *Pontotoc, Ripley, and *Starkville. *North Carolina:* *Gatesville, *Marshall, *Newland, and Salisbury. *Tennessee:* Charlotte, Chesterfield, Elora, Fayetteville, Floyd, *Franklin, Hartsville, Lafayette, *Lewisburg, *Lynchburg, Lynnville, Lunenburg, Manchester, McMinnville, Memphis, Nashville, Shelbyville, *Smithville, *Spencer, Wartrace, Winchester, and *Woodburg. *Texas:* *Bonham, Boston, Carlton, *Clarksville, *Cooper, *Emory, *Quitman, and Texarkana. *Virginia:* Charlotte, Chesterfield, Floyd, and Lunenburg.

Observations of magnetic declination, dip, and intensity were made at the stations specified by the observer named above between July 1 and December 31, 1911, and between May 7 and June 30, 1912. Meridian lines were established at the stations marked with asterisks. Selma, Ala., and Nashville, Tenn., were repeat stations.

The stations were marked as a rule with granite or limestone posts having brass caps embedded in their tops. These stones varied from 6 to 10 inches square and from 2 to 3 feet in length, and were set so as to project from 1 to 4 inches above ground.

NORTH DAKOTA AND WASHINGTON.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Primary base lines, 10.479 kilometers. Levels run over base site (double line), 10.479 kilometers. Triangulation: 3,250 square miles of area covered, 3 signals erected, 3 observing tripods and scaffolds built, 30 stations occupied for horizontal measures, 22 stations occupied for vertical measures, 36 geographic positions determined, 32 elevations determined trigonometrically.

The charge of the party for continuing the triangulation on the coast of Washington from the Columbia River to Grays Harbor and from Grays Harbor to Tacoma was transferred to Mr. E. H. Pagenhart on July 1, on which date the line clearing and signal building required was nearly completed.

Beginning at stations "Rain (1906)," "Hurst (1906)," and "Hal (1906)," the triangulation was extended westward to Grays Harbor, where connection was made with the line "North Jetty" to "Brack," with intersection on "Grays Harbor Lighthouse." The main scheme was then extended south to Willapa Bay and connected with stations "Goose (1871)," "Willapa Bay Lighthouse," and "Lead (1911)," all three stations used in the resurvey of Willapa Bay by Assistant R. B. Derickson. At the mouth of the Columbia River connection was made with the line "Tillamook Head (1874)" to "Scarboro Hill 2 (1873)." This line is common to the triangulation at the mouth of the Columbia River and that extending south to Tillamook Bay. "Saddle Mt. 2," the station occupied by Assistant J. S. Hill in 1909, was used; it is not the same as "Saddle Mt. (1876)."

The elevations of all new stations were determined by vertical angles, and secondary azimuths were measured at "Langley," "Pioneer," and "Goose Point." Primary azimuth was measured at "Longitude," Fort Stevens.

As nearly all the lines observed had to be cleared, only one intersection station, the tide gauge dolphin at Tokeland, used in the sea-level connection, was observed.

Mr. J. S. Hill, assistant, remained with the party for 16 days in July.

Owing to the broken and mountainous nature of the country, the dense forests necessitating heavy cutting, lack of communications, and unfavorable weather, this triangulation was an exceedingly difficult piece of work. Field operations were completed on January 28.

Work at the north end of the primary triangulation along the one hundred and fourth meridian was begun on May 28 from a base line measured in the vicinity of Ambrose, N. Dak., between May 16 and May 27. Connection was made with stations "Bowie" and "School" (N. E. base) of the United States and Canada boundary survey, occupied in 1911, and with station "Bilby" of the same survey, used as a supplementary station. The work was then extended southward following the reconnoissance made by Mr. J. S. Bilby in 1911, and had reached stations "Gladys" and "Marmon" on June 30.

WASHINGTON.

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

SUMMARY OF RESULTS.—Hydrography: 47.3 miles run while sounding, 4,915 soundings made.

The hydrographic survey of the east and west waterways and off the north end of Harbor Island, Seattle Harbor, which had been begun on April 13 under the direction of Assistant R. B. Derickson, was continued by the steamer *Explorer*, under command of Assistant R. S. Patton, from May 3 until the completion of the necessary soundings on June 3. Observations for magnetic declination, dip, and intensity were made at the Seattle magnetic station.

On June 27 the *Explorer* sailed for Alaska to take up work at the mouth of the Kuskokwim River. Observations on board ship to determine the ship's deviation, and for magnetic declination, dip, and intensity were made at Union Bay, British Columbia.

NEVADA AND UTAH.

[JOHN H. PETERS.]

SUMMARY OF RESULTS.—Two hundred and twelve elevations of permanent bench marks determined by leveling, 579 miles of leveling run.

Work on the line of levels between Brigham, Utah, and San Francisco, Cal., following the line of the Southern Pacific Railroad, through the States of Utah, Nevada, and California, had been begun at Brigham, Utah, in June, and was in progress at the beginning of the fiscal year.

In order to secure a connection with previous work, a line of levels was run from bench mark "R" at Brigham, Utah, to bench mark "Q" at Willard, Utah, a distance of 7 miles to the southward. As this connection was not considered sufficient the line was extended northward from bench mark "R" to bench mark "T" at Deweyville, Utah, a distance of 14 miles. This gave a satisfactory connection, and the elevation of "R" was used to begin work on the main line.

Before making the above connection bench marks "J9" and "K9" were established at Brigham, Utah, and while leveling between bench marks "R" and "T" bench mark "L9" was established at Honeyville, Utah, to replace bench mark "S" which had been destroyed.

Work on the main line was taken up July 11, 1911, at temporary bench mark No. 11, of the connection line between bench marks "R" and "T" and was carried on continuously until November 8, 1911, when, on account of weather conditions, leveling was discontinued at Beowawe, Nev., a small town about 48 miles west of Elko, Nev.

The first permanent bench mark of the main line set in Utah was "M9" and the last was "A_{11}," while the first bench mark established in Nevada was "I_3" and the last was "C6" at Beowawe, Nev. All the intermediate bench marks are included in the main line with the exception of bench mark "W_{10}" (Utah), which is situated on a spur run eastward from the main line to Lucin, Boxelder County, Utah.

The types of permanent bench marks used were the brass disk, the stone post, and the iron post, with brass cap. Wherever permanent structures of stone or concrete were found the brass disk form of mark was used both in the vertical and horizontal surfaces. In other cases the stone post or iron post with brass cap was used. Progress was retarded by heavy grades and the great distances necessary between camping places where water could be obtained. Nevertheless, the average progress made was about 6 miles greater per month than that during a number of preceding seasons.

Transportation was by rail and tents were used for the accommodation of the party. Toward the latter part of the season permission was obtained from the general manager of the Southern Pacific lines, east of Sparks, to operate a gasoline motor velocipede car in the prosecution of the work. Such a car was purchased and was found to add about 15 per cent to the efficiency and also to decrease the cost of transportation of party and outfit.

Work closed for the season on November 28.

Operations were resumed at the beginning of March at San Francisco. The line of levels began with a connection between bench marks 635, 640, 386, and 418 of the engineer department of the city of San Francisco, all of which had been referred by precise leveling to the tide station at the Presidio of San Francisco by a former officer of the Coast and Geodetic Survey. The elevation of bench mark 635 being nearest to the tide station was used in beginning the computation.

From bench mark 635 the line of levels follows the old line of the Southern Pacific Railroad to its junction with the new line of that railway at San Bruno, Cal. From this point the line proceeds in a southeasterly direction along the same line to Niles, Cal.; thence east to Lathrop, Cal; thence northerly to Sacramento; and thence northeasterly to Summit, Placer County, Cal.; to which point the work had been extended by June 30, 1912.

WASHINGTON.

[J. F. PRATT.]

Inspection of the portion of the Pacific coast comprised in the seventeenth lighthouse district was assigned to the above-named officer, with headquarters at Seattle, and he has been continuously on duty since October 18.

His duties include answering calls for information concerning charts, surveys, and other matter of interest to navigators or engineers; the examination of existing charts to discover defects or suggest improvements; to report the condition of harbor improvements and other changes affecting charts; to determine positions of prominent objects useful as aids to navigation; to supervise the repairs of vessels and the installation of machinery on the ships and launches of the Survey on the western coast, including the preparation of plans and specifications; and awarding contracts for construction. This officer also supervises the work of the tidal station at Seattle.

CONNECTICUT, NEW YORK, AND NORTH CAROLINA.

[H. P. RITTER.]

SUMMARY OF RESULTS.—Triangulation: 50 square miles of area covered, 13 signal poles erected, 5 observing tripods and scaffolds built, 14 stations occupied for horizontal measures, 23 geographical positions determined. Topography: (Chart revision) 12 square miles of area surveyed, 38 miles of general coast line surveyed, 2 miles of shore line of creeks, 2 miles of shore line of ponds, 15 miles of roads, 3 topographic sheets finished.

The work of triangulation in North Carolina to connect the triangulation of the Neuse River by the United States Engineers with that of the Coast and Geodetic Survey was in progress at the beginning of the year.

The instructions to the officer in charge of this work directed him to consult with the officer in charge of the United States Engineers office at Wilmington, N. C., to ascertain if the Engineers' triangulation of the Neuse River and its tributaries had been connected with three or more stations of the Coast and Geodetic Survey, and, if not, to proceed to the Neuse River and make such connections, and also to determine the geographic positions of any permanent objects along the shores, such as church spires, stacks, beacons, etc., not already connected with the Engineers' triangulation. The work done was to be primary triangulation, and any old station recovered was to be marked and described if necessary.

The examination of the maps and records of the United States Engineers showed that their triangulation of the Neuse River had been connected with only one of the Coast and Geodetic Survey triangulation stations, the Episcopal church spire at New Bern, which had been rebuilt on the same structure in 1871, since its determination by the Coast and Geodetic Survey. Although a search had been made by the Engineers for other Coast and Geodetic Survey triangulation stations, none had been found.

Under the circumstances it was necessary to make a search for the station marks of the 1863–1866 Coast Survey triangulation, having

in view the recovery of at least three stations, and, for the purpose of having a base line to start the new triangulation, two of them to be the ends of some line determined by the old survey. This examination was started in the vicinity of New Bern and extended down the river without success until the lower part of the old triangulation was reached, when four of the stations of 1866 were recovered, two of them being adjacent. All of these had been marked with heavy cast-iron screw piles.

While looking for the Coast and Geodetic Survey triangulation stations search was also made for available stations of the United States Engineers, to be used in connecting their survey of the Neuse River executed in 1909 and their survey made in 1907 for a dredged canal now completed, forming an inland waterway between Pamlico Sound and Beaufort Inlet. The northern end of this survey was at the junction of Adams Creek and the Neuse River, 24 miles below New Bern.

By May 27 the necessary triangulation stations were recovered and the building of signals commenced. Observation of angles was begun June 25 and completed August 3. During the latter period the marking of the new and re-marking of the old triangulation stations was also carried on. Transcripts were made of the field records of surveys of the Neuse River in the office of the United States Engineers at New Bern, and the observer expresses his grateful acknowledgment of facilities afforded by the officers in charge of that office.

Throughout the remainder of the year, except during time occupied on work of the Mississippi River Commission and attending the meeting of International Navigation Congress at Philadelphia, the work of topographic revision of charts in Greater New York and along the shores of Long Island Sound was steadily continued. The region covered during the year includes the north shore of Long Island Sound from Sheffield Island to Westcott Cove; north shore of Long Island Sound from Stanford Harbor to Little Captains Island; Hudson and East Rivers from West Sixty-seventh Street to Blackwells Island; Hell Gate and East River from Blackwells Island to Lawrence Point; Bay Ridge to Gowanus Bay; south end of Raritan Bay; and Hudson River from West Sixty-seventh to West One hundred and thirtieth Streets and west side of river.

TEXAS.

[EDWIN SMITH.]

SUMMARY OF RESULTS.—Astronomy: 6 stations occupied for observations of latitude.

Under date of March 18 Mr. Smith was instructed to take the field for the determination of the latitude of stations along the Texas-California arc of the transcontinental triangulation. Leaving Washington on February 5, the observer reached Ranger, Tex., on February 8. Between that date and March 12 latitude was observed at six stations—"Lacase," "Baird," "Sears," "Bynum," "Stanton," and "Smith."

On March 13 field work was closed and the observer returned to Washington.

NEW MEXICO, OREGON, AND TEXAS.

[EDWIN SMITH and C. V. HODGSON.]

SUMMARY OF RESULTS.—Triangulation: 12 signals erected, 18 stations occupied for horizontal measures, 16 geographic positions determined. Longitude: 9 stations occupied.

During the season beginning in September and ending in December two observers working in cooperation made determinations of the longitude of the following places: Fort Stevens, Oreg.; Jarilla, N. Mex.; Boracho, Tex.; Stanton, Tex.; Matagorda, Tex.; and Sabine Pass, Tex.

At Seattle it was decided to use the pier of the observatory at the University of Washington as a base for the Fort Stevens work, the old station having been destroyed. Signals were exchanged between Fort Stevens and Seattle on September 17, 18, 23, and 24, and the observers then proceeded to El Paso, Tex.

The old station at El Paso being lost, a new station was established. At El Paso signals were exchanged with Jarilla on October 10, 11, 12, and 13. The observations between El Paso and Boracho were completed on October 24. The Boracho pier was connected with a line of the primary triangulation about 10 miles distant. Besides recovering the two primary stations "Kronse" and "Reynolds," four new stations were built and five of the six stations occupied. Exchange of signals between Boracho and Stanton was made on the nights of October 30 and 31 and November 5. Matagorda and Sabine Pass were next occupied, using Austin as a base station. At both of these stations connections were made with the triangulation. At Austin a new pier was built to the eastward of the old one. The observations at Sabine Pass were closed on December 2, which ended the field work of the season.

Acknowledgment is made of courtesies shown and aid extended by the managers of the Western Union Telegraph Co. in the cities visited, and especially those at El Paso, Galveston, and Matagorda.

ILLINOIS, IOWA, KENTUCKY, MINNESOTA, NORTH DAKOTA, AND SOUTH DAKOTA.

[DON C. SOWERS.]

STATIONS OCCUPIED.—*Illinois:* Rushville. *Iowa:* Fort Madison, Montezuma, Primghar, and Storm Lake. *Kentucky:* Calhoun, Campbellville, Columbia, Danville, Edmondton, and Glasgow. *Minnesota:* Blue Earth, Buffalo, Caledonia, Fergus Falls, Hallock, Ivanhoe, Jackson, Litchfield, Long Prairie, Madison, Mahnomen, Red Lake Falls, Roseau, and St. Paul. *North Dakota:* Casselton, Devils Lake, Lamoure, Larrimore, Lisbon, New Rockford, and Pembina. *South Dakota:* Britton, Canton, Clark, Huron, and Parker.

Between July 1 and September 30 magnetic observations were made by the above-named observer at the stations mentioned. All of these except three were new stations. Each new station was permanently marked with a limestone or cement post with a brass station marker set in the top.

NEW YORK AND RHODE ISLAND.

[W. M. STEIRNAGLE.]

SUMMARY OF RESULTS.—Triangulation: 36 square miles of area covered, 8 signals erected, 9 stations occupied for horizontal measures, 67 geographic positions determined.

The revision of the triangulation at the eastern end of Long Island in the vicinity of Montauk Point, which had been carried on in turn by Assistants Sobieralski and Gauger, was assigned to Assistant W. M. Steirnagle on August 15, and the work was taken up by him on the following day. At that date the triangulation had been extended from Montauk Point as far west as station "Conklin," which had been re-marked.

The station known as "Gardiners Island" was next recovered and re-marked and the line from it to "Conklin" used as a base. The stations Acabanoc Cliff and Ram Island being no longer available, two new stations, "Woodhouse" and "Cartwright," were established so as to give a central point figure that commanded in a very satisfactory way nearly all the objects in Napeague Bay. Station "Gardiners Island" was re-marked.

During the progress of the work there were determined the positions of 11 buoys and a number of prominent objects useful as landmarks and for the topography and inshore hydrography.

On the completion of the foregoing work on September 6 the triangulation on Block Island, R. I., was taken up. After a reconnoissance of the entire island the station "Block Island" was recovered and marked in a permanent manner and three new stations, "Southwest," "Sandy Hill," and "Clay Head," were selected. Especial care was taken in marking the new stations and in establishing reference marks for them.

There were determined in position, besides the 3 new stations, 6 buoys, 5 harbor lights, 3 life-saving stations, 2 Weather Bureau signal towers, and a number of other prominent objects. Field work was closed on September 20.

TEXAS.

[PAUL M. TRUEBLOOD.]

SUMMARY OF RESULTS.—Triangulation: 400 square miles of area covered, 38 signal poles erected, 6 observing tripods built, 28 stations occupied for horizontal measures, 28 geographic positions determined.

Between January 15 and April 22 a revision was made of the triangulation of Corpus Christi Bay and Laguna Madre, Tex. Field work began January 24 with the re-marking and rebuilding of station "McGloins Bluff." Station "Mustang" was found to be in good condition, and two new stations were established and determined in Corpus Christi Bay, namely, "Shamrock," near the south end of Shamrock Island, and "Oso," at the mouth of Oso Creek.

After building the necessary signals in Baffins Bay the party was divided, one section continuing the work of signal building on the mainland to the south and the other the signal building and observing in the upper part of the laguna.

The following old stations were recovered: "Corpus," "McGloins Bluff," "Mustang," "North Base," "South Base," "Topo." Station "Padre" is known to be lost. A number of points on the edges of flats, windmills, gables of houses, etc., were determined by intersections. Old stations "Grants," "Peat Island," "Chappa," "Mott," "Richards D," "Pt. of Rocks," "Wheelbarrow," "Griffins," "Shells," "Penescal," "Rabbit," "Crawford," "Frank," "Coyote," "Indian," "Avoca," and "Mosquito" were searched for but not found, although in some cases the remains of old signals were found. In place of the foregoing, 33 new stations were established and permanently marked, after being determined in position. Tidal bench marks at Port Aransas and Point Isabel were inspected, and three new marks were established at Port Aransas.

CALIFORNIA, DISTRICT OF COLUMBIA, ILLINOIS, INDIANA, IOWA, MICHIGAN, MINNESOTA, NEVADA, NEW YORK, OREGON, WASHINGTON, AND WYOMING.

[T. L. WARNER.]

SUMMARY OF RESULTS.—Gravity: 18 pendulum stations occupied.

During the season from July 10 to November 27 determinations of the relative intensity of gravity, using half-second pendulums, were made at the following stations, given in the order of their occupation: Prentice, Wis.; Fergus Falls, Minn.; Sheridan, Wyo.; Boulder, Mont.; Skykomish, Wash.; Olympia, Wash.; Heppner, Oreg.; Truckee, Cal.; Winnemucca, Nev.; Ely, Nev.; Guernsey, Wyo.; Pierre, S. Dak.; Fort Dodge, Iowa; Keithsburg, Ill.; Grand Rapids, Mich.; Angola, Ind.; Albany, N. Y.; Port Jervis, N. Y.; and Washington, D. C.

Suitable locations for gravity stations were readily obtained in all places visited except Albany, N. Y., where a slight difficulty was experienced. Some delay was caused by the necessity of waiting for suitable weather for astronomic observations. The average time per station was 7.9 days. The unit cost per station was less than for the previous season. By certain changes in the method of operations a considerable saving of time was affected. The change most worthy of note made in the method of field work was the substitution of a wooden pier for the concrete one which it had been customary to use in gravity work. The new form of pier was constructed of four posts each about 8 inches square and 5 feet long. These were firmly fastened together so as to form a pier 16 by 24 inches on top, set in the ground about 2 feet, with the soil around and between the posts well packed. The part of the pier above ground was tightly boarded on all sides. Besides the saving in time and expense this pier has given very good results. This improvement was suggested by Mr. William Bowie, Inspector of Geodetic Work. The period of each pendulum was determined separately at the restandardization at the close of the season.

A considerable change in the period of pendulum B_4 took place between Albany and Port Jervis, N. Y., the cause of which has not been determined. Its period during that time was slightly increased. The theory that a large range of temperature causes an increase in the probable error of observation was not borne out by the results of this work.

ARIZONA.

[LLOYD W. WEED.]

At the Tucson magnetic observatory the usual observations were made. The Eschenhagen magnetograph and Bosch-Omori seismograph were operated without interruption, and the required absolute observations, scale-value determination, and magnetograph and seismograph records were obtained.

Special rapid-rate registration was carried out on specified term days each month in accordance with requests for international cooperation with Antarctic expeditions. Daily meteorological observations were made and reported to the local weather office at Phoenix, Ariz. About 50 earthquakes were recorded during the year, a slight increase over the previous year. Some minor repairs to the buildings were made.

CALIFORNIA.

[F. WESTDAHL, July 1 to May 31; F. MORSE, June 1 to June 30.]

The suboffice at San Francisco has been maintained during the year, the work including correspondence relating to matters of interest on the Pacific coast, replying to requests for information respecting charts and surveys, tidal data, and other matters, the forwarding of instruments and supplies sent from Washington to field parties in the Philippines, Hawaii, and Alaska, payment of travel expenses and issue of transportation orders to officers passing through San Francisco to the field or returning. Desk room for officers temporarily on duty at San Francisco has been provided.

Additional bench marks were established at the Presidio tidal station and levels were run between the fixed tide staff and the bench marks. Supervision has been maintained over the work of the Presidio tide station. An inspection was made of the agencies for the sale of charts in San Francisco. Contracts were made for the building of four boats for use in the Philippine Islands, and these were completed and shipped.

It having become desirable to establish new bench marks in connection with the tide station at the Presidio, San Francisco, Cal., a suitable location for the purpose was selected on the concrete abutment or sea wall at the base of the wharf. This abutment has been in existence for many years, and is apparently well settled and solid. The inshore side of the abutment was selected for one of the new marks and another was established on its top surface. Copper bolts placed in drilled holes and leaded constitute the bench marks. Lines of levels were run between the new bench marks and the fixed tide staff and connection was also made with the old bench marks. This work was done on May 8 and 11.

MAINE, MARYLAND, AND TEXAS.

[ISAAC WINSTON.]

SUMMARY OF RESULTS.—Triangulation: 875 square miles of area covered, 25 signal poles erected, 1 observing scaffold built, 54 stations occupied for horizontal measures, 143 geographic positions determined.

The field revision of the triangulation on the coast of Maine in the vicinity of Portland, and the determination of the position of aids to

navigation and of prominent landmarks for insertion on the charts, was begun early in September.

The United States engineer officer at Portland placed the records of his office at the disposal of the Coast and Geodetic Survey and assigned an assistant engineer to point out the location of triangulation which had been established in preparing a fire-control system and in the surveys for the improvement of Portland Harbor. This triangulation is based upon that of the Coast and Geodetic Survey. All of the important stations were recovered and supplementary descriptions made to show their present condition.

A hydrographic survey having recently been made in connection with the improvement of the harbor, copies were obtained and transmitted to the office. Copies were also obtained of topographical surveys made by the city engineer of Portland. The lighthouse inspector of the district furnished a list of prominent objects useful for insertion on the charts.

All of the fixed aids to navigation in Casco Bay and several shoals not shown on the charts were located, as also was a ledge and rocks off Yarmouth Island on which Dr. F. I. Proctor's yacht had struck. The positions of all permanent wharves were determined. Notes were made to show the condition of the aids to navigation, the condition of the rocks and islands, whether wooded or bare, and the heights estimated where no contours were shown on the charts.

A plan of South Portland showing the streets actually in use was obtained, the trolley lines leading out of Portland were located, and a blue print was obtained showing the location of the Texas Co.'s new wharf and the dredged area in front of this wharf. Photographs were obtained when practicable of prominent objects located. Acknowledgment is made of assistance rendered and data furnished by Col. W. E. Craighill, United States Engineers, and his assistants, and to Mr. Bion Bradbury, city engineer of Portland. Field operations closed on November 18.

On December 7 a determination was made of the position of the Italian steamer *Fortuna*, which had stranded on the beach about 1½ miles north of Ocean City, Md. The *Fortuna*, an iron vessel of about 2,500 tons, was bound for Philadelphia from Buenos Aires. In a storm on December 4 she was carried on Fenwick Island Shoals, and when gotten off it was found that she was leaking so badly that the captain decided to beach her.

While at Ocean City information was obtained in regard to certain abandoned fish pounds offshore constituting a danger to navigation and also in regard to prominent objects to be used as landmarks on the charts.

On December 9 instructions were issued to the above-named officer to take up the revision of the triangulation of the coast of Texas, beginning at West Bay and Oyster Bay, in the vicinity of Galveston, of Corpus Christi Bay and Sabine Pass and Lake; from Sabine Pass to East Bay; Oyster Bay to Brazos River, and Brazos River to Matagorda Bay, including the determination of the position of lighthouses and beacons and of prominent objects useful as aids to navigation; the recovery and re-marking of old triangulation stations and the inspection of tidal bench marks at various points.

Nearly all of the triangulation stations established in 1900 by the Corps of Engineers, United States Army, in the survey of Galveston

Bay were recovered and five old Coast and Geodetic Survey stations were found. All stations close to the shore line were destroyed by a storm in 1900.

