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R. P. LAMONT, Secretary

COAST AND GEODETIC SURVEY

R. S. PATTON, Director

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DIRECTOR OF THE COAST AND GEODETIC SURVEY

TO THE

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FOR THE

FISCAL YEAR ENDED JUNE 30, 1932

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Annual Report of the Superintendent of the Coast Survey

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CONTENTS

	Page
A review of the year	1
Introduction	1
Nautical charts	2
Control surveys	3
Tides and currents	5
Terrestrial magnetism	6
Seismology	7
Airway maps	7
Field operations	8
Hydrographic and topographic work	8
Geodetic work	11
Tide and current work	14
Magnetic and seismological work	17
Washington office	18
Chief clerk	18
Division of accounts	19
Division of instruments	19
Division of hydrography and topography	20
Division of geodesy	21
Division of charts	22
Division of tides and currents	23
Division of terrestrial magnetism and seismology	24
Distribution of field parties	25
Division of hydrography and topography	25
Division of geodesy	27
Division of tides and currents	31
Division of terrestrial magnetism and seismology	32

COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, July 1, 1932.

The honorable the SECRETARY OF COMMERCE.

DEAR MR. SECRETARY: I have the honor to submit my fourth annual report. This report is for the fiscal year ended June, 30 1932, and is the one hundred and first annual report of this bureau.

A REVIEW OF THE YEAR

INTRODUCTION

The outstanding feature of the year was the Federal reaction to the existing economic depression.

In response to the public demand for economy in Government, drastic cuts were made in the appropriations which support this and other Federal bureaus. In our own case, typical reductions in items of necessary work, stated in terms of the percentage reduction below the amounts available for 1932, are as follows:

	Per cent
Field surveys, Atlantic coast	14
Field surveys, Pacific coast	36
Magnetic and seismological work	50
Control surveys	54
Tide and current surveys	26

In this period of stress, no one can question the need for the maximum economy which can be accomplished without undue impairment of essential public service, and the Coast and Geodetic Survey is willing to accept its share in any retrenchments of that character. Reductions of the character indicated above, however, exceed that limit, and the Survey was gravely concerned as to its ability to meet its responsibility of helping to safeguard life and property at sea, until another congressional action saved the situation.

Learning that of any reasonable sum made available to the bureau, from 70 to 75 per cent would be paid out directly as wages to persons in need of work, and that the total would be spent in expediting completion of urgently needed work, the Congress included $1,250,000 for the bureau in the emergency relief and construction act.

This action prevents a critical situation from developing in the near future and postpones for subsequent consideration the question of a proper appropriation base for the bureau under such economic conditions as may then prevail.

NAUTICAL CHARTS

Radical improvements in apparatus during the past decade, with a corresponding progress in methods, have increased the accuracy and volume of offshore hydrographic surveys, the field work on which nautical charts are based.

The hydrographer is no longer dependent upon clear weather to see signals to carry on his surveying operations. He can now work through fog or at night with accurately fixed positions. Modern science, therefore, has furnished two other primary factors toward the expeditious prosecution of hydrographic surveying—the availability of soundings in seconds instead of hours and freedom from the limitations imposed by fog or darkness. The lifting of the barrier created by fog is particularly helpful along parts of the Atlantic and Pacific coasts of the United States where fog and haze are prevalent.

The introduction of these developments in hydrographic work has not only made possible a more vigorous and speedy prosecution of this work but has permitted the construction of charts suitable to meet the exacting demands of modern commerce.

The navigator of the past was often compelled to grope his way blindly with only the knowledge that he had sufficient depth of water under his vessel. The navigator of to-day looks to the nautical chart to supply him with a wealth of detailed submarine features, because the use of echo-sounding instruments on the ships of our merchant marine and of our Navy enable him to visualize these features over which his vessel is passing at full speed, thereby fixing his position in thick weather when celestial bodies are not available.

Many areas charted from hydrographic surveys under old methods, adequate for the mariner of yesterday, must therefore be resurveyed by the more precise and detailed means now possible. This applies especially to offshore areas along the Atlantic coast, where first surveys made years ago may now be considered in the nature of reconnaissance for detailed surveys. Georges Bank, under resurvey during the past three years, is an example.

As the first surveys on the outer Pacific coast had not proceeded to any large extent before the introduction of newer instruments and technique, charts constructed on that coast meet the requirements of the most exacting navigator. Surveys of the water areas in 1918 along the outer California coast were 27 per cent completed, with Oregon 14 per cent, and Washington 44 per cent. The California coast is now 78 per cent completed, with the coasts of both Oregon and Washington 100 per cent.

The entire water area of the Philippine Islands is about 86 per cent surveyed at the present time, the first survey of the more important places having been completed several years ago.