It was found that the United States Engineers had extended a triangulation from the Coast and Geodetic Survey work at Sabine Pass to cover Sabine Lake and the Nueces River to Beaumont, Tex., and Sabine River to Orange, Tex., and copies of the data necessary to compute this work were obtained. Data and blue prints of recent surveys of the south shore of Sabine Lake, the Nueces River to Beaumont, and the Sabine River to Orange, and of Galveston Bay were also obtained from the United States Engineers. The beacons recently established in Galveston Bay were located, and a triangulation was extended from Galveston Bay to Brazos River, a distance of 50 miles, covering West Bay, Oyster Bay, and the coast to Brazos River. This triangulation was based on two lines in the Galveston Bay triangulation and extends to known positions on the Brazos River. A number of channel beacons along the inland waterways were located and other material collected for use in chart correction.

A search was made for old triangulation stations at the head of Matagorda Bay, but none were found. At Corpus Christi several triangulation stations recovered by Assistant Harold D. King in 1905 were visited and found in good condition. Several prominent objects at Aransas Pass and Port Aransas were located. A number of tidal bench marks were inspected and several new ones established. Data were obtained from the United States Engineers of a survey for an inland waterway through Laguna Madre. Field work was closed on June 1.

ALASKA.

[F. L. ADAMS.]

The magnetic observatory at Sitka, Alaska, has continued in operation. The Eschenhagen magnetograph and the Bosch-Omori seismographs made continuous records throughout the year, and the required absolute observations, scale value determinations, and daily meteorological observations were made. About 85 earthquakes were observed. Special observations were made in studying irregularities in the results obtained with the earth inductor. Special rapid-rate registration was carried out on specified term days in each month in compliance with requests for international cooperation. Necessary minor repairs to the buildings were made.

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

SUMMARY OF RESULTS.—Triangulation: 38 square miles of area covered, 26 signal poles erected, 29 stations occupied for horizontal measures, 28 geographic positions determined. Topography: 24.4 square miles of area surveyed, 53.25 miles of general coast line surveyed, 2 topographic sheets finished. Hydrography: 22.7 square miles sounded, 473.9 miles of soundings, 4,556 positions determined, 12,832 soundings, 4 tide stations established, 4 hydrographic sheets finished.

During the summer season, beginning August 24 and closing October 16, the party on the steamer *Gedney* completed the hydrography and topography of Tongass Narrows from Ketchikan to Spire Island, including the head of Nichols Passage in the vicinity of Walden Rocks; the hydrography of Wrangell Strait from Burnt

Island to Sumner Straits and the development of the supposed 3 and 4 foot spots in the vicinity of buoy No. 11, opposite Petersburg; and the hydrographic and topographic survey of the approaches to the McAndrew Copper Co.'s wharf in Kasaan Bay.

The vessel sailed from Seattle on August 7 for the working ground in southeastern Alaska, stopped at Union Bay for coal, and arrived on August 16 at Metlakatla, where the steamer *Cosmos* and launch *No. 117* were placed in the water and prepared for active fieldwork. During the passage from Union Bay to Metlakatla the ship was swung at two places to determine the magnetic declination. Fog and cloudy weather prevented swings at other places along the route.

A party on the steamer *Cosmos* took up the hydrographic survey at the southern end of Wrangell Strait and carried this work from Burnt Island to well off the entrance to the south end of the strait. The triangulation stations established during the previous season were recovered and a number of auxiliary points were determined and connected with the main scheme in order to give controlling points in the small bays and bights where soundings were taken. The tidal bench marks established in 1910 in the vicinity of Burnt Island were recovered and connected with the tide staff from which tides were read during the progress of the work. Additional bench marks were established for the new staff, which was located opposite Mitkof post office, 1 mile below Burnt Island.

The development of the main channel shows no material change from that shown on the existing charts, with the exception that the shoal shown as making off Point Alexander does not exist, making it possible for vessels to pass close to the point. A small 4-fathom patch was found near the southwestern point but well out of the track of vessels.

While the *Cosmos* was at work in Wrangell Strait the remainder of the party on the *Gedney* was engaged in the hydrography and topography of Tongass Narrows, the work beginning at Pennock Island and extending down Revillagigedo Channel to the vicinity of Spire Island. This includes the area south of Nichols Passage to Blank Islands. The triangulation stations of the previous season were all recovered, signals built, and the topography and hydrography carried on simultaneously.

An automatic tide gauge was established on the Mill Wharf at Ketchikan and connected with the bench marks established in 1906. Tides were recorded at this station until the close of the season.

By October 9 the main part of the survey of Tongass Narrows was completed. The *Cosmos* returned from the work in Wrangell Strait, and the *Gedney* and launches proceeded to Kasaan Bay to survey the wharf of the McAndrew Copper Mining Co. Signals were built, a tide staff set up, and continuous readings made for four days, simultaneously with those on the automatic gauge at Ketchikan. The shore line was run in with the plane table. The waters in the approaches and vicinity of the wharf were closely developed and plotted as the work progressed. In the meanwhile an effort was made to extend the triangulation down from the head of Kasaan Bay. Three old stations established in 1906 and 1908 were recovered and marked, a reconnoissance made, and signals erected, but the

abrupt closing of the season by unfavorable weather prevented anything more being done than the carrying of an azimuth through to the hydrographic and topographic work.

The *Gedney* and launches returned to Ketchikan October 16, and thence proceeded to Metlakatla, where the *Cosmos* and launch *No. 117* were hauled out and housed for the winter. After coaling at Ketchikan the *Gedney* sailed for Seattle, arriving October 30.

On May 24, 1912, the *Gedney* sailed from Seattle for Alaska via Union Bay, British Columbia, arriving at Ketchikan May 30. Launch *No. 117* was placed in commission, and while the *Cosmos* was being repaired the *Gedney*, with launch *No. 117*, proceeded to Kasaan Bay to complete the triangulation left unfinished last year. While this was being done a number of soundings were taken in the vicinity of the McAndrew Wharf to verify some doubtful soundings obtained during the previous season. It was found that the sounding line showing 8 feet, 28 meters southeast and outside of the line of the McAndrew Dock, was in error. A least depth of 13 feet was obtained close to the line of the face of the dock. On June 16 the triangulation extending from Karta Bay to the McAndrew Wharf was completed and the vessel returned to Metlakatla. The *Cosmos* was launched and began work with launch *No. 117* and the *Gedney* in Tlevak Straits. Old triangulation stations were recovered, a tide station established, and the survey commenced on June 20.

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

SUMMARY OF RESULTS.—Triangulation: 5 stations occupied for horizontal measures, 6 geographic positions determined. Topography: 75 miles of general coast surveyed, 1 topographic sheet completed. Hydrography: 235 square miles of area covered, 875.5 miles run while sounding, 2,681 positions determined, 12,081 soundings, 1 tidal station established, 2 hydrographic sheets completed.

The party on the steamer *Yukon* at the beginning of the fiscal year was in the field engaged in the survey of the west shore of Cook Inlet. Surveying operations were continued until September 17, when the *Yukon* was housed over and secured for the winter, and on October 5 the party proceeded to Seattle, arriving there October 17.

During the season the hydrography and topography of the west shore of Cook Inlet were completed from West Foreland south to and including Kalgin Island. The west shore of Cook Inlet from Harriet Point north to the Kustatan River is low and covered with a growth of trees extending about 2 or 3 miles back, then rises in a steep mountain range, the most prominent peaks being Mount Redoubt and the two peaks called Double and Black. The Butte, on which the triangulation signal of that name is located, is one of the most prominent landmarks.

Harriet Point is a prominent point on the west shore about abreast of the south end of Kalgin Island. There is a good anchorage in moderate weather on the north side of Harriet Point.

Kalgin Island is about 11 miles long and 250 feet high at its southern and northern ends. The best anchorage in this locality is off the north end of this island.

Several sunken rocks were found off the northeast point of Kalgin Island, but no rocks were found south of the sand shoal midway between West Foreland and Kalgin Island.

In April and May, 1912, preparations were made for resuming work in Cook Inlet. The steamer *Yukon* was repaired at Seldovia and supplies and outfit were taken on board. The launch *Alpha* was put in commission and repaired. On June 14 the rock off Dangerous Cape, entrance to Port Graham, on which the *Yukon* struck during the previous season, was located. Two triangulation signals were rebuilt, and at the close of June the party was at work in Turnagain Arm.

Reports were submitted by the chief of party and by Mr. I. M. Dailey in regard to the volcanic eruption at Mount Katmai on June 6. Assistance was rendered the revenue cutter *Manning* by conveying letters and provisions to the relief station at Afognak, where the refugees had been taken from Katmai and other villages. The fall of ashes from the volcano was about 18 inches on the level at Kodiak, with drifts in some of the valleys from 4 to 8 feet, but the inhabitants were not in danger.

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

SUMMARY OF RESULTS.—Triangulation: 500 square miles of area covered, 12 signals erected, 9 geographic positions determined, 17 elevations determined trigonometrically. Magnetic work: 11 land stations occupied, 2 sea stations occupied. Topography: 424 square miles of area covered, 156½ miles of general coast line surveyed, 15 miles of shore line of creeks and sloughs surveyed, 8 miles of roads, 4 topographical sheets completed. Hydrography: 863.5 square miles of area covered, 202.84 miles run while sounding, 5,880 positions determined, 26,048 soundings, 2 tidal stations established, 1 automatic tide gauge erected, 6 current stations occupied, 6 hydrographic sheets completed.

During the season beginning June 2 surveying operations in Cook Inlet, Alaska, were extended by the party in the steamer *McArthur* from Harriet Point southward to Point Chinitna and joining the work done in 1910 by the party on the steamer *Patterson*. From Harriet Point to the southward of Chisik Island lines of soundings were run offshore at distances of half a mile apart, widening to the southward to nearly 2 miles apart off Chinitna, with an interval extending about 6 miles offshore and outside of the launch work. The topography was completed to a point a short distance south of Chinitna Bay.

By July 1 the work of signal building in the vicinity of Harriet Point, which had been begun on June 9, was completed; the signals required for the survey had been erected to and including Tuxedni Harbor, and hydrographic and topographic work was in progress.

A base line was measured in Tuxedni Harbor, a single figure of triangulation was made use of to bring in azimuth and geographical positions, and the remainder of the harbor was surveyed by plane-table traverse. A single triangulation figure was used also to check the position of signal "Wood," the termination of the traverse southward from Harriet Point.

The topography and inshore hydrography from Harriet Point to Chisik Island were surveyed on a scale of 1/40,000, as was the upper arm of Tuxedni Harbor. The main portion of Tuxedni Harbor was surveyed on a scale of 1/20,000.

Southward of Tuxedni Harbor there were only two located points on the sheet, Chinitna at the southern extremity and Iliamna at the northern, with an approximate determination of Bear Flat between

them, and about 10 miles from Iliamna. To avoid the great expense and time required to locate signals by triangulation, the main control having been completed previously, the summits of the first range of hills were cut in, the positions of the distinctive peaks computed, and these were used to check the traverse for locating the inshore hydrographic signals and determining the shore line. A plane-table traverse was carried to and around Chinitna Bay and about halfway between Chinitna Bay and signal "Chinitna."

The inshore hydrography on a scale of 1/40,000, as was also the topography southward of Chinitna Harbor, was completed to a point 2 miles south of the south point of the entrance to Chinitna Bay, and the survey of Chinitna Bay on the same sheet was completed.

The outside hydrography done by the ship was on a scale of 1/100,000, the distance between sounding lines varying from one-half mile in the northern half of the sheet to 2 miles in the southern; and the length of line varying from 9 miles at the northern end of the sheet to 20 miles at the southern end. In general, the lines were normal to the shore, and the work joined that of Assistant F. H. Hardy above Harriet Point, the inshore work of the *McArthur* during the same season, and the ship soundings by the *Patterson* in 1910. The bottom was found usually to be of sand or clay and free from irregularities.

Mountain peaks were used as signals over nearly the entire area. While sounding, a number of peaks were cut in by sextant angles and sextant vertical angles were taken, and with this base rough 1,000-foot contours were sketched in. Back of Chinitna Bay intersecting cuts could not be obtained and both distances and elevations were estimated.

Continuous tide observations were made with an automatic gauge at Seldovia during the season. Staff gauges were maintained in Tuxedni Harbor and Chinitna Bay while the parties were in camp in those localities. Compass declinometer observations of magnetic declination were made at several triangulation stations, and at other shore stations, including Ketchikan and Union Bay, on the voyage south, and the ship was swung in several positions at sea. Current observations were made off Cape Kasilof, at Tuxedni Harbor, and at other points. Work in Cook Inlet closed for the season on September 28.

At Fritz Cove a reported shoal was sounded over and examined with a drag. The shoal spot was found to be south of its reported position, with a least depth of 6 feet at mean low water, instead of 3 feet as reported.

The automatic tide gauge at Skagway was removed, and afterwards established on the Pacific Coast Steamship Co.'s wharf at Juneau. The elevation of the gauge was referred by leveling to bench marks on shore, and while this was being done a plane-table traverse on a scale of 1/5,000 was made of the water front at Juneau.

Returning from Alaska the *McArthur* sailed from Juneau on November 3 and arrived in Seattle on November 14.

The *McArthur* returned to Alaska in June, 1912. At Treadwell and Douglass examinations were made of the shore line, and a plane-table traverse on a scale of 1/10,000 was run from station "Pump"

to Sheep Creek. A tide staff was set up at Douglass and comparative readings made with Juneau. On June 7 a fall of ashes from the eruption of Mount Katmai on the Alaska Peninsula was noticed.

Hydrographic work was done in the channel to determine the amount of filling due to the deposit of tailings from the mines. The results of the survey show that the Treadwell mill has filled in a section about 1,000 meters long and extending about 250 meters from the shore. The 10-fathom curve is about 50 meters outside of this bank. It has filled in nearly to the face of the dock, and vessels discharging there frequently ground at low water. A clear channel of about 900 meters between the 10-foot curves is open, with depths from 20 to 26 fathoms over the greater part of the channel.

After completing work at Juneau, a reconnoissance was made for carrying a scheme of triangulation into Aialik Bay, a tide gauge was established, signals were built for the triangulation, topography, and hydrography, and the occupation of stations in the triangulation was begun.

A report was made concerning the eruption of Katmai Volcano and the fall of ashes on the mainland and adjacent islands, which, besides destroying vegetation, had covered up the station marks established by the Survey, making their recovery difficult.

[W. E. PARKER, Commanding Steamer *Patterson*.]

SUMMARY OF RESULTS.—Reconnoissance: 27 lines of intervisibility determined, 10 points selected for scheme. Triangulation: 800 square miles of area covered, 5 signals erected, 2 observing tripods built, 17 stations occupied for horiontal measures, 8 stations occupied for vertical measures, 35 geographic positions determined, 14 elevations determined trigonometrically. Latitude, longitude, and azimuth: 1 latitude station occupied, 1 azimuth station occupied. Magnetic work: 13 stations occupied for observations of magnetic declination, 7 stations occupied for observations of magnetic dip and intensity. Topography: 84.5 square miles of area surveyed, 151.5 miles of coast line surveyed, 3 topographic sheets completed. Hydrography: 172 square miles of area covered, 1,116 miles run while sounding, 6,974 angles measured, 10,135 soundings made, 5 hydrographic sheets completed.

Work on the coast of Alaska in the vicinity of Dolgoi Island had been begun by the party on the steamer *Patterson* on May 19, 1911. The work of the season included the triangulation, topography, and hydrography of Alaska Peninsula. A base line 1,988 meters in length had been measured on the north shore at the head of Volcano Bay with an invar 50-meter tape, and from this base the triangulation was extended over the entire region to be surveyed.

The *Patterson* proceeded to Unalaska for coal on May 28 and then returned to the working ground, reaching Dolgoi Island on June 7. While waiting for an opportunity to coal the vessel was swung off Dutch Harbor to determine compass deviation on all courses. Reconnoissance, signal building, and triangulation in the vicinity of Dolgoi Island were then resumed. An automatic tide gauge was set up inside the harbor, from which continuous records were obtained until the close of work in the vicinity.

On June 15 the launch *Reynard* dragged anchor in a heavy sea, went on a rocky shore, and sunk. The launch was got afloat the next day only slightly damaged.

Failing to obtain star observations for latitude and azimuth, a determination of latitude was made by vertical angles on the sun

near the meridian and several sets of horizontal angles were taken during the morning and afternoon at nearly equal altitudes for azimuth.

Topographic work was begun June 24 and hydrography on June 27 beginning with the passages between Dolgoi Island and the mainland and between the Iliask Islands, but when work in these places was impracticable on account of weather conditions surveys were made wherever possible. Dolgoi Harbor was surveyed on a scale of 1/20,000.

On July 1 the *Patterson* returned to Unalaska for coal, leaving a shore party with two launches and small boats at Dolgoi Bay to continue the field work.

In returning from Unalaska in a fog on July 12 the vessel touched slightly on a shoal or rock about halfway between Scotch Cap Lighthouse and Middle Point. Transportation from Unalaska to King Cove was furnished to Mr. Alexander Wetmore, of the United States Biological Survey, and his assistant, who were engaged in collecting birds and mammals on the Aleutian Islands.

Much difficulty was experienced with the engine of the launch *Reynard*, which required frequent repairs and finally became completely disabled.

Several triangulation schemes for connecting with the stations located by Assistant Westdahl on Umga and Amugat Islands were laid out, but considerable reconnoissance was necessary before a practicable solution was found. The station on Amugat was recovered and the old signal on Umga was found and repaired. The weather conditions here prevented any observing.

At the end of July the shore party was taken on board and efforts directed toward completing all work around Dolgoi Island. On August 14 and 15 latitude and azimuth sights were obtained at the astronomical pier in Dolgoi Harbor.

All work in this vicinity was completed by August 18. The eastern, southern, and western sides of Dolgoi Island, the Iliask Islands, and the mainland from East Bay to Kitchen Anchorage in Belkofski Bay, including Volcano and Bear Bay, were surveyed by plane table on a scale of 1/40,000. The northern side of Dolgoi Island, southern end of Ukolnoi Island, western side of Poperechnoi Island, and the remainder of Belkofski Bay were sketched from plane-table cuts to tangents and intersections on natural and artificial objects on the shore. The hydrography of the passage between Dolgoi Island and the mainland and between the Iliasik Islands and of the adjacent waters, including Volcano Bay, was executed on a sheet of the same scale. A new channel between Inner Iliasik Island and the mainland was developed, but this channel is too shoal and narrow to be of much benefit to commerce. A hydrographic and topographic survey of Dolgoi Harbor was made on a 1/20,000 scale.

On August 19 the party moved to the vicinity of Deer Island to complete the connecting triangulation. While cruising in this vicinity soundings were taken and position determined by sextant angles. The observers at the triangulation stations also got many cuts to points and tangents. These were plotted on a sheet and the intervening shore line sketched in. The triangulation was completed on August 21, and the vessel sailed for Unalaska. Magnetic observa-

tions for declination, dip, horizontal, and total intensity were made at the station at Dutch Harbor.

An examination was made of the reported positions of Leonard Rock and Anderson Rock with negative results, no indications of such dangers being discovered. A least depth of 4 fathoms was found in a kelp patch between Aleks and Omida Rocks.

A reported rock and shoal near Cape Pankof were searched for, but nothing was found to indicate their existence, and an examination of the south point at the entrance to West Anchor Cove showed no such reef as indicated on the chart.

A survey was made of West Anchor Cove, which was found to afford an excellent harbor for the largest vessels, being easy of access and quite free from dangers. The ship was swung at West Anchor Cove, magnetic observations were made at a station on shore, the shore line from Bold Cape to Cold Bay was sketched, and a line of soundings run along this coast and around Belkofski Bay.

A shoal with 5 fathoms of water reported by Mr. S. Applegate was found on a line between Acherk Harbor and Amugat Island and 9 miles from the former. Magnetic observations were repeated at Dutch Harbor and the vessel again swung, and on the return voyage magnetic observations were made at sea.

The *Patterson* sailed for Seattle on October 4; stopped at Ketchikan for provisions and water on the 12th, and at Union Bay for coal on the 17th, at which place magnetic observations were made, and arrived at Seattle on October 19.

[H. W. RHODES, Commanding Steamer *Explorer*.]

SUMMARY OF RESULTS.—Reconnoissance: 320 square miles of area covered, 82 lines of intervisibility determined. Base lines: 1 secondary, length of 2,329.2 meters. Triangulation: 111 square miles of area covered, 21 signal poles erected, 9 stations occupied for horizontal measures, 8 stations occupied for vertical measures, 14 geographic positions determined, 30 elevations determined trigonometrically. Latitude, longitude, and azimuth work: 1 latitude station occupied, 1 longitude station occupied, 1 azimuth station occupied. Magnetic work: 4 land stations occupied for declination, dip, and intensity, 6 sea stations occupied for declination, 8 sea stations occupied for dip, 7 sea stations occupied for intensity, 7 complete swings of ship. Topography: 25 square miles of area surveyed, 32.7 miles of general coast line surveyed, 5.8 miles of rivers surveyed, 1 topographic sheet completed. Hydrography: 5 square miles of area sounded, 139.5 miles run while sounding, 636 positions determined, 3,566 soundings, 1 tidal station established, 1 current station occupied, 1 hydrographic sheet finished.

Instructions issued in March to the commanding officer of the steamer *Explorer* directed that the party on that vessel take up as soon as practicable the survey of Kuskokwim Bay, Alaska, including the triangulation, topography, and hydrography. A preliminary survey of the approaches to the Kuskokwim had been made by the *Explorer* during the preceding fiscal year, and urgent requests for the completion of the work had been received from the Seattle Chamber of Commerce and others interested in the navigation and commercial development of that portion of the Alaska coast.

The *Explorer* was delayed in San Francisco undergoing extensive repairs until July 12, when she sailed via Seattle for Unalaska, Alaska. Arriving at the latter place on July 30, a supply of coal was taken on board and the vessel proceeded to Goodnews Bay, where a party was landed to begin work. It was then found necessary to take the vessel immediately to Nushagak for supplies. On September 1, the vessel

made another trip to Nushagak for coal, it having been found impossible to engage a vessel to transport coal to the locality of the work. These trips considerably shortened the season available for field operations.

A base line was measured at Goodnews Bay; an azimuth and an approximate latitude and longitude determined, but unfavorable weather greatly delayed the progress of the triangulation. Twelve triangulation stations were established and eight of them were occupied, the triangulation covering a stretch of about 18 miles, with Goodnews Bay in the center.

No offshore hydrography was done, as at first the determination of the mountain peaks was not far enough advanced to permit their use in that work, and during the last two weeks of the season they were almost continually obscured by clouds. While awaiting favorable weather for continuing the reconnoissance and triangulation a hydrographic survey was made of the entrance and a part of the inside channel of Goodnews Bay. One topographic sheet on a scale of 1/20,000 of the outside shore line in the vicinity of Goodnews Bay was about two-thirds completed.

Field work in Kuskokwim Bay was closed on September 22, owing to continued unfavorable weather, and the vessel proceeded to Unalaska, arriving there September 24.

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

SUMMARY OF RESULTS.—Reconnoissance: 288 square miles of area covered. Triangulation: 12 signal poles erected. Topography: 37.1 square miles of area covered, 79.3 miles of coast line surveyed, 4 topographical sheets finished. Hydrography: 100 square miles of area covered, 845.8 miles run while sounding, 6,184 soundings, 4,897 positions determined, 1 tidal station occupied, 1 square mile of area covered with drag, 8 hydrographic sheets finished.

At the beginning of the year the party on the steamer *Taku* was at work in Prince William Sound, Alaska, engaged on the topography of Naked, Peak, and Storey Islands, the necessary triangulation having been completed in June. For additional topographic control a plane-table triangulation was carried through Liljgren and McPherson Passages. The topographical work was completed by August 8. The shore line of the three islands is rocky, but not so abrupt as to furnish serious difficulty for plane-table work. The hills are regular in form and easily contoured.

The hydrography was begun on June 21 and completed on August 15. This includes all the bays indenting Naked, Peak, and Storey Islands and the passages between those islands. The hydrography was carried offshore to join work previously done by other parties, and a search was made for a rock reported between Naked and Smith Islands. This area was thoroughly examined, but no indication was found of the existence of such a rock. An area about 6 square miles in extent was covered with soundings, ranging from 80 to 100 fathoms and the soundings closely spaced. The foul ground, showing 18 fathoms on chart 8550, 1½ miles northwest of Little Smith Islands, was developed thoroughly. Eight fathoms was the least water found by running radiating lines with the steamer and afterwards drifting with the current in a dinghy and feeling with a hand lead. Lines were run in this way in the dinghy over the whole of the

doubtful area. Very few shoals or foul areas were found off the north, east, or south shores of the islands, but the bottom was found to be very irregular off the west shores, necessitating a close system of sounding lines over these areas.

An automatic tide gauge, in connection with a staff gauge, was established in Liljgren anchorage for this work, and a continuous tidal record was obtained from June 16 to August 16.

On August 18, when the vessel was on its way from Naked Island to Green Island, several lines of soundings were run between Smith and Seal Islands, where the steamer *Latouche* reported having found a depth of 12 fathoms. The topography of Green Island and the small islands near by was completed on September 16 and the hydrography on the 20th. The bottom was thoroughly developed along the west side of the island from the north point to the south point and offshore to join previous surveys. This area is very foul and covered with kelp in many places. The areas of kelp are shown on the hydrographic sheets. Gibbon anchorage on the west side is the only port visited by vessels. Here fish are dried during the summer months to be used as food for the blue foxes which are raised on the island.

At Landlocked Bay a day was spent by the topographic party in locating the wharves in the bay and also in determining the positions of houses to be used as signals by the hydrographic party in making additional soundings required at the head of the bay. Sounding lines were run at the head of Landlocked Bay to supplement previous work.

The hydrographic party was employed on wire-drag work off Copper Mountain Point searching for a rock reported inside the 10-fathom curve. The doubtful area was thoroughly dragged but the rock was not found, the reported rock being probably the 1¼-fathom spot about 500 meters off the point.

Field work closed for the season on September 27.

Field work in Prince William Sound was resumed in May, 1912. The steamer *Taku* was repaired at Cordova and other preparations made as rapidly as possible.

On May 22 a determination was made of the position of the rock off Cape Hinchinbrook on which the Lighthouse steamer *Armeria* was wrecked. Three lines of sounding were run close together parallel to the shore and on the third line a sounding of 4½ fathoms was obtained, with 6 fathoms or more on the remainder of the line. A further examination was made to develop the rock, on which the least water found was 15 feet at near low water. The *Armeria's* draft when she struck was stated as 14 feet, and there was a swell running. The rock is a pinnacle, very steep on all sides, but more so on the side toward the lighthouse. From 2½ fathoms the lead dropped very quickly to 5 and 6 fathoms. The summit was estimated to be 3 feet square. The rock was found to be about 350 meters offshore and directly off the middle of three caves in the cliffs.

A line of soundings was run in the unsurveyed area between Point Johnstone and Naked Island. The latter part of June was spent in erecting signals for the triangulation, topography, and hydrography, but no observing was done, owing to unfavorable weather.

OUTLYING TERRITORY.

PHILIPPINE ISLANDS.

[P. A. WELKER, Director.]

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 those islands, under general instructions from the Superintendent, and he makes plans for field work and issues instructions to field parties. The results of observations made in the field are computed and discussed in the office at Manila, and drawings for new charts are there prepared and transmitted to the office at Washington for publication.

Sailing directions and notices to mariners for the Philippine Islands are prepared and published at Manila.

Cooperation is maintained with the various bureaus of the insular government and with the military and naval authorities in the islands.

The collection of data in regard to geographic names and in relation to the geography of the Philippine Islands is among the important functions incidentally performed by the Coast and Geodetic Survey.

The progress of the work of the field parties is detailed in the abstracts which follow.

During the entire fiscal year the five steamers available for surveying duty have been continuously engaged in the field, except during the interval when repairs were necessary. In addition to the force attached to the steamers, one shore party was engaged in triangulation in Mindanao for nine months and another in making observations for the determination of the magnetic elements in various parts of the islands during a period of three months.

Special reference is made to the extensive and important trigonometric surveys that have been carried on during the year. The triangulation over the large water area bounded by Luzon, Burias, Masbate, Panay, and Tablas Islands, involving lines of as much as 83 statute miles in length, has practically been completed, only a few additional observations for the purpose of increasing the strength of the schemes being necessary. The triangulation crossing the island of Mindanao, connecting Iligan and Allana Bays, has been entirely completed. Both of these were difficult pieces of work. The triangulation connecting Mindoro and Panay and extending across the Cuyos Islands to the Calimanes and Palawan, including lines of a length as great as 91 miles, has been well advanced. This work will result in the connection of the surveys in Palawan with the surveys of the entire archipelago.

In planning field work the effort has been made toward taking it up in the order of the most pressing needs of the mariner, with due regard to the commercial importance of the various unsurveyed regions and to the economy resulting from continuous connected surveys, thus avoiding the necessity for any extensive future adjustment, extra labor, or expense. There are few localities of commercial importance now unsurveyed.

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

Tidal observations.—In addition to the regular tidal observations made in the field in connection with hydrographic surveys, the self-registering tide gauge at Manila has been in constant operation during the entire fiscal year. The two self-registering gauges of this service, which for a number of years had been operated under the direction of the Engineers of the United States Army, and the results for which had been furnished to this office, were discontinued during the fiscal year. The one at Corregidor was discontinued on July 28 and the one at Grande Island on February 1.

Table of distances.—At the request of the Board of Rate Regulation, a table of distances between ports of the Philippine Islands has been prepared by this office for use in determining the proper charges for transportation of freight and passengers. Information regarding distances not tabulated has also been furnished to the various bureaus of the Government and to private parties when requested. By recent action of the Board of Rate Regulation, all questions regarding the distances between ports are submitted to this office for determination.

Geographic names.—During the year the usual efforts have been made for gathering together the most reliable information in regard to the spelling of geographic names and to prepare a list of all places in the Philippine Islands. This list has been steadily growing, and it is estimated at present to consist of considerably more than 30,000 names. The Director of Coast Surveys is the secretary of the Philippine Committee on Geographic Names.

Harbor lines commission.—On August 9, 1911, the Director of Coast Surveys was appointed a member of the Harbor Lines Commission of the Philippine Islands by the Secretary of Commerce and Police, and since that date has served in that capacity.

Progress.—During the year 6,573 square miles have been covered by reconnoissance, 18,269 square miles of triangulation has been completed and 1,316 miles of coast line surveyed, 1,315 square miles of topography have been surveyed and 49 topographic sheets completed. The hydrographic work has covered 9,535 square miles. Twenty-five tidal stations and 10 current stations have been occupied and 53 hydrographic sheets have been completed.

The general coast line surveyed during the year is about 6.5 per cent of the total length. Since the beginning of the work about 57.8 per cent of the general shore line has been surveyed.

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

SUMMARY OF RESULTS.—Base lines: 5 base lines measured. Triangulation: 22.59 square miles of area covered, 117 signals and scaffolds erected, 98 stations occupied for horizontal measures, 190 geographic positions determined. Topography: 480 square miles of area covered, 400 miles of coast line surveyed, 101 miles of rivers and creeks surveyed, 84 miles of roads surveyed, 18 topographic sheets finished. Hydrography: 2,441 square miles of area sounded, 4,474 miles run while sounding, 42,664 soundings made, 6 tidal stations established, 19 hydrographic sheets finished.

On account of the necessity for obtaining the most favorable conditions during the northeast and southwest monsoons, the work of the

Pathfinder during the first half of the fiscal year was carried on in two localities, the east coast of Mindanao and the southwest coast of Negros.

At the beginning of the year the vessel was engaged in combined operations in the vicinity of Cauit Point, Mindanao Island. The work along this coast was extended in a southerly direction to Banculin Point, Liango Bay, at which place on September 28 the season's work was closed. No dangers to navigation other than those generally known were discovered.

After repairing at Manila, the *Pathfinder* took up the surveys on the southwest coast of Negros Island in the vicinity of Binalbagan, but the field of work was soon changed to the region south of Sojoton Point.

A station was selected on Sojoton Point and connected with the Guimaras Strait triangulation. A short base was measured on the beach immediately south of this point and a small tertiary scheme of triangulation was extended to the southward for locating points for the control of the topography and inshore hydrography, while a portion of the party was engaged in the development of the main scheme on mountain peaks difficult of access and ranging in height from 1,000 to 2,000 feet. A base line of approximately 1½ miles in length was prepared for measurement in the vicinity of Shipalay. A number of anchorages affording perfect shelter during the northeast monsoon were developed between Sojoton Point and Nabulao. A survey of Campomanes Bay, the only safe typhoon harbor on the southwest coast of Negros, was completed on a scale of 1/10,000.

After January 1 the *Pathfinder* continued the triangulation, topography, and hydrography of the southwest coast of Negros Island and southeast coast of Mindanao. The vessel was undergoing repairs at Manila, outfitting, etc., from April 19 to May 13.

At the beginning of the calendar year the party on the steamer *Pathfinder* was engaged in the survey of the west coast of Negros Island and adjacent waters from Sojoton Point to the southward. This work was continued until April 16, when a connection was made at Siaton Point with the previous work in that locality. Work of triangulation was difficult on account of the amount of clearing and high signals required. Base lines were measured in all available places. A plane-table traverse preceded the triangulation after the topography had been completed as far as Nabulao Bay. Signals were erected along the shore sufficient to control the traverse, which were afterwards connected with the triangulation, and the error of the traverse was adjusted.

The hydrographic survey of this locality developed a number of anchorages easy of access but chiefly suitable for use only during the northeast monsoon. Campomanes Bay affords a good anchorage in all monsoons, and is deep and clear of obstructions.

Tidal observations with an automatic gauge were made at Campomanes Bay, and with tide staffs at Linaon and Himamaylan. These three stations were connected by simultaneous readings.

On May 20 work was begun on the southeast coast of Mindanao at Pujada Bay and that work was in progress at the close of the fiscal year. A base line, 4,787 meters in length, was measured, and the triangulation of the coast was completed from Mayo Bay southward to within 10 miles of Cape San Augustin. The topography of Pujada Bay and the coast line as far south as Luban Island was completed.

The inshore hydrography of the region covered by the topography was also completed, and the offshore work was carried as far south as Cape San Augustin.

There are no safe anchorages along this coast, and much time was consumed in taking the working parties from the anchorage in Pujada Bay to and from the working ground.

[F. G. ENGLE, Commanding Steamer *Research*.]

SUMMARY OF RESULTS.—Reconnoissance: 510 square miles of area covered, 2 lines of intervisibility determined. Triangulation: 2,180 square miles of area covered, 56 signals and scaffolds erected, 25 stations occupied for horizontal measures, 98 geographic positions determined. Latitude, longitude, and azimuth work: 1 azimuth station occupied. Topography: 244 square miles of area surveyed, 301 miles of coast line surveyed, 84 miles of rivers and creeks, 57 miles of roads, 8 topographic sheets finished. Hydrography: 1,232 square miles of area sounded, 5,058 miles run while sounding, 76,900 soundings made, 3 tide stations established, 5 hydrographic sheets finished.

At the beginning of the fiscal year the party on the steamer *Research* was at work in the region between Biliran and Daram Islands and the west coast of Samar.

The first work done was the completion of the hydrography from Carigara Bay northward between Daram and Biliran Islands to the Canahuan Islands. In this area the contour of the bottom is very even between 25 and 40 fathoms. Sounding lines were run three to the mile with soundings on the lines a quarter of a mile apart. The inshore hydrography of the west coast of Daram Island had been done previously by another party.

The topography of the south and east coasts of Biliran Island was completed. All of the peaks on the east side of this mountainous island were located and their visible slopes contoured. An examination by plane table was made of the position of triangulation station "Ras" on Parassan Island and the shore line of the island corrected.

An examination was made for a reported shoal off Santa Fe, Bantayan Island, but no indication of such a shoal was found, and reasonable proof was obtained that it does not exist.

In October an examination was made of the southern entrance of Iloilo Harbor, where it was found that the sand spit on the northeastern side of the channel had extended since the previous survey, obstructing the buoyed channel.

Field work was next taken up in the vicinity of Catbalogan, Samar. A reconnoissance was made and points selected for the triangulation, and by December 31 six stations had been occupied.

Signals for hydrography were erected on the coast of Samar from the south end of Buri Island to Moroporo Point, and their positions determined by plane table. The contours between these two points were sketched. From Moroporo Point northward shore line was run, hydrographic signals built and located, and contours sketched. The Gandara River was surveyed as far up as Tugnao. The Canahuan Islands have also been surveyed.

In November and December inshore hydrography was done from Buri and Cagdullion Islands, on the coast of Samar, northward to the Tagdaranes Islands. The hydrography of the Canahuan Islands was also finished.

The offshore hydrography on sheet 7A, joining the work done by party under charge of Assistant Crowell on the south and west was

completed. From four to five lines to the mile were run over this area, the depths found ranging from 6 fathoms near the Samar Coast to 20 and 25 fathoms near the Canahuan Islands and Daram Island, respectively, with an even mud bottom.

On January 1 the vessel was at work in the vicinity of Calbayog, engaged in the work of triangulation, topography, and hydrography of the area bounded by Samar, Biliran, and Masbate Islands. The triangulation over the entire area bounded by these islands as far north as a line from Malayoc Point, on Samar Island, to Tagapula Island and thence to Tetas de Cataingan on Masbate Island. Zenith distance observations for the determination of elevations were carried through the main scheme and similar observations were made upon all mountain peaks that were located in the triangulation. Azimuth observations were made on four nights at the astronomical station at Calabog.

At the close of the calendar year the topographic work had been completed to Sundara, on the west coast of the island of Samar, and during the second half of the fiscal year it was carried as far north as Malayoc Point. The topography was also completed for the islands of Libucan, Limbancauayan, Camanday, Marial, Talajit, and Tagapula.

The hydrographic survey was completed over the entire region covered by the topography and over the greater part of the area between Samar Island and a line from the most northerly point of Biliran Island to the most easterly point of Tagapula Island.

SURVEY OF SUBTERRANEAN RIVER, PALAWAN ISLAND.

[E. R. Frisby and John Bach.]

At the request of the Secretary of Commerce and Police of the Philippine Government, two of the officers of the Coast and Geodetic Survey were directed to report to him for the purpose of exploring and surveying a subterranean river on Palawan Island.

Unfavorable weather conditions and the difficulty in reaching the entrance to the river, which required passing through a heavy surf, caused delay until October 1, when a successful entrance was made and the exploration and survey was commenced. As only two days were available for the execution of the work and the necessary instrumental outfit for underground work was far from complete, owing to the short time available for preparation, the survey was not as accurate and complete as it might have been if the party had been properly equipped, with more time at its disposal. Courses were determined with an ordinary boat compass and distances were measured with a cod line marked for the purpose, while illumination was obtained by means of ordinary hand lanterns.

The cove into which the river empties is near the center of St. Paul Bay and about 3 miles northeast of a small barrio situated in the extreme southern part of the bay. The entrance to this cove, on the southern side, is strikingly marked by a point sloping down to an elevation of about 25 meters and abruptly terminating in a massive, flat-topped tower of rock with vertical sides, closely resembling a fortified castle tower when seen from close inshore looking toward the northeast or southwest.

The river empties into a lagoon about 120 meters long by 25 to 30 meters wide, with depths of 6 to 8 feet, through an irregular arched opening at the base of a vertical cliff.

Just inside the entrance the channel was found to be much obstructed by columns and longitudinal knife edges hanging from the roof and dividing the channel into numerous small openings just capable of passing the boats. Fifty meters upstream these obstructions disappear, leaving a single clear channel, but for the first 400 or 500 meters there are numerous small openings or pockets, which it was impossible to examine on account of limited time. At a distance of 200 meters daylight is seen through one of these crevices, and at 500 meters the channel opens into the first prominent chamber containing columns, stalactites, and one very prominent stalagmite.

The next 1,000 meters is characterized by a long, straight tunnel with an easy curve near its center, the entire width of the tunnel being occupied by the river. Throughout this tunnel are numerous beautiful forms of stalactites. Continuing upstream for another 1,000 meters, the stream abruptly turns in a large chamber first to the right and then to the left, while on the right is a large, elevated cavern. Three hundred meters beyond this chamber the cavern opens into a series of chambers of increasing size, which continues for 1,000 meters, or to the 4,000-meter point, beyond which progress in the boats was found to be impossible, although the cavern continues onward in the same general direction.

The last point reached lies about 1,000 meters north-northwest from St. Paul Peak, 1,027 meters in height. A complete report of the methods used and results obtained was submitted by Mr. Frisby. On October 4 the entire party returned to Manila.

On April 19, 1912, the locality was again visited by the Director of Coast Surveys, accompanied by officials of the Philippine Government. The entire length of the river was again traversed up to the limit of the survey, where an immense rock fall obstructs the passage of boats. Further exploration shows that the river continues beyond the obstruction for an unknown distance. This subterranean river has been named "The Mystic River of Palawan."

[WALLACE M. HILL.]

STATIONS OCCUPIED.—Albay, Antipolo, Aparri, Batangas, Iloilo (old and new stations), Legaspi, Manila, San Fernando, San Isadro, Tabaco, Tarloc, Tuguegara, and Vigan.

On March 18 Mr. Wallace M. Hill arrived in Manila from the United States and immediately began to make preparations for a magnetic survey of the Philippine Islands.

Before beginning observations in the field, useful information regarding the location of magnetic stations established by the Jesuits was obtained from the Weather Bureau at Manila. Permission was also obtained to occupy the station at the Philippine Government's magnetic observatory at Antipolo. Actual field work was begun on March 25 and was in progress at the close of the fiscal year. During the period mentioned 14 stations were occupied.

At the request of the local authorities, a meridian line was established at Manila. This work was done in connection with the regular necessary observations for magnetic declination. Progress in this work was delayed owing to lack of facilities for transportation.

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

SUMMARY OF RESULTS.—Triangulation: 1,820 square miles of area covered, 30 signals erected, 39 stations occupied for horizontal measures, 23 geographic positions determined. Topography: 283 square miles of area covered, 180 miles of coast line surveyed, 6 topographic sheets completed. Hydrography: 1,679 square miles of area covered, 5,001 miles run while sounding, 84,191 soundings, 5 tidal stations established, 5 hydrographic sheets completed.

During the period from July 1 to December 31, the steamer *Romblon* was engaged chiefly in work of topography and hydrography for which the necessary points had been located previously. Some secondary triangulation was done on the west coast of Masbate Island and at Mount Enganosa on Burias Island, and a small amount of tertiary triangulation was done on the west coast of Masbate Island to furnish points for the topography.

The topography completed to December 31 includes the shore line of the west coast of Masbate Island and the off-lying islands from a point 2 miles south of Bugui Lighthouse to Talisay Point at the southern end of Nin Bay, and a large part of the shore line of Port Barrera, Masbate Island. Contours were run in adjacent to the shore line and farther inland when it seemed desirable.

The hydrography done during the same period covers the following areas: A small piece of inshore cutter work near Gorrion, Burias Island; a small piece of inshore ship work just west of Mount Enganosa, Burias Island; development work by the ship east of Banton Island; launch and cutter work to finish up the survey of Port Barrera, Masbate Island; ship deep-sea work over the area inside of a line drawn between Mabiton, Burias Island, and a point 5 miles off the northeast corner of Sibuyan Island, thence to Bennet Island, thence to Bugui Lighthouse, thence to near Mount Sargurun, Burias Island; cutter work along the west coast of Masbate Island from Bugui Lighthouse to Talisay Point, at the southern end of Nin Bay, with the exceptions noted later, this work extending from 1 to 2 miles offshore; and ship soundings with Tanner and Bassnett tubes over the area immediately west of this work, running out to the 100-fathom curve, at a distance of about 17 miles offshore. Within the area of cutter work on the Masbate coast, mentioned above, the following areas have not been covered: A strip near Gato Island about 8 miles long and one-half a mile wide, and a strip extending from Mariveles Point to Tumulaytay Island from the beach to a distance of about 1½ miles.

Tidal observations with an automatic gauge were continued at San Pascual, Burias Island, and tide staff readings were taken at various points. In Nin Bay and Looc Inlet an abnormal variation of the magnetic needle was noted.

After January 1 the party continued the work of triangulation, topography, and hydrography in the area bounded by Burias, Masbate, Tablas, Sibuyan, and Romblon Islands. The *Romblon* was undergoing repairs at Manila from February 1 to March 22.

By January 1 most of the necessary triangulation had been completed, and during the latter part of the year the only triangulation executed was of a tertiary character and intended for the location of points for the hydrography and topography.

The shore-line topography was completed in the following localities: The west coast of Masbate Island from Talisay Point, at the

southwest end of Nin Bay, to Pulanduta Point, at the southwest end of Masbate Island; the entire coast of Sibuyan Island with the exception of about 3 miles, which had been previously executed by another party; the coast of Cresta de Gallo Island; and the harbor of Romblon, Romblon Island. Considerable inshore topography was also surveyed in the localities mentioned.

The hydrographic work included inshore work on the west coast of Masbate Island from Tumalaytay Island to Mariveles Point, from Talisay Point to Pulanduta Point and a small strip near Gato Island, all of this work extending about 2 miles offshore; and about Sibuyan, extending about 1½ miles offshore and all around the island with the exception of about 4 miles on the south coast previously executed and about 5 miles on the north coast, which remains unfinished; development of Romblon Harbor; offshore shoals between Masbate and Sibuyan Islands; hydrography inshore and offshore over the greater part of the area between Masbate and Sibuyan Islands and to the northward of Sibuyan Island, and offshore work over an area of about 150 square miles north of Capiz, Panay Island.

Magnetic declination was determined at one station at sea.

An automatic tide gauge was kept in operation at Romblon, Romblon Island, and tide staff readings were made at various points during the progress of the survey.

[J. B. MILLER, Commanding Steamer *Fathomer;* E. MUELLER, Commanding Steamer *Fathomer.*]

SUMMARY OF RESULTS—Reconnoissance: 5,065 square miles of area covered, 22 lines of intervisibility determined, 9 points selected for scheme. Base lines: 1 base line measured. Triangulation: 8,753 square miles of area covered, 24 signals and scaffolds erected, 34 stations occupied for horizontal measures, 121 geographic positions determined. Latitude, longitude, and azimuth work: 1 azimuth station occupied. Magnetic work: 1 land station occupied for magnetic declination, 3 sea stations occupied for magnetic declination. Topography: 92 square miles of area covered, 161 miles of general coast surveyed, 97 miles of rivers and creeks, 3 miles of roads, 6 topographic sheets finished. Hydrography: 3,165 square miles of area sounded, 7,670 miles run while sounding, 51,125 soundings, 5 tidal stations established, 8 current stations occupied, 13 hydrographic sheets finished.

The party attached to the steamer *Fathomer* was in the field continuously from July 21 to November 24. During this time the triangulation in progress at the close of the previous fiscal year, between the islands of Tablas, Panay, Masbate, and Sibuyan, was completed, and also the topography and hydrography connecting the latter on a line from Romblon Island to the southern point of Masbate Island with the work that was being carried on by the steamer *Romblon.* On October 24 the work was closed in that vicinity, and the triangulation from Panay and Mindoro to the Calimanes Islands and Palawan, including the survey of the Cuyos Islands, was commenced. Reconnoisance, topography, and hydrography was done in the Cuyo Group during November, and the vessel arrived in Manila on November 25, for the annual repairing and outfitting.

The occupation of stations in the main scheme of triangulation was completed, as was also the base net connecting the Ibajay base with the main scheme of triangulation. This base line lies on the sandy beach between Ibajay and Navas, northwestern Panay, at about high-

water line, and is 7,100 meters long. The azimuth of the base was measured and time determined.

Topographical work was done on the north coast of Panay Island from Ibajay to the Aclan River, a distance of 14 miles, which completes the topography of that island; on the east coast of Tablas Island, from Concepcion to Pineda Point, a distance of 8 miles, completing that island; on Romblon and Sibuyan Islands portions of the shore line were surveyed.

Inshore hydrography was completed along the coasts for which the topography had been surveyed, thus finishing the remainder of the hydrography about the north coast of Panay, Tablas Island, and the west of Romblon Island. Offshore hydrography was done between Tablas, Panay, Masbate, and Sibuyan Islands, and the whole of it was completed except about 137 square miles near Masbate.

A reconnoissance was made for triangulation from Mindoro and Panay to the Calimanes and Palawan, including the Cuyo Islands; some stations occupied and points determined for the topography and hydrography.

About 600 miles of ship sounding was done, following many of the courses used in navigating the Cuyo Group, and several uncharted shoals were found. The ship was swung once for magnetic observations at Bararin Island, near Cuyo, and once in Manila Bay. Tides were observed with an automatic tide gauge on Tablas and Bisucay Islands.

From January 1 until the close of the year the vessel was engaged in triangulation, topography, and hydrography, west coast of Panay, Cuyos, and Palawan Islands.

On January 25 fieldwork was resumed in the region about the Cuyo Islands, which included the triangulation from Panay and Mindoro to the Calimanes Islands and Palawan. A special effort was made to connect this island with that part of the triangulation of the Philippine Archipelago which had been already completed. At the close of the fiscal year this had been accomplished with a degree of accuracy that will permit the commencement of work in this region. Incidentally, considerable topographic and hydrographic work was done in detached localities, chiefly off the west coast of Panay and in the vicinity of the Cuyos Islands. On the west coast of Panay 74 miles of shore line were resurveyed, which was necessary for locating signals for the hydrography. A topographic survey was also completed of two of the larger and three of the smaller islands of the Cuyo Group.

The hydrography of the west coast of Panay was completed to a junction with the work done in the years 1907 and 1908. Three uncharted shoals were discovered, and five reported shoals were found not to exist. This work was carried to a distance of 15 to 25 miles from the shore. At approximately this distance from the shore there exists a narrow submarine valley, 500 to 800 fathoms in depth, beyond which to the westward there is a great bank with less than 100 fathoms, which extend the entire distance to Palawan Island. Upon this bank several lines were run to a distance of 98 miles to the westward, within sight of Palawan. About the Cuyo Group a section from 5 to 7 miles and 46 miles long was surveyed through the center of the group and other lines were run outside of this. Cuyo Harbor, with its approaches, was surveyed. More than 50 shoals were discovered in this region.

Tides were observed with an automatic gauge near Cuyo Island. A staff gauge was used for six weeks on western Panay.

Currents were observed at eight stations distributed over an area of 4,000 square miles. A permanent eddy, with a velocity of from 1 to 2¼ knots, was discovered directly west of Panay. During the northeast monsoon this eddy follows north along Panay and southwest through the Cuyos. It is of sufficient strength to be of importance to navigators along the Panay coast.

One land station and three sea stations were occupied for observations of the magnetic declination.

[EBERHARDT MUELLER.]

SUMMARY OF RESULTS.—Reconnoissance: 1,000 square miles of area covered. Base lines: 1 base line measured. Triangulation: 1,000 square miles of area covered, 28 signals and scaffolds erected, 30 stations occupied for horizontal measures, 28 stations occupied for vertical measures, 45 geographic positions determined.

Early in the fiscal year arrangements were made to take up the triangulation across Mindanao Island, connecting Iligan and Illana Bays. As the work was in a region inhabited by the Moro tribes, not altogether peaceful, it was necessary that it should be carried on under the protection of troops controlled by officers of the United States Army. The Military Information Division of the Army desiring a topographical survey of this region, the opportunity was favorable for combining forces, rendering mutual assistance, and carrying on the work at the same time.

The chief object of this triangulation is to secure an accurate connected system of triangulation for the whole length of the Philippine Islands, based upon one standard datum, and to avoid the uncertainty of coordination of numerous independent and detached surveys.

The party was organized in the early part of August, and leaving Parang on August 22, arrived on the 24th at Camp Keithly, where work was immediately begun.

A reconnoissance in the high mountains west of Lake Lanao, proving the impracticability of the large scheme which had been contemplated, a smaller scheme embracing the region about Lake Lanao was planned. To carry out the object desired, stations had to be cleared from heavy timber, involving much labor, which was difficult to obtain, and as travel in the interior was necessarily on foot, progress was slow and laborious. For connections about Iligan Bay water transportation was necessary, which was obtained, after some delay, from the military authorities.

Considering the difficulties of the work, excellent progress was made and by the close of the calendar year all stations had been selected and cleared of timber, all but a few of the necessary signals had been erected, and the majority of the stations had been occupied for observations. A base line was measured and the stations of the base net erected and occupied so as to furnish points for an Army topographical party.

Acknowledgment is made of the valuable assistance received from the officers of the United States Army, without which this important work could not have been done.

Triangulation between Iligan and Illana Bays, Mindanao Island, was continued until March 26, when work was closed.

[PAUL C. WHITNEY, Commanding Steamer *Marinduque;* LEO O. COLBERT, Commanding Steamer *Marinduque.*]

SUMMARY OF RESULTS.—Base lines: 1 base line measured. Triangulation: 2,257 square miles of area covered, 53 signals and scaffolds erected, 43 stations occupied for horizontal measures, 59 geographic positions determined. Latitude, longitude, and azimuth work: 2 azimuth stations occupied. Magnetic work: 1 land station occupied for magnetic declination, dip, and intensity, 1 sea station occupied for magnetic declination, 1 complete swing of ship. Topography: 216 square miles of area surveyed, 274 miles of coast line surveyed, 36 miles of rivers and creeks, 14 miles of roads, 10 topographic sheets finished. Hydrography: 1,018 square miles of area sounded, 3,094 miles run while sounding, 59,843 soundings, 6 tidal stations established, 2 current stations occupied, 10 hydrographic sheets finished.

Combined surveying operations by the party on the steamer *Marinduque* in Basilan Straits were continued from July 1 to August 18. Work was then suspended for the purpose of making necessary repairs to the vessel, and during the interval the field records were completed. Operations in Basilan Straits were resumed on November 17 and were in progress on December 31. The work consisted almost entirely of hydrography in the southern half of Basilan Straits, where there are shoal spots and soundings requiring verification. In this region the hydrography was made difficult by the strong current encountered. Luzon reef was located and one-fourth fathom less sounding discovered than previously shown. A reported shoal west of Bongo Island with a depth of 22.7 feet over it was located and developed and also a 24-foot shoal about a mile distant. A few soundings were made in the area north of Iligan Bay not surveyed during the previous year.

In connection with the survey of Basilan Straits five triangulation stations were occupied and topographical work was done on the north and northwest coasts of Basilan Island from San Raman to Zamboanga.

On January 9 work was begun in Ragay Gulf. From a base measured by Assistant Luce the triangulation was carried up Ragay Gulf with subsidiary points for the control of the topography and hydrography. The plans for this work called for a connection across Luzon to the San Miguel Bay triangulation. The coast line of the gulf is generally heavily wooded and the establishment of main scheme stations made necessary a large amount of clearing, and towers from 40 to 60 feet high had to be built. To establish station "Bernacci" a six days' trip to the top of the mountain had to be made, and at the station near Port Pusgo hardwood trees of 25 feet in circumference were cut down to clear the lines.

The inshore hydrography was carried on from camps as rapidly as possible. An automatic tide gauge was erected at Port Pusgo on a wharf built by the party. The hydrography of the gulf was being carried on by the ship in depths ranging from 40 to 300 fathoms.

During the month of May the observations in the main scheme of triangulation were taken up and completed. This scheme extends from the head of the gulf, where a base was measured, to a line connecting Bondoc Head on Luzon Island and Mount Enganosa on Burias Island. This line joins the work with that of 1911. Connection was also made with the triangulation of San Miguel Bay on the east coast of Luzon. Observations for azimuth were obtained at the Coast and Geodetic Survey longitude station at Pasacao and at

the naval latitude and longitude stations at Guinayangan, and these stations were connected with the main scheme of triangulation.

The topography was carried from Caurusan Point to the head of the gulf on the east side and to Arena Point on the west side, with the exception of an 18-mile strip between Lian and Pusgo Points. At Arena Point it joined with the work of 1909.

The hydrographic survey was completed north and east of a line from Pusgo Point to Anima Sola Island, with the exception of the work between Point Pusgo and Palad Bank. A small area in the vicinity of Arena Island was also completed.

An automatic tide gauge was maintained at Port Pusgo from January until the close of the year. Tide staff readings were made at three stations for the reduction of soundings. Current observations were made at one station for a short period.

MANILA OFFICE.

At the office in Manila the records received from the field parties were examined, reduced, and checked wherever necessary, duplicates prepared, results of triangulation adjusted, and elevations computed.

The usual studies were made for each proposed piece of field work; notes, specifications, and instructions for field parties prepared, and general supervision exercised over the details of the field operations.

Finished tracings were made for chart publication, hydrographic sheets plotted, and topographic sheets inked and completed when necessary.

Sailing directions and notices to mariners for the Philippine Islands were prepared and a large amount of original hydrographic information was received and filed. Lights and buoys on the charts were colored and hand corrections to the charts made when necessary. The Survey has a representative on the Lighthouse Board of the Philippine Government.

The Geographic Division continued the compilation of a general map of the Philippines.

PORTO RICO.

[JOHN A. PHILLIPS, Jr., OSCAR H. GAARDEN, and CHARLES. F. WOODYARD.]

The magnetic observatory at Vieques, Porto Rico, was under the charge of Mr. John A. Phillips, jr., from July 1 to November 5, the date when he was drowned while bathing in Vieques Sound. Owing to this unfortunate and regrettable circumstance, the observatory remained closed until November 18, when Mr. Oscar H. Gaarden arrived at Vieques and took charge of the observatory. Mr. Gaarden remained in charge until relieved early in January by Mr. Charles F. Woodyard, who has remained in charge of the observatory for the rest of the fiscal year.

Special rapid-rate registration was carried out on specified term days of each month in accordance with the international program. The magnetograph and seismograph were in successful operation throughout the year with the exception noted, and the required scale-value

determinations, absolute observations, time, seismological and meteorological observations were made. About 25 earthquakes were recorded during the year. Some minor repairs to the buildings were made.

[G. HARTNELL.]

STATIONS OCCUPIED.—*Cuba*: Habana. *Florida:* Key West, Jupiter, and Miami. *Porto Rico:* Alganabo Point, Aibonito, Caguas, Obispo Cayo, Ponce, and South Base, San Juan.

Magnetic observations were made by Mr. Hartnell at the stations named above in returning to Washington after the transfer of the charge of the magnetic observatory at Vieques to another observer. Aibonito, one of the two stations at Habana, and Key West were new stations, the others having been occupied previously.

HAWAIIAN ISLANDS.

[OSCAR H. GAARDEN and J. W. GREEN.]

The Honolulu magnetic observatory was under the charge of Mr. Oscar H. Gaarden until July 16 and after that date under the charge of Mr. J. W. Green.

The Eschenhagen magnetograph and the Milne seismograph were in satisfactory operation throughout the year and the required absolute observations, scale value determinations, and daily meteorological observations were made. The reports of the meteorological observations were sent to the local office of the Weather Bureau at Honolulu, and exchanges of weather reports were made with the Ewa Plantation Co. as heretofore.

About 170 earthquakes were reported, nearly the same as for the previous year. Special rapid-rate registration was carried out on specified term days in cooperation with the English and Australasian antarctic expeditions. The necessary repairs to the observatory buildings were made.

[J. C. GAUGER.]

SUMMARY OF RESULTS.—Reconnoissance: 125 square miles of area covered, 39 lines of intervisibility determined, as per sketch submitted, 16 points selected for scheme. Triangulation: 25 square miles of area covered, 13 signal poles erected, 2 observing signals and scaffolds built, 4 stations occupied for horizontal measures, 12 geographic positions determined. Topography: 27 square miles of area surveyed, 133 miles of general coast surveyed, 67 miles of roads surveyed, 7 topographical sheets finished.

On August 30, 1911, instructions were issued for a revision of the triangulation and shore-line topography of the Hawaiian Islands.

The officer assigned to this duty arrived in Honolulu on October 18, and after collecting the necessary data from previous surveys and making other necessary arrangements, work in the field was begun on November 3 in the vicinity of Wailuku, island of Maui.

By the close of the fiscal year the shore line on Maui Island had been surveyed from the vicinity of the Hulu Islands on the north coast westward around the island to Huelo Landing, omitting two sections in the vicinity of Maalaea Bay and Makena which had been previously surveyed. The work was executed upon a scale of 1/20,000 on nine topographical sheets.

The unsurveyed shore line now remaining on the island is that portion of the north coast lying between Kahului and Huelo Landing.

[E. VANCE MILLER.]

The officer above named, who had been engaged since April 15 in collecting material for the correction of sailing directions for the Hawaiian Islands, completed that duty on July 11, and sailed for San Francisco on the 12th. The time from July 1 to July 11 was occupied chiefly in interviewing masters of the various inter-island vessels and other local authorities with a view to obtaining data useful for the Coast Pilot.

Acknowledgment is made of courtesies shown by the Inter-Island Steam Navigation Co. (Ltd.), and by masters of its vessels, from whom much valuable information was received.

CANAL ZONE.

[N. H. HECK.]

SUMMARY OF RESULTS.—Triangulation: 40 square miles of area covered, 2 signals erected, 3 stations occupied for horizontal measures, 2 stations occupied for vertical measures, 6 geographic positions determined, 10 elevations determined trigonometrically. Topography: 22.9 square miles of area surveyed, 2 topographic sheets finished. Hydrography: 200 square miles of area dragged, 395 miles run while dragging, 12,345 angles measured, 64 soundings made, 1 tidal station established, 1 hydrographic sheet finished.

The examination with the wire drag of the approaches to the Canal Zone in Panama Roads was begun on January 2 and closed on May 7.

The party arrived in Panama on December 14 and was occupied until January 2 in making the necessary arrangements for hire of launches, quarters, transportation, and supplies, and awaiting the arrival of the instruments and equipment, all involving considerable delay.

As soon as possible topographical work was begun on the mainland and outlying islands within the limits of the proposed charts. Two topographic sheets were completed between January 1 and March 2. A large portion of the area had already been carefully surveyed by the engineers of the Canal Commission, so that the work required was chiefly to bring this up to date and locate objects useful for purposes of navigation. A number of hydrographic signals were located for the use of the party on the steamer *Patterson*.

Sufficient triangulation work was done for the control of the work to the eastward of Panama and to locate the objects useful to navigators in that region.

All of the area outside the 45-foot curve was dragged to an effective depth at mean low water of 45 feet or more. This curve was found to be farther to the northward than indicated on existing charts. No uncharted shoals were found to the southward and eastward of a line from a point 3 miles east of San Jose Rock, to Farralon, to the sound end of Chame Island, to Chame Point.

In the vicinity of San Jose Rock a rocky area was developed, the most dangerous feature being a 12-foot rock near San Jose Rock on which the steamship *Triculo* reported striking in June, 1911. The pinnacle rock between Tortola and Taboga Islands, marked by a horizontal striped buoy, was located and less water found than shown on the charts. Between this rock and Taboga Island a 17-foot and a 29-foot pinnacle rock were located.

The total area covered was 200 square miles, at a cost of about $65 per square mile, the lowest cost thus far obtained in this class of work.

The Coast and Geodetic Survey steamer *Patterson* cooperated with the wire-drag party by furnishing positions of stations and depths for regulating the drag over a portion of the area covered. The *Patterson* also furnished transportation for the members of the party engaged in topographical work. The drag party undertook the development of all shoals discovered within the dragged area.

Acknowledgement is made of valuable assistance rendered by the officers of the Isthmian Canal Commission in furnishing supplies, quarters, and transportation.

[H. W. RHODES, Commanding Steamer *Patterson*.]

SUMMARY OF RESULTS.—Triangulation: 410 square miles of area covered, 12 signals erected, 14 stations occupied for horizontal measures, 11 stations occupied for vertical measures, 53 geographical positions determined, 33 elevations determined trigonometrically. Magnetic work: 6 stations occupied for observations of the three magnetic elements, 29 stations occupied at sea. Topography: 7.3 square miles of area surveyed, 83.7 miles of general coast line surveyed, 3 topographical sheets finished. Hydrography: 450 square miles of area sounded, 1,962 miles run while sounding, 12,418 angles measured, 29,524 soundings made, 3 tidal stations occupied, 2 current stations occupied, 8 hydrographic sheets finished.

The survey of the Pacific entrance to the Panama Canal by the party on the steamer *Patterson* was begun on January 15 and completed on April 12. The *Patterson* left San Francisco on December 22 and arrived at Panama on January 15, after a stop of three days at Acapulco, Mexico, for coaling ship and for magnetic work.

Before leaving San Francisco shore observations with magnetometer and dip circle were made at the Goat Island station, and the ship was swung for the determination of the deviation, dip, and total intensity in San Francisco Bay. En route, besides occupying the magnetic station of 1907 at Acapulco, the ship was swung at 17 stations at sea for the determination of declination, dip, and total intensity. During the season on the working ground the ship was swung twice for determination of the magnetic elements; once southeast of San Jose Rock and once in the area west of Taboga Island. Four shore stations were occupied in Panama Bay for complete observations. On the return passage eight sea stations were occupied.

The Carnegie Institution station at San Diego and the Goat Island station at San Francisco were occupied for complete observations on the return trip, and the ship was swung again in San Francisco Bay.

Triangulation.—Primary stations "Ancon" and "Cobra" and secondary stations "San Jose" and "Venado" of the Canal Commission's triangulation were recovered. Stations "Ancon," "San Jose," and "Venado" were reoccupied, and through them the triangulation was extended to the southward and westward to cover the whole field of work. All stations were permanently marked and full descriptions made.

Topography.—The topography was completed on two projections furnished by the office on a scale of 1/20,000, embracing respectively the Taboga and the Otoque Groups of islands, and in addition a projection was made in the field covering the west shore line of Panama Bay from the limits of the second projection furnished to Assistant

N. H. Heck, to Chame Bay, and the plane-table survey of the shore line and outlying islands was completed.

Four men and transportation were furnished by the *Patterson* to aid Mr. N. H. Heck's party in the survey of the main shore and outlying islands from Panama City westward to the limits of his sheet.

Hydrography.—The hydrographic projection, scale 1/40,000, furnished by the office, was supplemented by two additional projections on a scale of 1/40,000, covering the whole offshore territory to be developed together with the necessary shore line. In addition, five projections, scale 1/20,000, and one projection on 1/10,000 scale were made for the inshore hydrography and for the detailed work around the outlying islands. Two of these sheets will be included in one of the 1/40,000 sheets, so that all of the work will be included on six finished sheets. The sheet on the scale of 1/10,000 covers the channel leading into the Canal proper, together with the immediate approach to it.

Tide stations.—An automatic tide gauge was established on Naos Island and the tides observed from February 1 to April 12. The records of the staff gauge maintained at Taboga Island by Mr. N. H. Heck were used in reducing the greater part of the soundings. A tide station was also established on Tabor Island in Chame Bay and connected with Naos Island by simultaneous observations.

No dangers to navigation in the usual tracks of traffic were developed by the hydrography. Several shoal areas were discovered and their positions given to the wire-drag party for more thorough investigation.

Two lines of soundings were run between Cape Mala and the Otoque Islands and the depths where comparison can be made agree closely with those given on Hydrographic Office chart No. 1019.

SPECIAL DUTY.

VIRGINIA.

[W. B. FAIRFIELD.]

Between April 22 and May 6 a determination was made of the position of three points in lower Chesapeake Bay for the United States Engineers, and of four tripod beacons on Willoughby Bank.

In order to determine these seven points it was necessary to occupy five stations, two of the Engineers' points and three lighthouses. The objects mentioned were connected with the triangulation of the Coast and Geodetic Survey.

MAINE: OBSTRUCTION IN TWO-BUSH CHANNEL ON WHICH THE U. S. S. ARKANSAS STRUCK.

[R. L. FARIS.]

In June a consultation was had with the officers of the New York Shipbuilding Co. at Camden, N. J., for the purpose of securing information as to the time and position of the U. S. S. *Arkansas* when she struck a rock in Two-Bush Channel, coast of Maine.

From the courses and distances given in the ship's log book, an inspection of the charts used, and other information obtained from the officers of the company, it appears that the ship struck on the

southerly side of the 3¾-fathom spot in Two-Bush Channel shown on the Coast and Geodetic Survey charts, which is about six-tenths of a mile to the southward and westward of Two-Bush Island Lighthouse.

In this conclusion the naval officer who was on the bridge of the *Arkansas* at the time, although not in command, concurs.

MAINE: ROCKLAND NAVAL SPEED-TRIAL COURSE.

[O. B. FRENCH.]

The permanent beacons for the naval speed-trial course at Rockland, Me., plans for which had been made by an officer of the Survey, were satisfactorily completed by the contractor and accepted on July 28.

The beacons were planned to meet the following conditions:

1. That they should have a sky background as seen from a ship on the course.
2. That the transiting objects should be tall, slender poles or tubes, large enough to be visible to the eye from the ship on the course in good weather.
3. That the pole on the front beacon should appear of the same size as the pole on the rear beacon as seen from the ship.
4. That some part of the pole on the front beacon must transit over some part of the pole on the rear beacon for an observer on the course at a height anywhere between high tide and 40 feet above high tide.
5. That there should be a larger visibility surface at the top of each rear beacon to aid in its identification, and make it more distinct in hazy weather.
6. That there should be visibility surfaces on the faces of the towers to make them more easily seen in hazy weather.
7. That the structures should be strong enough to withstand a wind pressure of 40 pounds to the square foot, using a factor of safety of 5.

The rear beacons are wrought-iron tubes of 12-inch inside diameter and 50 feet in length anchored to a concrete foundation and held erect by a steel tower 25 feet in height. An elliptical target 8 feet by 6 feet, composed of slats 6 inches in width, is fastened to the top of each rear tube.

The Monroe Island (front) beacon is a tube 6 inches in diameter projecting 27 feet above the top of a tower 85 feet in height. Sheep Island beacon is an 8-inch tube projecting 30 feet above the top of a tower 50 feet in height.

The legs of all the beacons are embedded in concrete, which extends 5 feet into the ground or else rests on solid rock. When completed the beacons were entirely covered with black paint.

The exact positions for the beacons were located by triangulation, which connects a measured base on Sheep Island with two trigonometric points near the entrance to Rockland Harbor. The two ranges are parallel and exactly 1 nautical mile apart.

The positions of the rear beacons are fixed on the ground by the large concrete piers upon which the 12-inch tubes are mounted. The center of each front beacon is fixed in the ground by a 20-penny copper nail (small end up) embedded in concrete.

Before the completion of the beacons observations were made to determine the positions of the buoys indicating the course on which ships should run. The observations were made at about the middle stage of flood tide, and the positions of the buoys were found to be as follows: North buoy, north of north range, 43 meters; north buoy, east of Monroe Island beacon, 2,644 meters; south buoy, north of south range, 14 meters; south buoy, east of Sheep Island beacon, 3,463 meters. Monroe Island beacon is east of Sheep Island beacon 789 meters. Consequently, a line through the south buoy perpendicular to the ranges will pass 30 meters east of the north buoy. The above distances are all either perpendicular to or parallel with the ranges.

The angle at south buoy when it is placed exactly on the south range and distant 3,463 meters from Sheep Island beacon, between this range and Monroe Island beacon, is 34° 43.4′. The angle at the north buoy, when it is on the north range and in the same perpendicular to the ranges as south buoy, between Sheep Island beacon and the north range, is 28° 09.1′.

The south buoy is probably as near the course as it is practicable to place it, hence by merely moving the north buoy over to the range and working backward or forward until the angle given above, viz, 28° 09.1′ is obtained, both buoys will then be in correct position to indicate the true course for the running of ships.

DISTRICT OF COLUMBIA.

[O. B. FRENCH.]

In the latter part of April, at the request of the Superintendent of Public Buildings and Grounds, District of Columbia, a line of levels was run between the various bench marks established in the vicinity of the Washington Monument.

There are four iron plates attached to the monument and four brass bolts in the roadway near the four corners of the monument, which are used in determining the condition of the monument. The elevations of these bench marks were determined with reference to a stone obelisk located some 34 meters south of the monument, a complete circuit being run around the monument in both directions. There was no line of sight more than 30 meters in length and the mean of the two circuits closed exactly.

Three sets of backward and forward measures were then run between the obelisk and the bench marks.

The results of the leveling indicate that no perceptible change has taken place in the elevation of the monument since the last examination.

NEW YORK: FORT SLOCUM, DAVIDS ISLAND.

[E. H. PAGENHART.]

SUMMARY OF RESULTS.—Triangulation: 2 stations occupied for observations of horizontal angles, 155 positions determined. Topography: 1 square mile of area surveyed, 2½ miles of shore line run. Hydrography: 5½ miles of sounding lines run, 633 soundings made.

At the request of Capt. J. L. McArthur, Quartermaster, U. S. A., a resurvey was made in the early part of April of the shore line and adjacent hydrography of Davids Island, N. Y., for the purpose of

locating reported rocks and changes in natural and artificial features which have occurred since the last surveys were made, and of determining accurately the positions of aids to navigation in that vicinity.

To furnish points for the topography stations, "Blanzes Rock" and "Execution Rock Light House" were occupied and angles measured to "Tower" and "Pole" on Davids Island, and also to the Episcopal Church spire at New Rochelle.

The general location of the rocks was indicated by Capt. Sypher, of the Quartermaster's Department steamer *Barry*, so that the hydrographic examination was confined to a comparatively small area. The rocks are small, only a few square feet in area, and rise from 1 to 3 feet above the mud bottom. The least water found was 8.1 feet on the northwest end of the rocky ridge and 8.2 feet on the southeast end, with deeper water between them. The plane of reference is based on 17 low waters observed in 1894–95. A vessel drawing 6 feet could strike on these rocks at very low tide.

All of the buoys between Blanzes Rock and Echo Bay were determined in position.

CURRENT OBSERVATIONS ON LIGHT VESSELS, SOUTH ATLANTIC COAST.

[W. E. PARKER.]

The Bureau of Lighthouses having agreed to cooperate with the Survey by permitting a series of current observations to be made by the masters of light vessels stationed along the South Atlantic coast, an officer of the Survey was directed in June to install the necessary apparatus and to instruct the observers in its use. Through the courtesy of the Bureau of Lighthouses it was arranged that transportation of the officer of the Survey and the current apparatus on the lighthouse tender *Sunflower* should be made during her regular visits to the light vessels.

The instruments for current observations were installed on light vessel *No. 46*, Tail of the Horseshoe, Va.; light vessel *No. 49*, Cape Charles, Va.; light vessel *No. 72*, Diamond Shoals, N. C.; light vessel *No. 80*, Cape Lookout Shoals, N. C.; light vessel *No. 84*, Brunswick, Ga.; light vessel *No. 1*, Martins Industry, S. C.; and light vessel *No. 34*, Charleston, S. C.

A complete set of the necessary apparatus with full instructions was left with the master of the lighthouse tender *Cypress*, to be delivered on board the light vessel on Frying Pan Shoals, off the coast of North Carolina, on the next regular trip of the *Cypress*. The masters of the several light vessels were fully instructed in the use of the instruments and the methods of making the necessary observations, which are to be made daily for a period of three months.

The information thus obtained, after discussion, will be published for the benefit of mariners in the Coast Pilots and tide tables and on the charts.

EXAMINATION OF INLAND WATERWAYS.

[W. E. PARKER.]

To meet a growing demand for sailing directions for navigating the inland waterways between the Capes of the Chesapeake and Key West, Fla., an officer was detailed in February to make a careful

examination of the entire route and to gather the necessary information. These waterways had previously been shown on the charts and a small leaflet descriptive of them had been published, but as many of the channels are under improvement by the United States Engineers and changes had taken place, it was necessary to examine each link in the system in detail in order to show present conditions adequately. The inspection was made in a launch drawing 2 feet forward and 3 feet aft.

The route taken was as follows: Passing up Elizabeth River and through the Dismal Swamp Canal to Elizabeth City, N. C., thence through the new Government canal to Morehead City and Beaufort. From Morehead City the route was through Bogue Sound to Swansboro, thence out to sea at Bogue Inlet, down the coast to Little River Inlet, and through North Inlet to Winyah Bay, thence to Charleston, thence south to Jacksonville, thence to St. Augustine, thence to Miami, and from Miami to Key West.

The entire travel from Norfolk to Key West was through inside passages and waterways, except between Bogue Inlet and Winyah Bay and across Bull Bay. At the latter place low tide prevented crossing in the lee of the shoals at the head of the bay. From Biscayne Bay to Key West the route was north and west of the keys through cuts dredged by the Florida East Coast Railroad Co.

Information was obtained regarding the general conditions at places along the route and their facilities for supplying passing craft.

From Key West the route was retraced to Norfolk, a more detailed examination was made of the waterways, and alternate routes were examined. Particular attention was paid to the shallow waterways not accessible to ocean-going vessels.

Nearly all the inlets on the coast of Florida having depths of 3 feet or more over the bars were examined, and the least depths determined by soundings. Information was obtained also from local pilots.

At St. Augustine a survey was made of the San Sebastian River below the town, which is becoming commercially important. A new inside route around the head of Bull Bay was examined. When this is completed, there will be an inside passage around Bull Bay, limited to drafts of 4 feet at low water. At present this draft can be carried through at half tide.

North Inlet at Winyah Bay, Corncake Inlet at Cape Fear, Wrightsville, New Topsail, and New River Inlets were sounded and examined.

The yacht *Triomyx*, of New York, sighted offshore and displaying a distress signal, having lost her rudder and sustained other injuries in a storm, was towed to a safe anchorage in Wrightsville Inlet.

On the northward passage the ocean travel was reduced over 15 miles by entering at New River Inlet instead of Bogue Inlet. An inside route, good for 4 feet at high tide, was found to connect the two inlets. From Bogue Inlet the route was through Bogue Inlet to Beaufort, thence through Core Sound, along the eastern side of Pamlico Sound, through Roanoke Sound and across Albermarle Sound to North River and Albemarle & Chesapeake Canal.

Detailed information concerning these routes will be published hereafter.

WASHINGTON: SPEED-TRIAL COURSE FOR SUBMARINES, PORT TOWNSEND BAY.

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

At the request of the Navy Department, the speed-trial course for submarines in Port Townsend Bay, Wash., was verified by the party on board the steamer *McArthur*, acting under the instructions of Assistant J. F. Pratt, in charge of the Seattle suboffice.

The *McArthur* sailed from West Seattle on May 8, arriving in Port Townsend Bay the same day early enough to inspect the ranges and make plans for the field work. On the 9th, 10th, and morning of the 11th, eight signals were erected and occupied. At Southwest Base station it was necessary to erect a tripod and scaffold signal.

The trial course is on a line connecting a range mark on a cannery wharf a little to the eastward of the railroad station in Port Townsend and a range mark on the chemical works at the southerly end of Port Townsend Bay.

The north end of the trial course is abreast two range beacons on Walan Point. This Walan Point range, called North Range, was used for the initial range, both in distance and direction. The course extends toward the south end of the bay 1 nautical mile, and is subdivided into quarter knots.

With the exception of North Range all of the front beacons are built on two piles in the water at each front, while the rear ones are built at high-water mark along the shore.

The two north range beacons and the remaining four rear ones are tall poles, 6 to 8 inches in diameter at their bases, planted in the ground. All of these range beacons, both front and rear, are painted in red and white bands and surmounted by white triangular-shaped gratings whose faces are parallel with the trial course.

Auxiliary signals were built exactly on line between North Front Range and North Rear Range and exactly 8 feet from each of their centers. Auxiliary signals were also built on the line of each of the remainining rear ranges and at the same distance from them. All of these auxiliary stations were carefully centered and plumbed and formed the framework to carry the positions of the ranges.

ALASKA: LONGITUDE DETERMINATION AT COPPER CENTER.

[EDWIN SMITH and C. V. HODGSON.]

SUMMARY OF RESULTS.—Latitude, longitude, and azimuth; 2 latitude stations occupied; 2 longitude stations occupied.

Between July 1 and August 27 a determination was made by two cooperating observers of the latitude and longitude of a point at Copper Center, Alaska, for the use of the United States Land Survey Office.

Upon arrival of the observers at Valdez, Alaska, on July 22, the work was delayed by floods which interfered with the transportation of the observers to Copper Center and also with the building of the observatory at Valdez. The pier used by Assistant Welker in 1910 was found standing, but in an insecure condition. At Copper Center the station was located a little northwest of the United States Army

telegraph station. The center of the transit was the station, and is marked by a copper disk triangulation station mark on which are stamped the words "Astronomical Station" about the triangle.

The latitude of Copper Center was determined by 20 observations on 19 pairs of stars. These observations were made on the nights of August 6, 8, 13, 14, and 17, with meridian telescope No. 2.

It was not until August 5 that an exchange of signals with Copper Center was obtained. On the 8th, 11th, 13th, and 16th the exchange of signals was continued, completing the determination required, and on the 26th the observers started for Seattle.

Acknowledgment is made of assistance rendered by the Signal Corps, United States Army, and by the United States Road Commissioner.

MISSISSIPPI RIVER COMMISSION.

[H. P. RITTER.]

As authorized by law, an officer of the Survey has continued to serve as a member of the Mississippi River Commission and has performed the duties incident to that office and attended the meetings of the commission in addition to his work as an officer of the Survey. The same officer was designated by the Secretary of Commerce and Labor as a delegate on the part of the United States to the twelfth meeting of the International Association of Navigation Congresses held at Philadelphia in May, 1912.

CALIFORNIA AND MARYLAND: INTERNATIONAL OBSERVATIONS TO DETERMINE THE VARIATION OF LATITUDE.

[F. E. ROSS and S. D. MADDRILL, Observers in Charge.]

Work at the latitude observatories at Gaithersburg, Md., and Ukiah, Cal., maintained by the International Geodetic Association has been continued under the direction of the Superintendent. Observations with the zenith telescope to determine the variation of latitude at these observatories have been made in accordance with the program adopted by the association. At Gaithersburg a simultaneous series of observations have been made with the optical zenith telescope and with the photographic zenith tube designed by Dr. F. E. Ross, the observer in charge, which was completed and installed during the preceding year.

NORTH CAROLINA: BOUNDARIES OF FISHING GROUNDS.

[W. M. STEIRNAGLE.]

In the early part of October, at the request of the Fish Commission of North Carolina, Mr. W. M. Steirnagle was directed to execute certain work desired by the commission in defining the fishing limits in Albemarle, Croatan, and Pamlico Sounds. For use in this work the State launch *Gretchen*, in charge of Mr. E. T. Jones, inspector for the commission, was assigned.

The most pressing necessity was for a survey of the 2,000-yard limit along Durant Island on the south side of Albermarle Sound, as the fishermen were beginning to set nets there in large numbers for the fall fishing.

Along this section of the coast, from Alligator River to Croatan Light, a distance of about 11 miles, fishing had never been carried on so extensively before, and no survey had been made there.

There was also need for an examination of the buoys in Pamlico Sound, and the establishment of ranges for determining the position of buoy No. 24, known as the 10-mile buoy, its position being fixed by law as 10 miles south-southeast magnetic from Big Island. This buoy was reported to have been moved several miles to the northward by the fishermen, thus enlarging their fishing limits.

It was decided, however, to proceed at once with the surveys along Durant Island and to leave the work in Pamlico Sound for later investigation. A reconnoissance having been made, work began at the west end of the line on October 10.

As the work progressed difficulties arose as to the interpretation of the State laws, the provisions of which appeared to conflict. Some of the nets were also found to have been set a considerable distance over the line at a place called the Haulover and the owners declined to move them. However, the work was continued with some interruptions, and on November 17 six buoys were placed in the vicinity of Caroons Point, thus completing the work in Albermarle and Croatan Sound.

On November 20 work was taken up in Pamlico Sound, beginning on the west side from Roanoke Marshes to Shoal River, a distance of of about 22 miles. Here every one of the buoys previously established was found to have disappeared, as also later proved to be the case on the east side of the sound. All of the signals from Stumpy Point southward had also disappeared.

Stations "Marsh" and "Sandy Point" were reestablished by points farther inshore. West of Long Shoal Point three bases were measured, making six in all for the season. Six stations were visited and re-marked, signals erected, 22 buoys placed, and a reconnoissance made at Oregon Inlet and at Pea Island for ranges to fix the position of the 10-mile buoy. At Oregon Inlet a tower 38 feet high was erected to serve as the back range mark, and a similar mark was erected just south of the Pea Island Clubhouse to serve the same purpose for the south range.

To provide for the possible destruction of the fish house which furnishes the front range mark at Pea Island, a second point on the range was marked about 1 mile eastward of the back range mark.

With the placing of nine more buoys in Pamlico Sound the work was brought to a close on December 15.

Acknowledgment is made of assistance rendered by Mr. C. S. Vann, the Fish Commissioner of North Carolina, and Mr. Theodore G. Meekins, his predecessor in office; the crew of the Oregon Inlet Life-Saving Station, and the owners of the Pea Island Clubhouse.

CALIFORNIA: SAN LUIS OBISPO BAY.

[T. L. WARNER.]

SUMMARY OF RESULTS.—Triangulation: 11 square miles of area covered, 2 signals erected, 8 geographic positions determined. Hydrography: 9.4 square miles of area gone over with wire drag, 84 miles run with drag, 55 soundings made, 1 tidal station established, 1 hydrographic sheet completed.

In accordance with urgent requests from the shipping interests of the port, an examination with the wire drag was made of the harbor

of San Luis Obispo, Cal., for the purpose of determining the position of certain isolated pinnacle rocks dangerous to navigation, upon which several large vessels had struck, one of them, the steamer *Lansing*, being damaged to the extent of about $30,000. The commercial importance of this port, due to the large shipments of oil, the shipments of one company aggregating over 8,000,000 barrels in 1911, called for a careful examination of the harbor, such as could only be made effectively by the use of the drag.

Wire-drag work was begun March 14 and completed April 24. As the results of this examination, many hidden dangers were discovered, which will be plotted on the charts.

The total area covered was 9.4 square miles, of which about two-thirds lying in deep water outside the breakwater was rapidly completed. In the remaining area, where the depths were less and the bottom irregular, the examination took a longer time.

Numerous rocks were found in the locality of the former wharf at Oilport, and to the southward and southeastward of the wharf at Port San Luis. The wharf at Avila was found not to have sufficient depth of water for large vessels and not entirely protected from the heavy ocean swells. A site between the wharf at Port San Luis and that at Avila would appear to offer the greatest advantages.

INTERNATIONAL BOUNDARIES.

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

UNITED STATES AND CANADA BOUNDARY.

[E. C. BARNARD.]

SUMMARY OF RESULTS.—Topography: 166.25 miles of boundary mapped, 338 square miles of topography, 6 topographical sheets finished. Leveling: 287.12 miles of levels run, 137 miles of check levels run, 136 permanent bench marks established, 134 temporary bench marks established. Boundary location: 163.40 miles of boundary located, 42 monument sites recovered, 45 monument sites located. These statistics are for the entire season, beginning in May and ending in October, 1911, and for May and June, 1912.

The survey of the international boundary line between the United States and Canada, along the forty-ninth parallel, east of the summit of the Rocky Mountains, which had been resumed in the spring of 1911, was continued from the beginning of the fiscal year until October 21. The survey and interpolation of monument sites was carried from monument 261, near the crossing at the east fork of the Poplar River, to monument 219, a distance of 124.40 miles, connecting with the work of the Canadian surveyors. The line of primary levels along the boundary was continued from monument 265 to monument 219, a distance of 136.15 miles, and 106.97 miles of levels were run to connect with bench marks for check and elevation control.

The topography of the region for a width of 1 mile on each side of the boundary was executed on a scale of 1/45,000 with a contour interval of 20 feet, and the positions of the monument sites were located on the sheets. The level lines were run so as to determine the elevations of all monument sites. The levels were started from a point on the

Poplar River about 20 miles below Scobey, from a bench mark established by the United States Geological Survey.

In order to check the levels run along the boundary line during the season, a line of primary levels was run from the United States Geological Survey bench mark in Ray, N. Dak., northward along the roads to the boundary, and permanent bench marks were established at intervals of 3 miles. The line of levels was also extended to Portal, N. Dak., to connect with the line of levels run by the Canadian party, and a bench mark was established there. The leveling was done with wye levels; the lines run in one direction only.

The permanent bench marks along the boundary line were bronze tablets set in the foundation of each monument, and on the levels lines to connect with marks already established; they were hollow iron posts 4 feet long and 4 inches in diameter, with brass caps and flanged base, set 3 feet in the ground. The elevation of each bench mark to the nearest foot was stamped on the boundary monuments and on the brass caps of the iron posts.

The intermediate monument sites were located by offsets from chords joining the adjacent monuments. The monument sites were marked by hubs with reference stakes, and a pole with a small flag at the top set over the hub. A monument was established locating the boundary line between Montana and North Dakota.

The original site of monument No. 230 was recovered by the extension of a chord through monuments 231 and 232, and in setting a monument at the point determined, the original mark, a hub, 5 inches in diameter, was found.

In September the chief topographer made a trip to the Lake of the Woods for the purpose of inspecting the region over which the work was to be extended during the next season. The Canadian party, under charge of Mr. J. J. McArthur, was visited.

An inspection was made of the topography along the boundary from Point Roberts to Sumas, Wash., and in the vicinity of Chapaka, Moulson, and Midway, Wash., and Eastport, Idaho, with especial reference to the location of roads and railroads, and the necessary additions were made to the boundary maps.

A case of smallpox in the boundary party under charge of Assistant C. H. Sinclair necessitated a strict quarantine and other precautionary measures, which proved effective in preventing the spread of the disease.

Some delay in the work in the early part of the season was caused by the straying of the pack animals. A fire in the camp on Lone Tree Lake resulted in the loss of two of the tents, but no other serious damage.

Work was resumed in May, 1912, from Red River eastward and included topography leveling and vista cutting.

The leveling was started from the Canadian geodetic bench mark in the post-office building in Emerson, Manitoba, the elevation of which had been furnished by the Canadian commissioner. A line of check levels was run over the work of the preceding section. Topography was begun at the first monument west of Red River by two parties. Another party was engaged in vista cutting through the brush on the east bank of Red River.

Rapid progress was made in the work at the beginning, as the country for 10 miles east of the river was very flat, clear of timber,

and traversed by many roads. Further to the eastward, however, numerous swamps were encountered along the boundary, which retarded progress and made the work more laborious.

On June 30 the topographic work had advanced to monument 31, a distance of 39 miles; the leveling to monument 25, a distance of 44 miles, and the vista cutting for 45 miles had been completed.

The Canadian representative, Mr. R. L. Rannie, joined the party on May 15 and rendered valuable assistance in the prosecution of the work.

[J. B. BAYLOR.]

SUMMARY OF RESULTS.—Base lines: 6 base lines measured, length of base lines 1,050 meters. Triangulation: 158 stations occupied for horizontal measures, 160 geographic positions determined. Leveling: 9 miles of levels run. Latitude, longitude, and azimuth work: 2 azimuth stations occupied. Topography: 26.5 square miles of area surveyed, 32.4 miles of shore line of rivers, 11.7 miles of shore line of lakes, 32.4 miles of shore line of creeks, 5.3 miles of shore line of ponds, 6.2 miles of roads, 1.6 miles of railroads, 5 topographic sheets finished, 18.6 miles of boundary surveyed, 59 monuments erected, replaced, or determined in position.

Work on the survey of the boundary between the United States and Canada in the valley of the St. Francis River, as stated in the last annual report, was in progress on June 30.

The plan of work adopted for the season was that the American party should continue the survey from Cross Lake up the St. Francis River and that the Canadian party should commence their work at Lake Pohenegamook where the international boundary leaves the St. Francis River and carry their surveys down the river until a joint line connecting the two surveys should be reached.

By the early part of November this program had been carried out, and the survey of the St. Francis River was completed. Progress was greatly retarded by the dense forests on both banks of the stream.

During the season the American party occupied 157 triangulation stations, making a full series of observations at each station. Six check base lines were measured with a standard tape line, and two azimuth stations were occupied.

The unfinished plane-table sheet of the previous season at Cross Lake was completed, and four other plane-table sheets on a scale of 1/5,000 were completed by the American party, showing in detail every bend in the river, with a complete map of the adjacent shores.

The Canadian party completed a similar survey of the upper St. Francis River to the line of junction with the American party, a short distance above the mouth of "Riviere Bleue," where it empties into the St. Francis River.

An independent party was organized in June to open a lane along the straight line, forming the boundary, south and west of Lake Pohenegamook, through the dense forests, in advance of the work to be done next season. For the first 45 miles of this boundary, to a point near St. Pamphile post office, this boundary can only be reached at a few points by almost impassable trails running for miles through an unbroken forest. Before the close of the season a 30-foot trail had been opened and cleared of trees through this most difficult section of the boundary, so as to be ready for the line measures and monumenting to be undertaken next season.

In May, 1912, work was resumed on the measurement of the 65-mile straight line between Maine and Quebec through the dense forest

southwest of Boundary Lake. For this measurement 100-foot invar tapes were used by the American party and 100-foot steel tapes by the Canadian party, each party measuring alternate sections of the line. The old iron boundary monuments of 1842 were reset in concrete below the frost line, and additional monuments of concrete were established where necessary on prominent points. A topographical survey on a scale of 1/10,000 was made of the country adjacent to the boundary where possible to do so. By June 30 about 4 miles of the measurement and topographical survey had been completed by the American party.

About the middle of June a separate party was put in the field for the purpose of opening up a lane through the forest south and west of Boundary Lake, and at the end of June had completed about 5 miles of the boundary line adjacent to St. Pamphile, Province of Quebec.

[W. B. FAIRFIELD.]

SUMMARY OF RESULTS.—Triangulation: 22.7 square miles of area covered, 67 signals erected, 243 stations occupied for horizontal measures, 70 stations occupied for vertical measures, 275 geographic positions determined, 121 elevations determined trigonometrically, 2 azimuth stations occupied. Topography: 16.5 square miles of area covered, 118½ miles of shore line surveyed, 4 topographic sheets completed.

The survey of the portion of the United States and Canada boundary between the mouth of Pigeon River and Lake of the Woods was resumed early in June, 1911, the first work undertaken being the completion of the topography of Rose Lake, which had been left unfinished at the close of the previous season. At the same time the triangulation was extended to the westward from the line Agile–Bold. By using the high hills and bluffs on either side of the lakes, generally from one-quarter to one-half mile back from the shores, the main or controlling scheme of triangulation, with sides from one-half mile to 3 miles in length, was made to cover South, North, and Gunflint Lakes. The triangulation was then carried north to the two stations "Droit" and "Carlos," about halfway between Gunflint and Saganaga Lakes, covering the rough and broken country through which flows the stream connecting those two lakes.

Between North and Gunflint Lakes a smaller scheme of triangulation, connected with the large scheme, was carried on, covering Little North and Little Gunflint Lakes, to furnish points for the topography. A similar scheme was extended between Gunflint and Round Lakes, covering the narrows and small ponds between those two lakes.

All of the triangulation stations were permanently marked either with a brass plate set in the solid rock or by a drill hole with a triangle cut around it.

The topography on a scale of 1/20,000 covers the shore line of all the boundary lakes, large and small, also that of North Lake, the greater part of which lies in Canada. The streams connecting the various lakes and the portages, and also that part of the water route between Magnetic and Round Lakes, known as the "River," were all surveyed on a scale of 1/5,000. At Height-of-Land portage and at Pine portage 5-foot contours were run.

Double zenith distances were observed at enough triangulation stations to carry the elevations through the entire scheme and to determine the levels of all the lakes. Observations for azimuth were

made at three stations. A base line 973 meters in length was measured along the unused railroad line on the north shore of Gunflint Lake and connected with the triangulation.

The Canadian latitude and longitude station pier, located at North Lake, about 40 meters west of the railroad station, was connected with the triangulation. The pier is of concrete and is in a good state of preservation.

From the last camp occupied on Pine Lake work was extended as far north as Round Lake. Field operations were closed for the season on October 18.

Work was resumed on North Lake in May, 1912, and by June 30 the triangulation had been extended from above Round Lake to Saganaga Lake and a considerable portion of the topography completed.

[O. B. FRENCH.]

SUMMARY OF RESULTS.—Reconnoissance: 25 square miles of area covered, 27 lines of intervisibility determined, 16 points selected for scheme. Base lines: 5 secondary base lines measured. Triangulation: 25 square miles of area covered, 29 signal poles erected, 14 stations occupied for horizontal measures, 4 stations occupied for vertical measures, 27 geographic positions determined, 3 elevations determined trigonometrically. Leveling: 11 miles of levels run.

In May, instructions were issued for the measurement of 13 base lines along the United States and Canada boundary. A party was organized for this work and work begun in the vicinity of Pembina, N. Dak., early in June.

A base 2½ kilometers in length was measured along the boundary at Neche, N. Dak., and connected by triangulation with stations "Neche," "Long," and "Criton XXXIII" of the boundary triangulation. At Haskett, Manitoba, a base 4.6 kilometers in length was measured along the railroad with tapes resting on the top of one of the rails. It is practically the same line measured by Mr. McArthur in 1911. Mr. McArthur's station "South Base" was not recovered, but his station "North Base" was found and connected with the new base by tape and angular measurement. At Hannah, N. Dak., a base 2.8 kilometers long was measured and connected by triangulation with stations "Hannah," "Star," and "Water Tank" of the boundary work. At Bannerman, Mr. McArthur's base, 3.9 kilometers in length, was recovered and measured. A base 2.3 kilometers long was measured just south of the boundary north of Souris, N. Dak., and connected with stations "Knoll" and "Bottineau," with an approximate check on "Steel." The Souris base measure was completed on June 29.

Valuable assistance was rendered by the Canadian surveyor, Mr. J. J. McArthur, in recovering the old stations in this work and in the section of base sites.

The progress of the work was much facilitated by the use of an autotruck for the transportation of the party and outfit, no difficulty being experienced in moving camp from 75 to 100 miles in a day over all sorts of roads.

[F. G. GRANGER.]

By June 30, 1911, the operations of the Canadian party under charge of Mr. J. J. McArthur, in the survey and monumenting of the boundary line between the United States and Canada in North

Dakota and Manitoba, had reached the iron monument No. 154 (long. 99° 03′). This monument was the westernmost of the iron pillars which were placed 1 mile apart along the boundary westward from Lake of the Woods in 1870–1872.

An inspection of these monuments was made in the autumn of 1910 by a member of the Canadian party, who found many of them in a damaged condition. All of the damaged monuments as far east as No. 70 at the Red River, where the season's work ended, were replaced in 1911 by new cast-iron monuments, and all of those found to be in good condition were removed, filled with a mixture of sand and cement and reset in a mixture of sand, cement, and broken stone. Each monument was afterwards given a coat of red paint.

A scheme of triangulation was carried along the boundary, covering a distance of 118 miles along its axis, during the season. Work began in May, 1911, at monument No. 170 in Turtle Mountain and ended November 8, 1911, at monument No. 70, situated west of and near the Red River. The last points occupied were well marked and will be available for the future connection of the work with the triangulation of the Coast and Geodetic Survey along the ninety-eighth meridian, the terminal points of which are at Emerson, Mont.

During the season two base lines were measured and observations for azimuth were made in the vicinity of each base. All monuments along the line of survey were connected with the triangulation.

As usual, a line of levels was run along the boundary and a contour level was also employed where rendered necessary by the topographic features in mapping the 2-mile wide strip required of the survey. The plane table was also used to delineate the streams, roads, farms, and other topographic features.

Mr. F. D. Granger, as heretofore, accompanied the party of Mr. McArthur as representative of the commissioner.

In May, 1912, Mr. Granger again was directed to join the party of Mr. J. J. McArthur, Dominion Land Surveyor, to act as the representative of the United States commissioner in the survey and demarcation of the international boundary from the northwestern angle of the Lake of the Woods southward through said lake to and following the Rainy River. Mr. Granger joined the Canadian party at Northwest Angle Inlet on June 15. The Canadian party had begun work in May, and had begun a scheme of triangulation near North West Point and extending to within a mile or two of the mouth of the inlet; a preliminary base line had been measured and a portion of the work done.

Search was made for the North West Point and for the reference monument, but without success. The two iron monuments on the meridian boundary were found in a good state of preservation and preparations made to connect them with the triangulation. Three water-level gauges have been established and soundings have been made in the inlet. The water level of the lake on June 30 was 3.2 feet below its mean level, as determined by seven years' observations by the United States Engineers (1904 to 1910, inclusive) at Warroad, Minn. The gauges established are being connected with the Government gauge at Warroad by simultaneous observations.

[J. E. McGrath.]

Summary of results.—Reconnoissance: 70 square miles of area covered, 328 lines of intervisibility determined, 64 points selected for scheme. Triangulation: 70 square miles of area covered, 43 signals erected, 1 observing scaffold built, 48 stations occupied for horizontal measures, 98 geographic positions determined. Leveling: 1,851.7 feet of levels run. Topography: 9 square miles of area surveyed, 39 miles of shore line of rivers surveyed, 4 miles of shore line of creeks surveyed, 16 miles of roads surveyed, 2 topographical sheets completed.

Work on the northeastern boundary between the United States and Canada in the valley of the St. Croix River was resumed in June, 1911, by an American party working in conjunction with a Canadian party. The work planned for the season was a topographical survey to show the limits of the present river area between Woodland and Pomeroy Landing, between which points is an artificial lake about 7 miles in length created by the construction of the great concrete dam erected at Woodland by the International Paper Co.

As the result of this construction the original shore line of the river has been obliterated or greatly changed. The wooded character of the country and the logging operations in the river combined to make the progress of surveying work both slow and difficult. By the beginning of the fiscal year, however, the necessary lines of sight were opened and work with the plane table begun. This being completed, the party was moved to the next field of work in the vicinity of Vanceboro. Here a topographical survey was made, on a scale of 1/10,000, of the section of the St. Croix River included between the dam above the railroad bridge at Vanceboro and McPhails's rolling tier, the only section of the river which remained to be surveyed topographically upon this scale. In addition to this work the triangulation above Vanceboro was revised and supplemented by the addition of several new stations necessary for the control of the topography, and a small triangulation was carried down the river below Vanceboro, connecting the topography in vicinity of Simsquish Creek. This completed the scheme prescribed for the connection of the triangulation and topography of the St. Croix Valley between Vanceboro and Woodland. In the meanwhile the Canadian surveyor, Mr. Brabazon, who had just completed a traverse survey of the Canadian shore line in the overflowed area above Woodland, moved to Vanceboro with his party and began the reference-station marking at the lower end of Chiputneticook Lake.

The American party next took up the work at the lower end of Grand Lake. Stations of the surveys of 1890 and 1891 around the shores of Grand Lake and North Lake were recovered, reoccupied, and re-marked, and new stations were established and occupied where needed. On the completion of the work in Grand Lake and the location of new points near the passage connecting North and Grand Lakes, known as the "Thoroughfare," "Gull Rock" in North Lake was located and marked, and certain topographical features about the mouth of Monument Stream (the brook at the head of the St. Croix River) and the shores of North Lake were located by triangulation. This completed the necessary connections and marking from Forest City, at the lower end of Grand Lake, to the mouth of Monument Stream, and the station marking for the St. Croix River from its mouth to Monument Stream, excepting what remains to be done in Mud Lake and Chiputneticook Lake.

No change of any moment was noticed at Forest City except the construction of a small dam by the International Paper Co. and the deepening of the outlet to Grand Lake by about 2 feet. A traverse line was surveyed, by which the location of the dam could be shown on the old topographical map, its salient points being thereby connected with a triangulation station and readily identified points on the sheet.

Work was closed for the season on October 27.

Work was resumed in June, 1912, and after gathering such data as could be obtained at Calais, Me., concerning the location of certain mills in relation to the boundary line, and after a conference with the Canadian representative, active field operations were at once begun near the mouth of Monument Stream. Signals were erected and a reconnoissance made along the shores of North Lake and up Monument Stream for the selection of stations for the triangulation and the recovery of such old stations as might remain. Station "Poplar" was recovered and also station "Hornet," the latter after the close of the fiscal year.

During the remainder of the time the party was engaged in clearing lines of sight and locations for signals.

[C. H. SINCLAIR.]

SUMMARY OF RESULTS.—Reconnoissance: 476 square miles of area covered. Base lines: Length of, 2,145 meters. Triangulation: 476 square miles of area covered, 193 signals erected, 193 stations occupied for horizontal measures, 193 stations occupied for vertical measures, 204 geographic positions determined, 204 elevations determined trigonometrically. Latitude, longitude, and azimuth: 1 azimuth station occupied. (These statistics are for the season from May to October.)

As mentioned in the last annual report, a party engaged in the survey and monumenting of the international boundary line resumed work in May, 1911, near the middle branch of Poplar River, in longitude 105° 52′, and by July 1 had extended the boundary triangulation to the eastward about 40 miles and the reconnoissance about 10 miles farther.

During the period beginning July 1 and ending October 14 the survey was carried to the eastward to the neighborhood of Short Creek, longitude 102° 47′. Monuments were set along the line and their positions determined by triangulation as the work progressed. At Ambrose, N. Dak., on September 16, a base line 2,145 meters in length was measured with a 50-meter invar tape on the south rail of the "Soo" railroad track. An azimuth was measured at West Base on July 12, 13, and 14 with a Berger & Sons repeating theodolite, and time was observed with the same instrument.

Near Ambrose is the terminus of the principal triangulation running north from the thirty-ninth parallel near Denver, Colo. The line at the boundary is 11.2 miles in length, and to connect it with the small triangulation along the boundary two extra points, "Jasper" and "Bilby," were put in, making a line 5.25 miles long, and forming a main quadrilateral and three subordinate ones.

The last camp was at the second crossing of Long Creek, counting from the west, nearly 8 miles north and 1 mile west of Kermit, and about 5 miles from the end of the section between Frenchmans Creek and Short Creek, where a junction was made with the Canadian triangulation on two lines. The last of the monuments was set from this camp.

A monument was set on the international boundary to mark its junction with the boundary between Montana and North Dakota.

Work on the boundary was resumed in May, 1912, in the vicinity of Emerson, Manitoba, from which point the reconnoissance was continued, signals built, and observations made. Owing to the high timber, signals 30 feet in height had to be built in many places for the triangulation. The triangulation began west of the Red River from the last line in the Canadian scheme of the previous season, and by June 30 signals had been erected as far east as monument 47, a distance of about 25 miles. Monuments 71 to 59, inclusive, were located by triangulation. Monuments 58 to 47 were located by invar tape measurements and each monument was measured to carry along the azimuth.

By utilizing the primary line "States" to "Canada" of the ninety-eighth meridian scheme, a base measurement near Red River was unnecessary, and the triangulation along the forty-ninth parallel east of the Rocky Mountains was put upon the United States standard datum. Ten stations in the main scheme were occupied. All of the monuments from 71 to 53 were occupied, besides nine subordinate stations. The monuments are 1 mile apart. Sixteen signals were erected, of which seven were towers.

ALASKA BOUNDARY.

[ASA BALDWIN.]

SUMMARY OF RESULTS.—Reconnoissance: 240 square miles of area covered, 14 points selected for scheme. Base lines: 1 base-line site selected, 1.75 miles in length. Triangulation: 14 signal poles erected, 9 stations occupied for horizontal measures. Latitude, longitude, and azimuth work: 1 latitude station occupied, 1 azimuth station occupied.

Mr. Asa Baldwin was instructed in the spring of 1912 to execute the triangulation of the Alaska boundary in the Mount St. Elias region in the vicinity of Scolai Pass, and to cooperate with the party of Mr. D. W. Eaton. He arrived in Alaska March 27. Complete details of progress made in this work are not yet available.

[D. W. EATON.]

In the spring of 1912 Mr. D. W. Eaton was instructed to proceed to Alaska and take up the topography of the one hundred and forty-first meridian boundary line between Alaska and Canada in the region between Mount Natazhat and Mount St. Elias. This work was in progress at the end of June, but the details of work are not yet available.

Earthquake shocks were experienced on the evening of June 6, and on June 8 a slight fall of ashes was noticed, probably from the Katmai volcano.

[FREMONT MORSE.]

SUMMARY OF RESULTS.—Reconnoissance: 7 square miles of area covered, 30 lines of intervisibility determined as per sketch submitted, 15 points selected for scheme. Triangulation: 7 square miles of area covered, 14 signal poles erected, 15 stations occupied for horizontal measures, 15 stations occupied for vertical measures, 13 geographic positions determined, and 10 elevations determined trigonometrically.

A Canadian party under charge of Mr. Frank H. Mackie, engaged in the survey and marking of the boundary between Alaska and Canada on Portland Canal, was in the field at the beginning of the fiscal year. Mr. Fremont Morse, Assistant, Coast and Geodetic

Survey, was attached to this party as the representative of the United States Commissioner.

The plan of the season's work as laid out by the Canadian surveyor included a scheme of triangulation down Portland Canal, with stations located on the mountains on either side. This triangulation was planned as the foundation for a photographic survey of the country bordering the canal. In addition to the topographic work, boundary reference monuments were to be erected opposite turning points of the boundary line on each side of the canal, and each was to be connected with the triangulation executed in 1888 by the Coast and Geodetic Survey. The reference monuments were also to be connected with the mountain triangulation wherever practicable.

Work in the early part of the season was delayed by the deep snows upon the mountain peaks.

The party was divided, one section going ahead and selecting the triangulation points, putting up signals, and taking the photographs necessary for the topography, while the other made all the mountain triangulation observations and a part of the triangulation for the location of the reference monuments. The rest of this triangulation was done by the American representative. The field computations were carried on as the work progressed.

Signals were erected and stations occupied at all accessible points from the first camp at Portland City, the old stations "Eagle Point Monument," "Lion Point Astronomical Station," and "A" being used as starting points.

From the camp at Glacier Bay monuments U.S. 26, C 26, U.S. 25, C 25, U.S. 24, and C 24, were located and determined in position. From the camp near Georgia River a scheme of triangulation was executed, starting from the line "Deer" to "Pack" of the Coast and Geodetic Survey triangulation, for the location of reference monuments U.S. 23, C 23, U.S. 22, and C 22. Reference monuments U.S. 21 and C 21 were located from the River Point camp. Monuments were built at U.S. 22, C 22, U.S. 23, C 23, U.S. 24, C 24, U.S. 25, C 25, U.S. 26 and C 26.

The monuments were constructed of concrete, and each was in the form of the frustum of a square pyramid, with a base 12 by 12 inches, tapering to 6 by 6 inches, and 3 feet in height. Each was secured to the solid rock on which it stood by an iron rod, which was sunk half its length into a hole drilled in the rock and secured therein by a wedge-shaped key that projected up into the split end of the rod, as well as by cement poured around it in the drill hole. The upper half of the rod was embedded in the concrete of the monument. In one case, U.S. 25, the monument stood on a gravel foundation, and a concrete base was made for it.

Work was closed for the season on September 25.

[THOMAS RIGGS, Jr.]

SUMMARY OF RESULTS.—Triangulation: 826 square miles of area covered, 98.1 statute miles of boundary triangulated, 85 stations occupied, 13 stations reoccupied, 2 base lines measured, length of base lines 3,197.0971 meters and 2,081.9152 meters. Magnetic observations: 9 magnetic stations occupied. Line projection: 9 stations occupied, 122.5 statute miles of line covered. Topography: 814 square miles of area surveyed, 621 miles of traverse lines run, length of topographic belt 164 statute miles, extremes of latitude 66° 42′ 50″ and 69° 04′ 00″.

The party for continuing the survey and demarcation of the one hundred and forty-first meridian boundary between Alaska and

Canada was organized early in the spring of 1911. Owing to the remoteness of the region to be traversed and the amount of work to be done before reaching the Arctic Ocean, it was decided to leave a party in the North during the winter of 1911–12 for the purpose of forwarding supplies along the boundary and to be on the ground so as to take advantage of the earliest favorable weather for field work in the spring. For this reason the chief of party left Washington earlier than usual, in order to personally inspect the supplies to be purchased for the winter party and for the use of the main party in 1912.

The organization of the party was completed at Seattle, Wash., in March. An officer was sent to Whitehorse early in April to supervise certain details connected with the launches to be used for transportation during the season. The main party sailed from Seattle May 6 and arrived at Skagway on the 10th, leaving Skagway for the interior on the 12th and 13th.

Some delay was caused by the wreck on Thirty Mile River of the steamer *La France*, carrying a large amount of freight for the boundary party. This was afterwards recovered; but in the meanwhile certain portions of the outfit had to be replaced.

The advance party arrived at Dawson May 23 and left that place on the 27th, arriving at the Rampart House on June 1. The Canadian party and the remainder of the American party arrived on June 6. Field work was begun on June 3. The weather proved most favorable, and excellent progress was made during the season.

An outbreak of smallpox among the Indians in July called for immediate action, and in the absence of other authority the chief surveyor and the surgeon of the boundary party took control of the situation, vaccinated the Indians, isolated those who had developed the disease, established a strict quarantine, and adopted such other sanitary measures as were practicable. The Canadian authorities soon sent assistance, and later on a representative of the United States Bureau of Education was sent by the Government to investigate and report, with authority from the governor of Alaska to establish a quarantine at the mouth of the Porcupine River. While a number of cases occurred, the disease was kept under control, and but one death resulted.

Mr. William B. Gilmore, surveyor, as representative of the United States Commissioner, was attached to the line-locating party under Mr. D. H. Nelles, D. L. S.

Dr. D. D. Cairnes of the Geological Survey of Canada operated between the Porcupine and Yukon Rivers with the Canadian line cutting parties.

To guard against any possible trouble along the boundary with the whites or the Indians, at the request of the commissioners, Mr. W. B. Reaburn was appointed as United States Commissioner for Alaska for such time as he might be connected with the boundary work, and Mr. F. S. Ryus was appointed a United States deputy marshal to assist Mr. Reaburn.

For the transportation of supplies on the Porcupine and Old Crow Rivers, the 50-foot launch *Midnight Sun* equipped with 25-horsepower Doak gasoline engines, was built at Whitehorse during the winter and transported by sledge to the foot of Lake Le Barge before the breaking up of the ice. A similar launch, the *Frontierman*, was chartered for

the season. These launches were capable of pushing a 45-foot barge carrying about 8 tons. They proved invaluable.

A sufficient number of horses in addition to those wintered at Champagne Landing to fill out the required number of 105 were purchased in Montana. They arrived in Seattle on May 6. Of these, 80 remained at the close of the season. A large shipment of supplies for the boundary party via St. Michaels arrived at Fort Yukon on July 24.

The party left Dawson on their way out October 5 and arrived at Seattle on the 19th.

The relations between the American and Canadian parties were most cordial and full cooperation existed between them at all times. The details of the various operations are stated separately under the following headings:

Reconnoissance.—W. B. Reaburn, surveyor in charge. The duty of laying out the triangulation scheme and erecting signals thereon was assigned to this party. The method employed was the same as used in previous years, namely, with special reconnoissance plane table and open-sight alidade. The base sites and connections were also selected by this party.

In all 39 signals were erected on main scheme stations and 17 on secondary points for topographic control and line points. Reconnoissance was carried for a full quadrilateral beyond the triangulation, so that in the coming season there may be no delay in beginning the triangulation.

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

The instruments used were the 6¼-inch and 7-inch Berger repeating theodolites on the main scheme stations and at main line points. The monument sites were tied into the main scheme with 4-inch Berger repeating theodolites.

The starting point was the line Cone-Nassau, the two most northerly points reached by Mr. Gilmore in 1910. These points are about 10 miles north of Rampart House.

Throughout the season there was only one party devoting itself entirely to triangulation. This party was in charge of Mr. Asa C. Baldwin. Mr. Gilmore, the United States representative on the line projection party, tied in the main line points, and Messrs. Stewart and Lambart, in charge of the Canadian line cutting parties, tied in the monument sites.

The boundary, as run by the joint line projection party, has been accepted as the true one hundred and forty-first degree of longitude, and all points adjusted to it.

The triangulation was carried to latitude 68° 54′, or a distance of approximately 100 miles north of the Porcupine River. The average width was from 10 to 12 miles.

Bases.—Two bases were measured during the year, the Porcupine base just south of the Porcupine River and the Firth base between the two main forks of the Firth River in the valley of Three Rivers.

The Porcupine base was measured by Mr. D. W. Eaton, assisted by Mr. Riggs on a remeasurement. The Firth River base was measured by Mr. Eaton, assisted by Mr. Baldwin and Mr. Gilmore

Mr. Eaton prepared the base lines sites for measurement and made the observations for connecting them with the triangulation. He also made preparations for the erection of buildings, in the valley of the Old Crow River, which it was the original intention to use for winter quarters, but this plan was afterwards abandoned.

Magnetic observations.—Mr. Baldwin, in addition to the work of triangulation, occupied nine stations with the Coast and Geodetic Survey compass declinometer No. 744 for magnetic declination. Mr. Guerin and Mr. Ryus, whenever possible, obtained a very close declination by scaling with a protractor from their plane-table sheets the true azimuth from the magnetic bearing.

Line projection.—W. B. Gilmore, surveyor, attached as American representative to the Canadian party under charge of Mr. Douglas H. Nelles, D. L. S. Taking up the line projection at station "P" of the boundary, the last point located by Messrs. Craig and Baldwin in 1910, the work was carried by August 6 to station "Y," in latitude 69° 20′, on the last high ridge overlooking the Arctic Ocean. Nine points on the meridian were determined and marked; eight of these connected with the triangulation and a total distance of over 120 miles covered. On August 7 a reconnoissance was made to the northward of the summit of the range.

Topography.—W. C. Guerin and F. S. Ryus, topographers in charge. Topography was carried on by two parties; one under Mr. W. C. Guerin started on the north bank of the Porcupine and completed a topographic belt at least 4 miles wide for a distance of 99 miles; the other, under Mr. F. S. Ryus, started on the south bank and connected up with the finished topography of the season before. Mr. Ryus then moved north, through Mr. Guerin's work, and completed an additional 1½ field sheets before the close of the season. It took him 26 days of travel from his most southerly point to reach the point at which he re-commenced work.

The method employed was the same as in previous season: Horizontal and vertical control, furnished by field computation of triangulation supplemented by plane-table triangulation from intersections with elevations computed from vertical angles, traverse by stadia, and pacing. The instruments used were the Johnson head plane tables with 18 by 24 inch board and Bausch & Lomb special alidades.

The field scale is 1/45,000; contour interval, 100 feet; datum, mean sea level carried from the line of precise levels run to a point on the boundary, from Skagway.

A timber sheet was kept by each topographer and the growth classified for species and density for the benefit of the Forest Service.

Vista cutting, monumenting, and stadia.—This duty was assigned to two Canadian parties; one under Mr. Frederick Lambart, working north from Rampart House, and the other, under Mr. A. G. Stewart, taking up the work where left in 1910. In addition to these parties, there were two launches, poling boats, and the usual supply trains.

Winter party.—W. B. Reaburn, surveyor in charge; Gilbert T. Smith, surgeon. Mr. W. B. Reaburn was left in charge of the party to winter at Rampart House. The duty of the party was to arrange caches convenient to the boundary trail, to assemble provisions and forage now on the Old Crow River, to maintain a quar-

antine, and to be on the ground in the early spring, so that no time might be lost in getting to work.

The launch *Midnight Sun* was put into winter quarters at Rampart House and was available as soon as the ice left the river.

Dr. Smith was requested by the Canadian Government to act as quarantine officer and to look after the welfare of the Indians. He was empowered to authorize any expenditure considered necessary to control the smallpox situation. Two male nurses and a member of the Northwest Mounted Police were on the ground to assist him.

Mr. Reaburn and Dr. Smith were instructed by the chief of party to maintain a quarantine on the Alaskan side and to prevent, by force if necessary, any person from going down the Porcupine and into Alaska without a two weeks' detention for observation.

For the benefit of the mail carriers, a cabin was rented at Fort Yukon and equipped with everything necessary, so that none of the party need enter any house in Fort Yukon. Three horses and 10 dogs were with the party, to be used by the freighters and mail carriers.

The chief of party expresses his appreciation of the energetic way in which the chiefs of the various subparties carried on the work intrusted to them. The favorable weather during the summer enabled them to locate the line and complete the topography to within easy reach of the Arctic Ocean.

Work was resumed in the latter part of May, 1912, on the topography in the vicinity of the Rampart House, and was in progress at the close of the fiscal year. Details and statistics for the work of this season are not yet available.

DETAILS OF OFFICE OPERATIONS.

The Assistant in Charge has direct supervision of the work of the divisions of the office. The Miscellaneous Section and the Tidal Research Section form parts of his immediate office.

COMPUTING DIVISION.

The reduction of field observations and the preparation of results for publication; the preparation of data for field parties of the Survey and replies to requests for information from Government departments, civil engineers, and others outside the Survey, occupied the major portion of the time of this division. The use of the photostat for copying documents and records reduced greatly the amount of clerical work required in the division and at the same time made it possible to furnish data more promptly and economically.

The computation and reduction of the triangulation in the United States and along the international boundaries made excellent progress. A revised and enlarged edition of the manual on the determination of time, longitude, latitude, and azimuth was prepared. A revised edition of the tables and factors for the computation of geodetic positions was also prepared and published.

The adjustment of the precise level net in the United States was continued.

Progress was made in changing the book triangulation registers to vertical file registers. The effective force of the Computing Division averaged 17.4 persons. For the more rapid publication of the results of the work an increase in the force of computers is recommended.

A report on the "Investigation of the Effect of Topography and Isostatic Compensation on the Intensity of Gravity" was prepared and published. The manuscript for a second paper on the "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity" was prepared and sent to the printer. A report on Geodetic Operations in the United States, 1909–1912, to be presented to the Seventeenth General Conference of the International Geodetic Association, was prepared.

Besides the foregoing, five publications giving results of triangulation in the United States were published.

DIVISION OF TERRESTRIAL MAGNETISM.

The demand for information concerning terrestrial magnetism continues to increase.

The results of field observations on land and at sea in the United States and outlying territory, for the fiscal year 1911, were prepared and submitted for publication as Appendix No. 3 to the Annual Report for 1911. Reports were prepared for publication on the results of observations at the magnetic observatories in Porto Rico, 1907–8 and 1909–10; Cheltenham, Md., 1909–10; Honolulu, 1909–10; and on the distribution of the magnetic declination in the United States for January 1, 1910, and the proof of these and other publications was read.

The office revision of field work was kept up to date, the reduction of observatory results continued, and certain records prepared for binding.

Reduction tables for the equation of equal altitudes and forms for the determination of time by the method of equal altitudes of the sun were prepared.

Tabulations were prepared of data pertaining to earthquakes recorded at the magnetic observatories and copies made for the International Seismological Association. Similar information obtained at the Honolulu observatory was furnished to Prof. John Milne, secretary of the seismological committee of the British association. Values of the magnetic elements at the time of the solar eclipse of April 28, 1911, were computed and furnished to the Journal of Terrestrial Magnetism.

A corrected formula for computing the scale value of a declination variometer was determined.

Copies of magnetograms from the five observatories during 21 days in March were furnished to Dr. Bidlingmaier at Wilhelmshaven, Germany. Other data was sent to Dr. Kr. Birkland, of Christiania, Norway. Other requests for data from the magnetic observatories have been promptly complied with as heretofore.

TIDAL DIVISION.

The report of the Chief of the Tidal Division contains the usual detailed information in regard to the work done during the year; the tidal observations received from field parties and from foreign

sources; and the information and data furnished to field parties, to the Drawing and Engraving Division, and to the public.

The Tide Tables for 1913 were completed; Harmonic Analyses were completed for two stations with a combined length of two years, and summations were made for an analysis of three other stations of one year each; nonharmonic reductions were made for 95 stations with a combined length of nearly 16 years; mean tide level was computed for five stations with a combined length of five years; high and low waters and hourly heights of the sea were tabulated for 272 stations with a combined length of 70⅓ years; 340 volumes of soundings were reduced, involving the computation of the plane of reference for 290 stations, and the entering of many thousand tide reducers.

There were received, examined, registered, and indexed, tidal records from 43 stations in the eastern division, six stations in the middle division, five stations in the western division, 21 stations in the Alaska division, and 20 stations from outlying territories, such as the Philippine Islands, etc.

In addition to the observations regularly made by the Survey, tide observations have been received from the Alaska boundary survey, the Hawaiian Government survey, the Government of the Philippine Islands, the Corps of Engineers of the Army, the Hydrographic Office of the Navy Department, the Government of New South Wales, and the Government of Cuba.

Tidal information has been furnished to the Imperial Hydrographic Office at Wilhelmshaven, Germany, in return for which their predictions for Apia and Hamburg have been sent. The Hydrographic Office at Wilhelmshaven was also furnished with sample forms used in tidal work.

Copies of tidal predictions for Wellington and Auckland were furnished to the Secretary of the Marine Department at Wellington, New Zealand.

CHART CONSTRUCTION DIVISION.

During the year satisfactory progress was made in the preparation of a series of 18 new charts on the Mercator projection, oriented with the meridian, with a single depth unit, for the Atlantic and Pacific coasts, and in the correction of the existing charts.

In engraving new charts on copper the practice has been adopted of dividing each chart into several plates, which permits more rapid work, as several engravers can thus work on the same chart simultaneously.

An increased number of charts was published by lithography, and the complete substitution of metal lithographic plates for stone during the past four months has increased the rapidity of production. Additional accommodations are needed for lithographic plant.

Experiments were made with an etching process to place a drawing or printed chart directly on a lithographic metal plate.

A photostat installed in the photographic section turned out a large number of satisfactory copies of records for the different divisions of the office.

In the Electrotype Section certain chart plates were cut and reassembled so as to orient the charts, and some experimental work

was done in connection with local electro deposits to avoid either bumping-up or the making of a new basso for a new printing plate.

Electrical installation and repair work in the buildings was attended to.

The statistics of work during the year are as follows:

CHART PREPARATION.

Schemes approved by the office for new charts	23
Drawings for new charts finished	24
Drawings for new charts in hand	20
New drawings for new editions finished	4
New drawings for new editions in hand	1
Extensive corrections finished	133
Extensive corrections in hand	17
New chart drawings received from Manila, finished	10
New chart drawings received from Manila, in hand	1
New chart drawings received from Manila, for new editions finished	6

Various miscellaneous drawings and tracings were also made.

ENGRAVING.

New plates for new charts, finished	3
New plates for new charts, in hand	12
New plates for new charts etched, finished	1
New plates for former lithograph charts, finished	3
New plates for former lithograph charts, in hand	3
New etched plates for former lithograph charts, finished	15
New etched plates for former lithograph charts, in hand	2
New bassos finished for new editions	27
New bassos in hand for new editions	13
New bassos for reissues, finished	1
New bassos for reissues, in hand	5
New editions, using current plate, finished	25
Extensive corrections applied to plates	207
Extensive corrections in hand	3
Miscellaneous plates engraved or corrected	23
Minor corrections applied to plates	1,448

Two charts are on hand for which the engraving has not been started.

PRINTING.

New charts printed from copper plate	1
New charts printed by transfer from copper plates	3
New charts printed by photolithography	28
New edition of charts printed from copper plates	47
New edition of charts printed by transfer from copper plates	18
New edition of charts printed by photolithography	42
New prints from stones (number of different charts)	94
New prints from plates (number of different charts)	906
Miscellaneous photolithographic publications	4
Miscellaneous engraved publications	4
Charts printed and delivered, from stones	56,473
Charts printed and delivered, from plates	80,335
Miscellaneous printed and delivered, from stones	4,833
Miscellaneous printed and delivered, from plates	120
Total	141,761
Number of impressions from stones (all work)	132,670
Number of impressions from plates (all work)	90,629
Total	223,299

PHOTOGRAPHING.

Glass negatives made	1,202
Paper negatives made	40
Velox prints made	1,579
Vandyke prints made	199
Bromide prints made	406
Blue prints made	2,979
Photostat prints made	1,047
Lantern slides made	17
Matrices made	96
Prints mounted	115
Negatives developed	42
Copper plates etched	11
Photolithographic negatives, number of charts	91

ELECTROTYPING.

Altos completed	69
Bassos completed	46
Total	115
Pounds of copper deposited	4,202

CHART DIVISION.

In this division the usual work was continued relating to the general issue of charts, Coast Pilots, and Tide Tables to the public, to the Navy and other departments; the large correspondence relating thereto and keeping the accounts of 164 agencies; the hand correction of charts, and the coloring of lights and buoys on charts.

The total issue of charts during the year was 144,425, an increase of 18,000 over the previous year. The Chart Division also issued during the year 3,792 volumes of the Coast Pilot, 1,881 copies of Atlantic Coast Tide Tables, 10,603 copies of Pacific Coast Tide Tables, and 1,205 Complete Tide Tables.

The regular force of this division is too small to keep up the work and details of clerks and draftsmen from other divisions have been made from time to time to meet the deficiency.

During the year charts were received from the Drawing and Engraving Division as follows: Prints from plates, 80,335; prints from stone, 56,473. In addition there were received 11,361 copies of Maryland oyster charts, printed by contract, and 150 copies of a special chart of Controller Bay, Alaska.

Charts were issued as follows:

Sales agents	54,367
Sales by Office and Chart Division	2,470
Congressional account	3,626
Hydrographic Office	41,214
Bureau of Lighthouses	3,806
Coast and Geodetic Survey Office	6,805
Suboffice, Manila, P. I.	11,194
Executive departments	6,043
Foreign Governments	753
Miscellaneous	1,059
Total	131,337
Condemned	12,788
Total issued and condemned	144,420

The following Coast Pilots were issued during the year:

Part I–II	453	Part VIII	250
Part III	489	Porto Rico	48
Part IV	584	California, Oregon and Washington	506
Part V	380	Alaska, Part I	352
Part VI	367		
Part VII	363	Total	3,792

The following Tide Tables were issued during the year:

Atlantic coast:		Pacific coast:		Complete:	
1909	2	1901–1910	12	1908	1
1910	3	1911	183	1909	2
1911	52	1912	10,404	1910	3
1912	1,803	1913	4	1911	113
1913	30			1912	918
Total	1,887	Total	10,603	1913	168
				Total	1,205

Charts were issued at the suboffice, Manila P. I., as follows:

Sales agents	981
Sales at suboffice	1,723
Army	832
Hydrographic Office (Navy)	1,076
Suboffice in Manila and vessels of the Survey	445
Executive departments, Philippine Islands	1,561
Miscellaneous	234
Total	6,852

INSTRUMENT DIVISION.

The report of the Chief of the Instrument Division shows in detail the work accomplished in the instrument and carpenter shops, and in his office, and gives the usual statistical information relative thereto.

The dismembering, polishing, lacquering, plating, fine finishing, and reassembling of the Coast and Geodetic Survey's tide predicting machine No. 2 did not progress as rapidly as was expected owing to the unforeseen demands upon the employees for other work. The machine is, however, practically completed and ready to mount in a specially prepared room in the Tidal Division.

The chief of this division, in addition to his regular office duties, was frequently called upon for other services, such as the standardization of the German half-second pendulum apparatus, belonging to the Mexican Government; superintending the removal and remounting of the float pipe of the electrical tide indicator in the offices of the New York docks and ferries department; improving the electrical tide indicator of the Seaman's Friend Society's Institute; fitting out of eight lightships with current poles, suitable for both day and night observations; and inspecting at St. Paul, Minn., 67 cast-iron monuments for boundary between the United States and Canada and arranging for their shipment to their respective destinations.

The Instrument Division, heretofore, has attended to keeping the accounts and inventories of the various kinds of property used in the field and office, to which have been added during the year the furniture and general office inventories.

LIBRARY AND ARCHIVES.

The report of the Chief of the Library and Archives Division contains the usual statistical information in regard to the collection of books, maps, periodicals, and charts, and the receipt of original topographic and hydrographic sheets, photographs, and field records of every description.

Three thousand books and pamphlets and 100 maps no longer needed in this bureau were listed, and the Librarian of Congress selected from the list such as were of value to his library; a list of useless field and office records was prepared for the Department with a view to condemnation by Congress.

ACCESSIONS.

Classification.	Purchased.	Donated.	Exchanged.	Total.
Books and pamphlets	117	181	604	902
Maps and charts	30	.....	1,498	1,528

The following is a list of the original records received:

Subjects.	Volumes.	Cahiers.	Sheets.	Miscellaneous.
Astronomy:				
Observations, original	16	5	.....	6
Computations, field	.....	9	.....	.....
Geodesy:				
Observations, original	154	31	.....	4
Computations—				
Field	.....	35	.....	.....
Office	18	33	.....	.....
Gravity:				
Observations, original	7	8	.....	.....
Computations, field	1	9	.....	.....
Hypsometry:				
Observations, original	22	3	.....	.....
Computations	1	3	.....	.....
Field	.....	2	.....	.....
Office	.....	4	.....	.....
Magnetics:				
Observations, original	.....	310	.....	.....
Computations, office	.....	9	.....	.....
Soundings	404	.....	.....	.....
Sheets:				
Hydrographic	.....	.....	74	.....
Topographic	.....	.....	32	.....
Boundary reports	.....	3	.....	.....
Tides:				
Original observations	125	19	.....	.....
Marigrams	.....	.....	.....	154
Meteorology	1	7	.....	.....
Currents	5	3	.....	.....
Levels	2	.....	.....	.....
Miscellany	15	10	.....	.....
Views	.....	.....	.....	361
Lantern slides	.....	.....	.....	35
Total	771	496	106	593

TIDAL RESEARCH SECTION.

The compilation of matter relating to the tides from published (French and German) sources was continued at intervals throughout the year.

Current tables, diagrams, and predictions were prepared for use in the Coast Pilots and on the charts, and current observations received

from observers in special localities were tabulated, reduced, and analyzed. A current chart, Cape Ann to Point Judith, with description, was prepared for the Atlantic Coast Pilot, Part III. A brief description of the Gulf Stream was prepared. Notes on physical hydrographic and oceanographic work with special reference to the Carribean Sea were nearly completed.

A revision of the tidal and current reductions for Newark Bay and adjacent waters was commenced.

Studies were made of the tides, currents, temperatures, winds, density of water, etc., in particular localities.

Attention was given to various questions bearing on the tidal theory, and information was furnished in reply to a number of requests concerning tides, currents, and related subjects.

MISCELLANEOUS SECTION.

This section attends to the ordering and distribution of supplies and the keeping of the accounts relating thereto; the making of requisitions for printing and binding; the issue of stationery to field parties and office divisions; the auditing of accounts payable from the appropriation for "Office expenses;" the correspondence pertaining to the above, and various miscellaneous duties.

On March 11, 1912, the press copying of all correspondence, excepting orders for purchase, was discontinued and carbon copies substituted. Purchase orders for 1913 will be carbon copied.

Since March 11, 1912, all correspondence pertaining to the work of the Miscellaneous Section has been filed therein.

A new set of forms for requisitions, orders, and registers, relating to accounts, was prepared and approved by the Comptroller of the Treasury and by the President's Commission on Economy and Efficiency.

The filing and indexing systems relating to purchase requisitions have been revised.

Respectfully submitted.

O. H. TITTMANN,
Superintendent.

To Hon. CHARLES NAGEL,
Secretary of Commerce and Labor.

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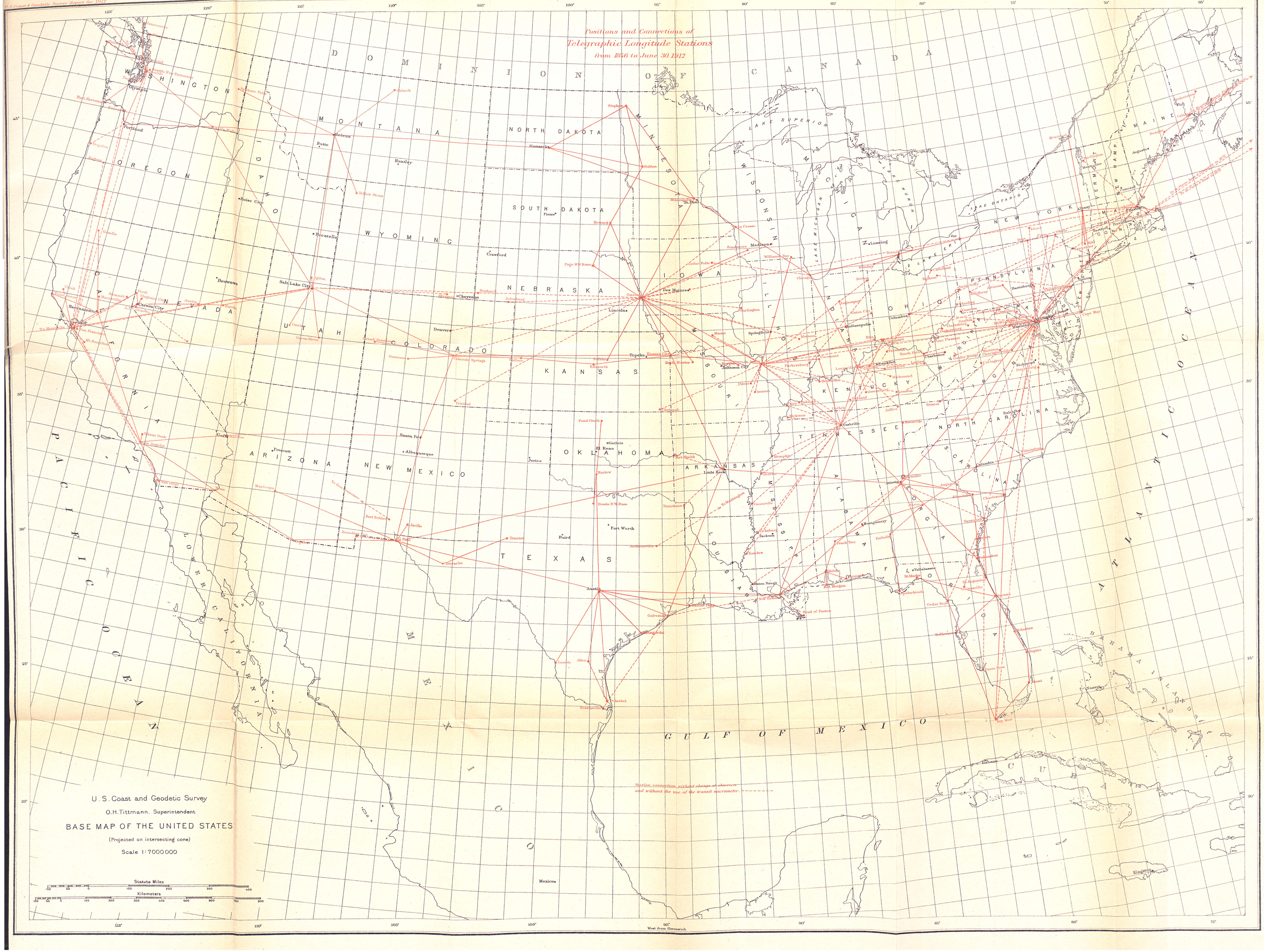
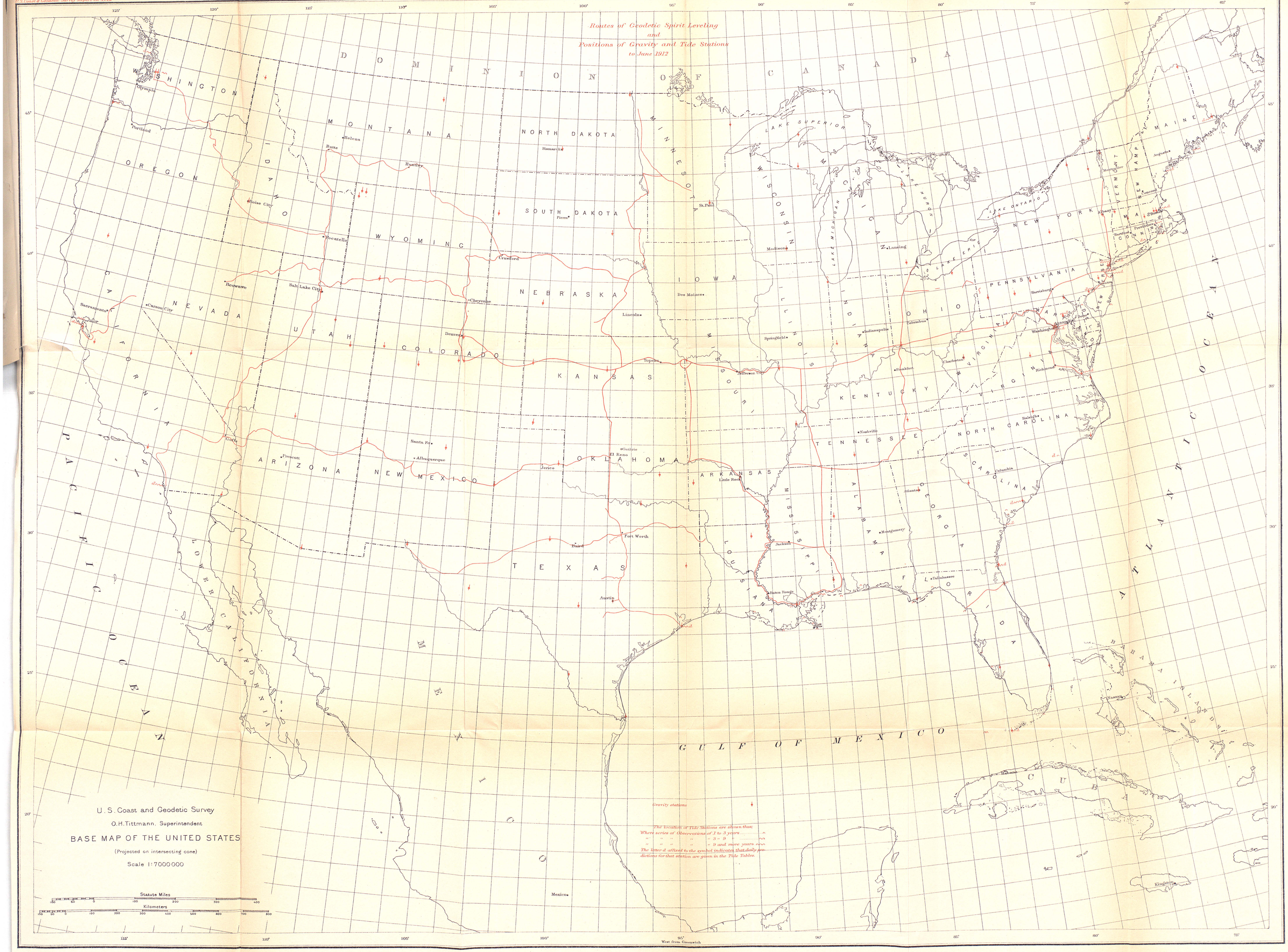
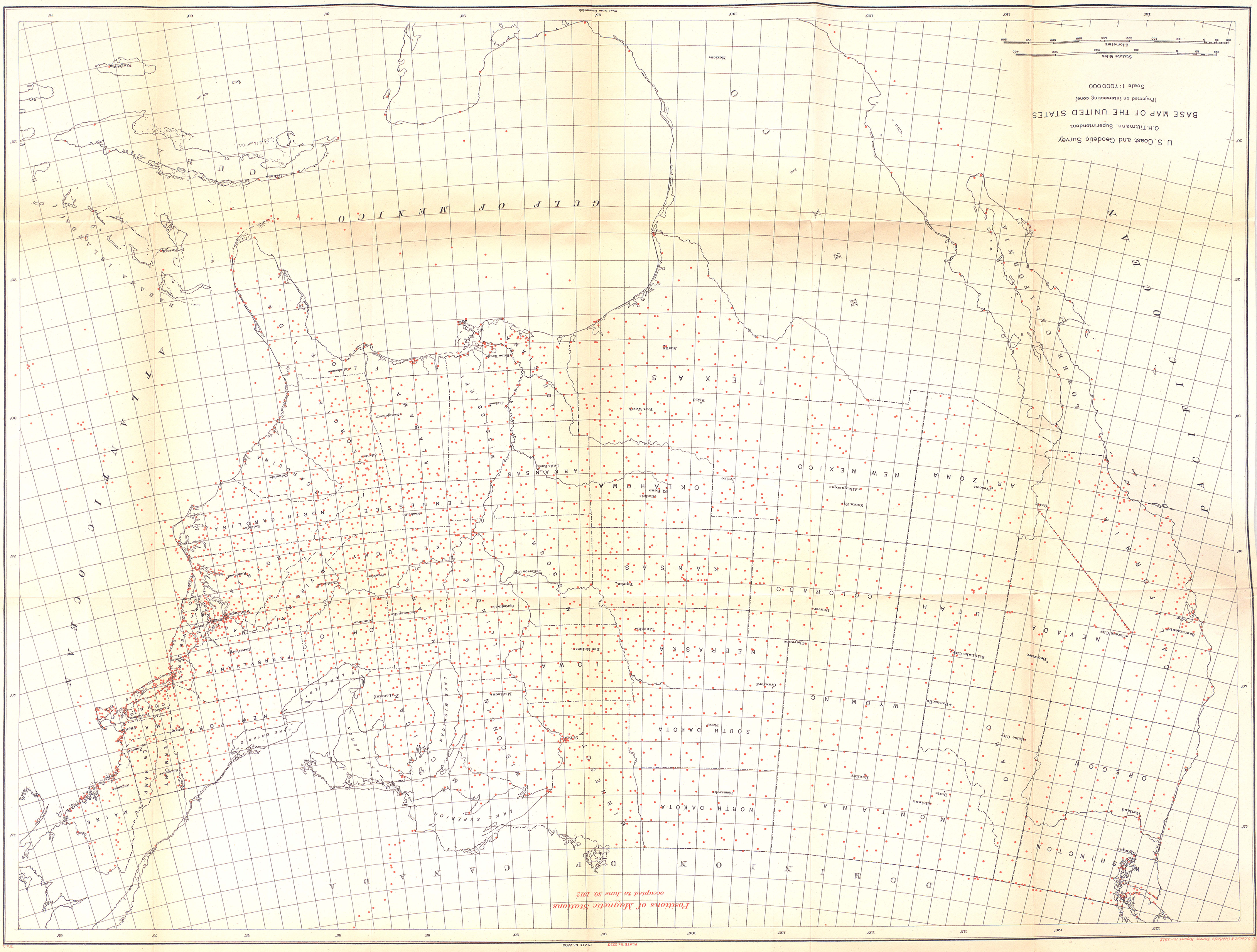
1

Distribution of the principal astronomic stations occupied by the U.S. Coast and Geodetic Survey
for Latitude, Longitude and Azimuth to June 30, 1912
U.S. Coast and Geodetic Survey
O.H. Tittmann, Superintendent
BASE MAP OF THE UNITED STATES
(Projected on intersecting cone)
Scale 1:7000000
Statute Miles
Kilometers
Explanation of Signs:
Latitude Stations
Longitude "
Azimuth "
Combination Stations
95° West from Greenwich
DOMINION OF CANADA
ATLANTIC OCEAN
PACIFIC OCEAN
GULF OF MEXICO
MEXICO
LOWER CALIFORNIA
BAHAMA ISLANDS
CUBA
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
NEW JERSEY
MARYLAND
VERMONT
NEW HAMPSHIRE
MAINE
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO


Positions and Connections of
Telegraphic Longitude Stations
from 1866 to June 30 1912
U. S. Coast and Geodetic Survey
O. H. Tittmann, Superintendent
BASE MAP OF THE UNITED STATES
(Projected on intersecting cone)
Scale 1:7000000
Statute Miles
Kilometers
Station connection without change of observers and without the use of the transit micrometer.
West from Greenwich
DOMINION OF CANADA
WASHINGTON
OREGON
IDAHO
MONTANA
WYOMING
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
NEVADA
UTAH
COLORADO
KANSAS
OKLAHOMA
TEXAS
ARIZONA
NEW MEXICO
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMP.
MAINE
MASS.
CONN.
N. JERSEY
DELAWARE
MARYLAND
LOWER CALIFORNIA
MEXICO
GULF OF MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
CUBA
BAHAMA ISLANDS
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
Vancouver
Seattle New University
Olympia
Port Stevens
Portland
Pendleton
Spokane Fort
Chinook
Helena
Butte
Huntley
Yellow Stone
Boise City
Pocatello
Ogden
Salt Lake City
Beaverville
Cheyenne
Crawford
Pierre
Bismarck
Stephen
Dalton
Minneapolis
St. Paul
La Crosse
Madison
Howard
Page S.W. Base
Cedar Falls
Williams Bay
Des Moines
Omaha
Lincoln
Burlington
Denver
Topeka
Kansas City
Jefferson City
Springfield
Macon
Sacramento
San Francisco
Carson City
Austin
Eureka
Summit
Marysville
Tonopah
Yosemite
Los Angeles
San Diego
Flagstaff
Prescott
Goffs
Santa Fe
Albuquerque
Jerico
Trinidad
Pond Creek
Guthrie
El Reno
Fort Smith
Little Rock
Marlow
Fort Worth
Baird
Stanton
Austin
San Antonio
Galveston
Brownsville
Laredo
Alice
Isabel
Jacksonville
Tallahassee
St. Marks
Pensacola
Mobile
Montgomery
Atlanta
Augusta
Savannah
Charleston
Columbia
Wilmington
Raleigh
Norfolk
Richmond
Washington
Baltimore
Philadelphia
Harrisburg
Albany
Boston
Portland
Montpelier
Concord
Augusta
Bangor
Calais
Detroit
Lansing
Cleveland
Buffalo
Toledo
Chicago
Indianapolis
Columbus
Cincinnati
Louisville
Frankfort
Nashville
Memphis
Vicksburg
New Orleans
Baton Rouge
Jackson
Mobile
Pensacola
Key West
Miami
Jacksonville
Cedar Keys
Havana
Nassau
Kingston


Routes of Geodetic Spirit Leveling
and
Positions of Gravity and Tide Stations
to June 1912
DOMINION OF CANADA
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W. VIRGINIA
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMP.
MAINE
MASS.
CONN.
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
LOWER CALIFORNIA
MEXICO
BAHAMA ISLANDS
CUBA
Olympia
Portland
Helena
Butte
Bismarck
Huntley
Boise City
Pierre
St. Paul
Bocatello
Crawford
Beowawe
Salt Lake City
Cheyenne
Sacramento
Carson City
Denver
Lincoln
Des Moines
Madison
Lansing
Springfield
Indianapolis
Columbus
Harrisburg
Washington
Richmond
Charleston
Frankfort
Nashville
Raleigh
Columbia
Atlanta
Montgomery
Jackson
Baton Rouge
Tallahassee
Topeka
Jefferson City
Gothic
Santa Fe
Albuquerque
Prescott
Jerico
Guthrie
El Reno
Little Rock
Fort Worth
Baird
Austin
Mexico
Nassau
Habana
Kingston
Gravity stations
The location of Tide Stations are shown thus;
Where series of Observations of 1 to 3 years
" " " " " 3 " 9 "
" " " " " 9 and more years
The letter d affixed to the symbol indicates that daily predictions for that station are given in the Tide Tables.
U.S. Coast and Geodetic Survey
O.H. Tittmann, Superintendent
BASE MAP OF THE UNITED STATES
(Projected on intersecting cone)
Scale 1:7000000
Statute Miles
Kilometers
West from Greenwich

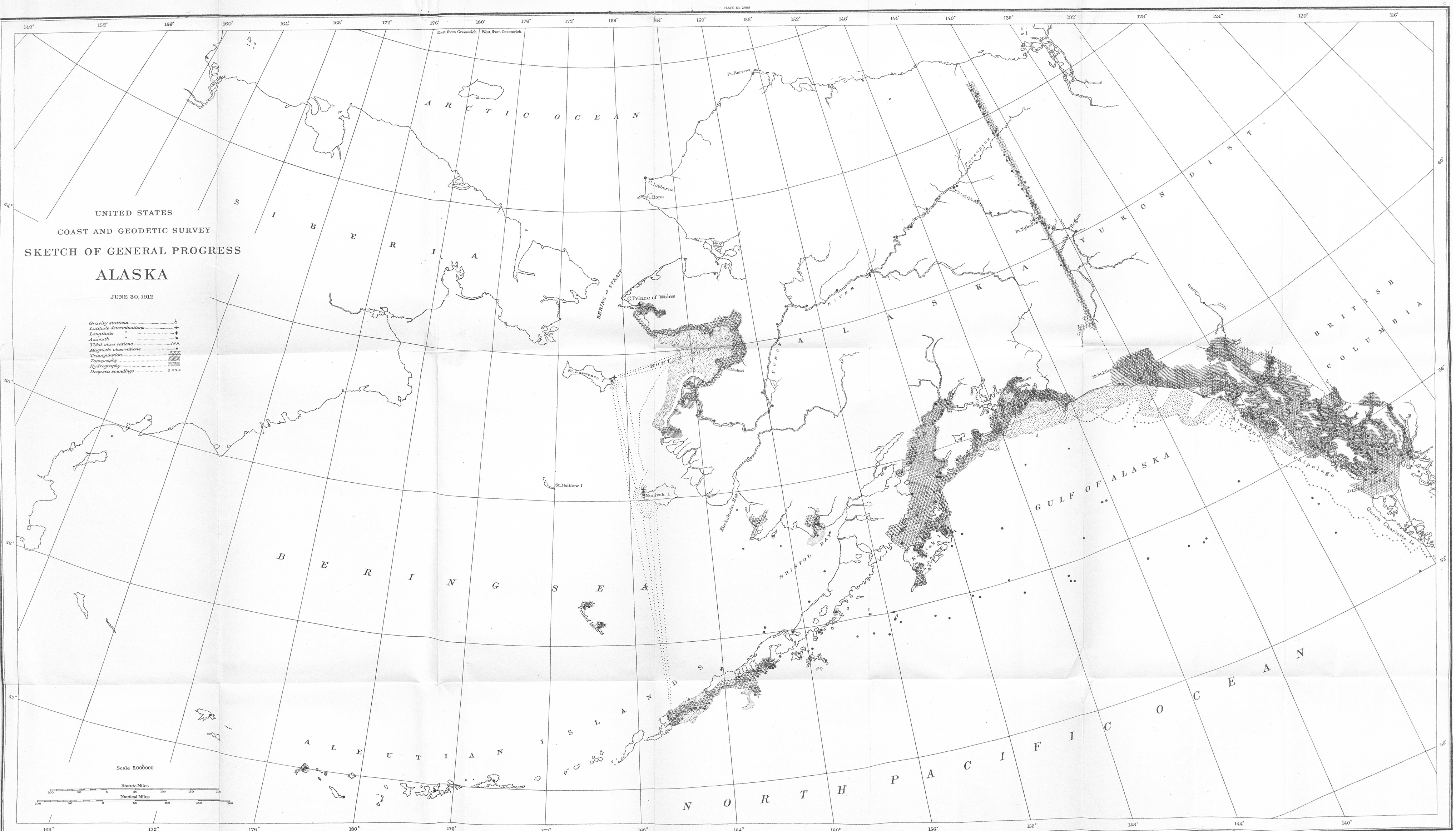

U.S. Coast and Geodetic Survey
O.H.Tittmann, Superintendent
BASE MAP OF THE UNITED STATES
(Projected on intersecting cone)
Scale 1:7000000
Statute Miles
Kilometers
Positions of Magnetic Stations
occupied to June 30, 1912
GULF OF MEXICO
ATLANTIC OCEAN
PACIFIC OCEAN
DOMINION OF CANADA
CUBA
BAHAMA ISLANDS
TEXAS
OKLAHOMA
KANSAS
NEBRASKA
SOUTH DAKOTA
NORTH DAKOTA
MONTANA
WYOMING
COLORADO
UTAH
NEVADA
ARIZONA
NEW MEXICO
CALIFORNIA
OREGON
WASHINGTON
IDAHO
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
TENNESSEE
KENTUCKY
VIRGINIA
WEST VIRGINIA
OHIO
INDIANA
ILLINOIS
MICHIGAN
WISCONSIN
PENNSYLVANIA
NEW YORK
MAINE
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
Mexico
Austin
Fort Worth
Baird
Jerico
Santa Fe
Albuquerque
Prescott
Colfax
Sacramento
Carson City
Salt Lake City
Bedwave
Denver
Cheyenne
Topeka
Lincoln
Des Moines
Madison
Springfield
Jefferson City
Columbus
Pittsburg
Harrisburg
Albany
Boise City
Pocatello
Helena
Butte
Bismarck
Fierro
Crawford
Hartford
Portland
Olympia
Kingston
Nassau
Tallahassee
Montgomery
Atlanta
Columbia
Raleigh
Nashville
Jackson
Little Rock
Baton Rouge
Galveston
Lansing
Augusta
Dover
Hartford
Providence
Boston
Montpelier
Concord
Albany
Hyde Park
Washington
Dover
Annapolis
Richmond
Charleston
Frankfort
Columbus
Indianapolis
Springfield
Madison
Lansing
Bismarck
Huntley
Fort Worth
Galveston
Jackson
Little Rock
Nashville
Columbia
Raleigh
Richmond
Washington
Dover
Hartford
Portland
Augusta
Montpelier
Concord
Boston
Hyde Park
Albany
Harrisburg
Pittsburg
Columbus
Indianapolis
Springfield
Madison
Lansing
Bismarck
Helena
Butte
Boise City
Pocatello
Cheyenne
Denver
Lincoln
Topeka
Jefferson City
Des Moines
Salt Lake City
Bedwave
Carson City
Sacramento
Colfax
Prescott
Santa Fe
Albuquerque
Jerico
El Reno
Galveston
Fort Worth
Baird
Austin
Tallahassee
Montgomery
Atlanta
Columbia
Raleigh
Nashville
Jackson
Little Rock
Baton Rouge
Kingston
Nassau
West from Greenwich
PLATE No. 2200
PLATE No. 2233
U.S. Coast & Geodetic Survey Report for 1912

UNITED STATES
COAST AND GEODETIC SURVEY
SKETCH OF GENERAL PROGRESS
JUNE 30, 1912
Eastern Sheet
Scale 5,000,000
Statute Miles
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
NEW YORK
PENNSYLVANIA
OHIO
INDIANA
ILLINOIS
IOWA
NEBRASKA
KANSAS
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
TENNESSEE
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
S. CAROLINA
FLORIDA
LOUISIANA
TEXAS
OKLAHOMA
INDIAN TERRITORY
GULF OF MEXICO
MEXICO
CUBA
YUCATAN
Bismarck
Aberdeen
Watertown
Pierre
Chamberlain
Sioux Falls
Yankton
Sioux City
Des Moines
Davenport
Rock Island
Peoria
Keokuk
Quincy
Springfield
Columbus
Omaha
Lincoln
North Platte
Julesburg
Colby
Atchison
Topeka
KANSAS CITY
Salina
Scott
Dodge City
Wichita
Guthrie
Amarillo
Jericho
Baird
Dallas
Fort Worth
Greenville
Waco
Temple
Austin
San Antonio
Eagle Pass
Laredo
Rockport
Corpus Christi
Galveston
Houston
Port Arthur
Baton Rouge
NEW ORLEANS
Mobile
Pensacola
Tallahassee
Apalachicola
Jacksonville
Keys
Tampa
Punta Gorda
Miami
Key West
Cape Canaveral
Savannah
Brunswick
Fernandina
Charleston
Georgetown
Wilmington
Newbern
Raleigh
Norfolk
Richmond
Lynchburg
Harrisburg
Williamsport
Pittsburg
Wheeling
Zanesville
Cleveland
Toledo
Erie
Buffalo
Rochester
Toronto
Ogdensburg
Ottawa
MONTREAL
Albany
Poughkeepsie
Trenton
PHILADELPHIA
BALTIMORE
WASHINGTON
Cumberland
Frederickburg
Lynchburg
Chicago
Fort Wayne
Detroit
Saginaw
Grand Rapids
Lansing
Milwaukee
Madison
Fond du Lac
Dubuque
Davenport
Rock Island
Peoria
Keokuk
Quincy
Springfield
Terre Haute
Indianapolis
Cincinnati
Columbus
Zanesville
Frankfort
Lexington
Louisville
Evansville
Cairo
Nashville
Chattanooga
Knoxville
Memphis
Corinth
Little Rock
Helena
Vicksburg
Jackson
Natchez
Shreveport
Texarkana
Birmingham
Atlanta
Augusta
Macon
Montgomery
Mobile
Havana
Cienfuegos
C. San Antonio
Cape Catoche
Progreso
Campeche
Tampico
Vera Cruz
Coatzacoalcos
Frontera
Belize
Monterey
Matamoras
Rio Grande
EXPLANATION OF SYMBOLS
Primary Triangulation
Secondary } Triangulation
Tertiary }
Reconnaissance
Surveyed Topography
do. In-shore Hydrography
do. Off-shore do.
Lines of Deep Sea Soundings
do. Geodetic Levelling

UNITED STATES
COAST AND GEODETIC SURVEY
SKETCH OF GENERAL PROGRESS
JUNE 30, 1912
Eastern Sheet
Scale 5,000,000
Statute Miles
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
MASSACHUSETTS
CONN.
R.I.
NEW JERSEY
DELAWARE
MARYLAND
WEST VIRGINIA
VIRGINIA
KENTUCKY
TENNESSEE
NORTH CAROLINA
S. CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
LOUISIANA
ARKANSAS
MISSOURI
KANSAS
NEBRASKA
FLORIDA
CUBA
BAHAMA ISLANDS
MEXICO
YUCATAN
QUEBEC
MONTREAL
Ottawa
Ogdensburg
Toronto
Rochester
Albany
Buffalo
Saginaw
Grand Rapids
Lansing
Detroit
Erie
Cleveland
Toledo
CHICAGO
Milwaukee
Madison
Fond du Lac
Dubuque
St. Paul
St. Peters
Duluth
Des Moines
Davenport
Rock Island
Peoria
Keokuk
Quincy
Springfield
Fort Wayne
Indianapolis
Terre Haute
Columbus
Zanesville
Wheeling
Pittsburg
Harrisburg
Williamsport
Poughkeepsie
Springfield
Providence
Hartford
New London
Portland
Bangor
St. John
Cape Sable
Cape Cod
PHILADELPHIA
Trenton
Atlantic City
BALTIMORE
Annapolis
WASHINGTON
Cumberland
Charleston
Frankfort
Lexington
Louisville
Evansville
Cairo
Nashville
Chattanooga
Knoxville
Memphis
Corinth
Little Rock
Helena
Texarkana
Shreveport
Vicksburg
Jackson
Natchez
Baton Rouge
NEW ORLEANS
Port Arthur
Galveston
Mouth of Mississippi
Mobile
Pensacola
Montgomery
Birmingham
Atlanta
Macon
Columbia
Augusta
Charleston
Georgetown
Savannah
Brunswick
Fernandina
Jacksonville
St. Augustine
Tallahassee
Apalachicola
Carrabelle
Keys
Cape Canaveral
Tampa
Punta Gorda
Miami
Tortugas
Key West
Nassau
HAVANA
Cienfuegos
Santiago de Cuba
C. San Antonio
Cape Catoche
Progreso
Campeche
Frontera
Coatzacoalcos
Belize
Raleigh
Newbern
Wilmington
Norfolk
Richmond
Lynchburg
Fredericksburg
Cape Hatteras
Cape Fear
Axis of the Gulf Stream, Warmest Band
ATLANTIC OCEAN
GULF OF MEXICO
EXPLANATION OF SYMBOLS
Primary Triangulation
Secondary
Tertiary
Triangulation
Reconnaissance
Surveyed Topography
do. In-shore Hydrography
do. Off-shore do.
Lines of Deep Sea Soundings
do. Geodetic Levelling
95°
90°
85°
80°
75°
70°
65°
45°
40°
35°
30°
25°
20°

UNITED STATES
COAST AND GEODETIC SURVEY
SKETCH OF GENERAL PROGRESS
JUNE 30, 1912
Western Sheet
Scale 1/5.000000
Statute Miles
50 40 30 20 10 0 50 100 150 200
EXPLANATION OF SYMBOLS
Primary Triangulation
Secondary Tertiary Triangulation
Reconnaissance
Surveyed Topography
do. In-shore Hydrography
do. Off-shore do.
Lines of Deep Sea Soundings
do. Geodetic Levelling
125°
120°
115°
110°
105°
100°
45°
40°
35°
30°
25°
20°
PACIFIC OCEAN
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
LOWER CALIFORNIA
MEXICO
Cape Flattery
Vancouver
Victoria
Port Townsend
Everett
Seattle
Tacoma
Spokane
North Yakima
Pasco
Walla Walla
Umatilla
Lewiston
Portland
Dalles
Salem
Baker City
Empire
Roseburg
Boise
Shoshone
Pocatello
Missoula
Helena
Virginia City
Shelby
Great Falls
Glascow
Lewistown
Miles City
Buford
Bismarck
Grand Forks
Fargo
Aberdeen
Watertown
Pierre
Chamberlain
Deadwood
Belle Fourche
Sheridan
Lander
Douglas
Crawford
Yankton
Sioux
Alliance
Rawlins
Green River
Cheyenne
Julesburg
North Platte
Columbus
Omaha
Lincoln
Logan
Ogden
Salt Lake City
Provo City
Beowawe
Cape Mendocino
Carson City
Sacramento
San Francisco
Grand Junction
Leadville
Colorado Springs
Pueblo
Colby
Salina
Scott
Dodge City
Wichita
Panguitch
Monticello
Durango
Conejos
Trinidad
Pt. Concepcion
Santa Barbara
Goffs
Kingman
Flagstaff
Holbrook
Prescott
Santa Fe
Albuquerque
Amarillo
Jericho
El Reno
Guthrie
Socorro
Roswell
Yuma
Tucson
Tombstone
Deming
Juarez
El Paso
Pecos
Baird
Greenville
Dallas
Fort Worth
Waco
Lampasas
Austin
San Antonio
Presidio del Norte
Eagle Pass
Laredo
Port Lavaca
Rockport
Corpus Christi
Matamoras
Rio Grande
Monterey
Chihuahua
Guadalupe I.
Cerros I.
Guaymas
Cape San Lazaro
La Paz
Cape San Lucas
Mazatlan
San Blas
Cape Corrientes
Manzanilla
Tampico
Vera Cruz

115°
110°
105°
100°
95°
90°
50°
45°
40°
35°
30°
25°
20°
MONTANA
NORTH DAKOTA
MINNESOTA
LAKE SUPERIOR
WISCONSIN
IDAHO
SOUTH DAKOTA
WYOMING
NEBRASKA
IOWA
ILLINOIS
UTAH
COLORADO
KANSAS
MISSOURI
OKLAHOMA
INDIAN TERR.
ARKANSAS
MISSISSIPPI
LOUISIANA
ARIZONA
NEW MEXICO
TEXAS
GULF OF MEXICO
MEXICO
Spokane
Lewiston
Missoula
Helena
Shelby
Great Falls
Glasgow
Bismarck
Grand Forks
Duluth
St. Paul
St. Peters
Aberdeen
Watertown
Pierre
Deadwood
Chamberlain
Sioux Falls
Yankton
Sioux City
Fond du Lac
Madison
Milwaukee
Dubuque
Des Moines
Davenport
Rock Island
Peoria
Keokuk
Quincy
Springfield
Omaha
Lincoln
Columbus
North Platte
Alliance
Chadron
Julesburg
Cheyenne
Sheridan
Lander
Douglas
Crawford
Rawlins
Green River
Logan
Ogden
Salt Lake City
Provo City
Boise
Pocatello
Shoshone
Kingman
Flagstaff
Prescott
Holbrook
Albuquerque
Santa Fe
Socorro
Roswell
Amarillo
Jericho
El Reno
Guthrie
Fort Smith
Little Rock
Memphis
Helena
Jackson
Vicksburg
Natchez
Shreveport
Texarkana
Greenville
Dallas
Fort Worth
Baird
Waco
Austin
San Antonio
Galveston
Houston
Port Arthur
Baton Rouge
New Orleans
Port Lavaca
Rockport
Corpus Christi
Laredo
Eagle Pass
Brownsville
Matamoras
Rio Grande
Monterey
Tampico
Vera Cruz
Coatzacoalcos
Frontera
Campeche
Cape Corrientes
Manzanilla
San Blas
Mazatlan
Cape San Lucas
La Paz
Guaymas
Chihuahua
Durango
Conejos
Trinidad
Pueblo
Monticello
Panguitch
Salina
Topeka
KANSAS CITY
Atchison
Jefferson City
Cairo
Scott
Dodge City
Wichita
Pecos
Juarez
Ft. Bliss
Presidio del Norte
Chihuahua
Cape Corrientes
Manzanilla
MEXICO

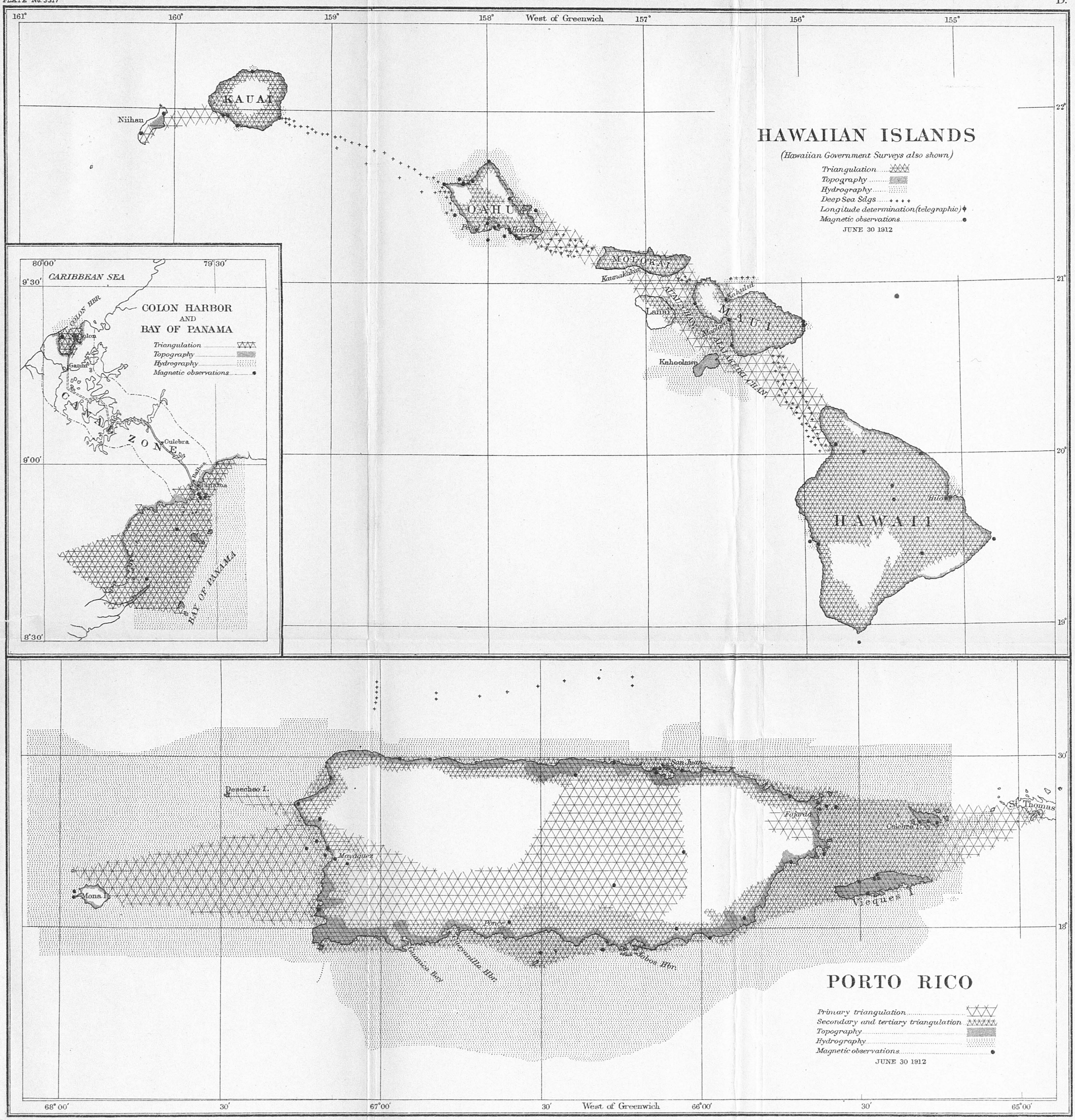

UNITED STATES
COAST AND GEODETIC SURVEY
SKETCH OF GENERAL PROGRESS
ALASKA
JUNE 30, 1912
Gravity stations
Latitude determinations
Longitude "
Azimuth "
Tidal observations
Magnetic observations
Triangulation
Topography
Hydrography
Deep sea soundings
Scale 5,000,000
Statute Miles
Nautical Miles
East from Greenwich
West from Greenwich
ARCTIC OCEAN
SIBERIA
BERING SEA
ALEUTIAN ISLANDS
NORTH PACIFIC OCEAN
GULF OF ALASKA
ALASKA
YUKON DIST.
BRITISH COLUMBIA
BERING STRAIT
NORTON SOUND
YUKON RIVER
BRISTOL BAY
Alexander Archipelago
Queen Charlotte Is.
Pt. Barrow
C. Lisburne
Pt. Hope
C. Prince of Wales
St. Lawrence I.
St. Matthew I.
Nunivak I.
Kuskokwim Bay
Pribilof Islands
Kodiak I.
Mt. St. Elias
Pt. Egbert
Porcupine
Klondike Region

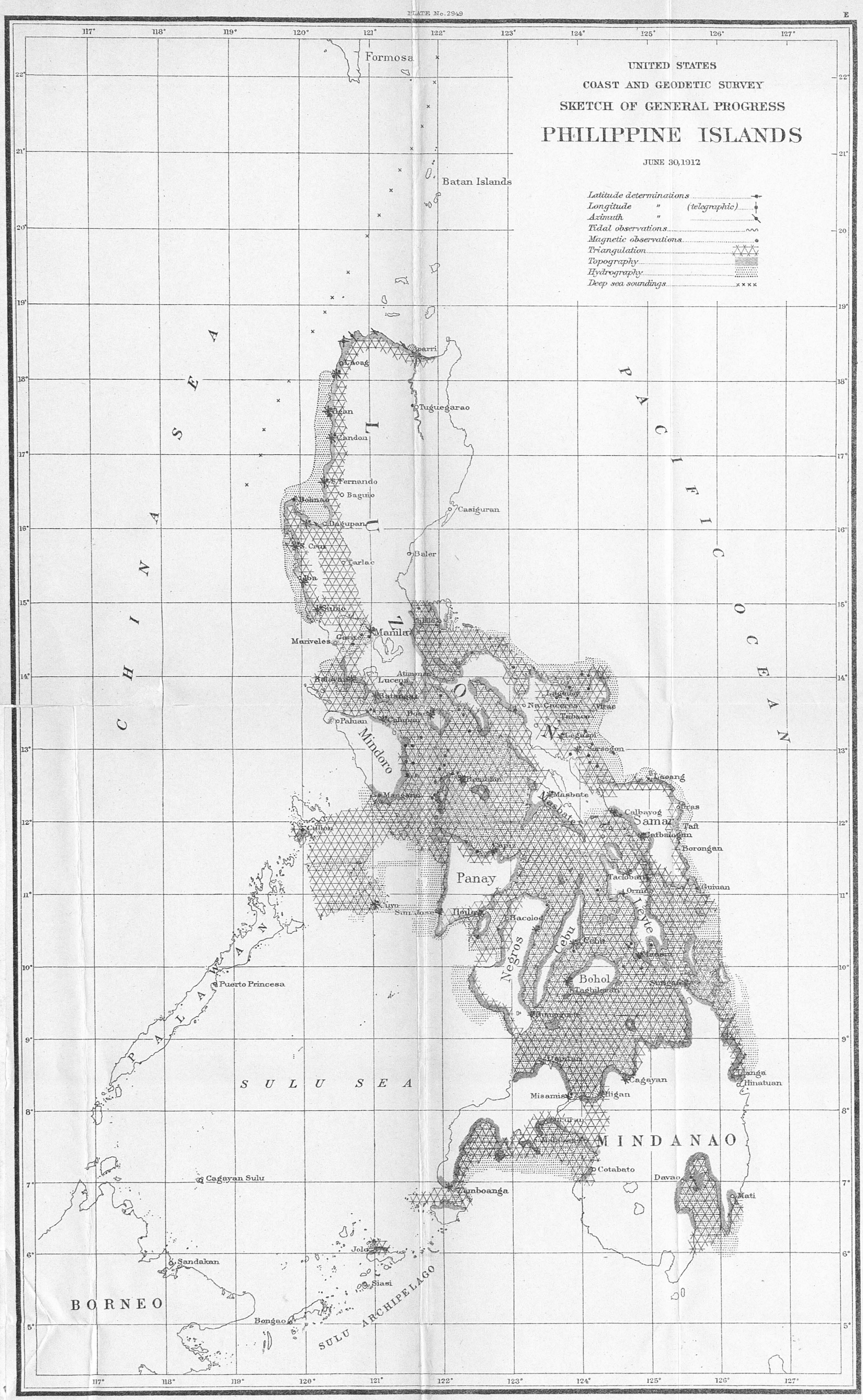
COAST AND GEODETIC SURVEY

GENERAL PROGRESS SKETCH

PLATE No. 3317

D.





Mercator projection $\frac{1}{5000000}$ *in lat. 13° N.*