The first survey of the Hawaiian Islands, including waters along the chain of reefs and islets westward from the main group for some 1,200 miles, has progressed rapidly and satisfactorily during the past few years. The end of that job was in the not-far-distant future when curtailed appropriations forced the recall of the party on the *Pioneer* and the laying up of the ship in San Francisco.

Alaska has not been so fortunate, with surveys of about 18 per cent of its waters accomplished at the present time. Only 9 per cent of her water area was surveyed during the period 1867 to 1918.

With few exceptions, the waters mentioned in the preceding paragraphs are in unchangeable areas, requiring no further detailed surveys to keep charts current. On the Atlantic coast, however, the greater part of the outer coast and the vast network of inland waters comprise changeable areas which in many cases are undergoing marked development. These regions are in urgent need of resurveys, especially along the inside water route, now known as the intracoastal waterways. Many of these charts, even within the important and rapidly growing metropolitan areas, are based on surveys made prior to the Civil War.

Data from hydrographic surveys are applied to chart construction as soon as possible after field work is completed. Advance information is in many cases furnished the mariner before a revised chart can be supplied. A typical example is the survey of Georges Bank, off the New England coast, an area of about 60,000 square miles. The importance of this area and the discovery of several unusual submarine features of exceptional aid to the mariner in fixing his position, caused the Survey to issue advance information on December 21, 1931, on chart No. 1107, less than 90 days after the close of work for the 1931 season. This preliminary chart, based on field plottings during the 1930–31 seasons, may require some slight adjustments in the final charting.

The number of surveys from other organizations, used in correcting nautical charts, was almost double that of any previous year. To apply these amendments, it was necessary to simplify the land area by showing less general topographic detail and largely confining efforts to landmarks and features essential to the navigator. Those who need details omitted from the chart have recourse to the large-scale field sheets in the files of the Washington office. While not kept up to date, they represent conditions at the time of the survey.

The demand for air-photo compilations from engineers and others engaged in coastal improvements has been gratifying. These sheets have also proved their value to the Survey in chart construction. Because of the large number of identifiable points shown with a high degree of precision it has been possible to use much valuable data that would otherwise be discarded or incorrectly used. A large part of San Francisco Bay was covered during the year by air-photo compilations, and photographs were obtained of the Sacramento-San Joaquin delta, for use in the construction of a chart of that region.

CONTROL SURVEYS

Remarkable progress was made in extending control surveys over the country, with 3,400 miles of arcs of first-order triangulation, 5,945 miles of first-order levels, and 1,555 miles of second-order leveling added to the horizontal and vertical control nets. This is greater progress than has ever been made in one year, in this or any other country.

At the end of the year, the readjustment of the triangulation net of the eastern half of the United States was nearing completion. With its early completion (the net of the western half of the country having been adjusted last year) we thus have a triangulation net comprising more than 30,000 miles of strongly welded arcs. The resulting data of accurately determined latitudes, longitudes, distances, and azimuths or true bearings, are now standard. Engineers can use these data for their projects, with assurance that no change will be made in the future, except for the few States subject to earth movements caused by earthquakes.

The adjustment of the level net, involving more than 70,000 miles of first-order leveling, is also nearing completion. A few years ago the most probable elevations of bench marks at the junctions of the lines had been determined. These have been accepted as standard and the lines joining the junction points are now being fitted into the scheme.

With the very strong horizontal and vertical skeleton nets adjusted into single units, it will then be possible to fit in short connecting arcs of triangulation and lines of levels.

The readjustment of the control survey nets resulted in upsetting previously published data. It is essential that these new data be published in pamphlet form in order to serve the public. At present the Survey is issuing the essential data as rapidly as possible in manuscript form, because of the lack of printing funds. This is not adequate, for with printed pamphlets the attention of the public can be called to the data they contain, making possible great economies in carrying on many of the industries of this country. Surely the cost of printing, but a small percentage of the cost of the field and office work involved in these control surveys, is a justifiable expenditure.

Greater use in being made of the horizontal control data in the establishment of property lines. At each of the triangulation stations an azimuth mark is set at a distince of about 400 yards, for the use of the local engineer and surveyor. He can set up his instrument at the station, observe on the azimuth mark, and start his work with an azimuth as well as a position. By using triangulation in the location of property boundaries, whether private or public, the boundary can be considered as fixed for all time. There is only one spot on the face of the earth with a given latitude and longitude, and hence, when the monuments of a boundary survey are connected with the Federal triangulation net, the positions of those monuments can be recovered at any time in the future.

The Survey has as its principal object the securing of data of practical value. These data have scientific value as well, which should be analyzed and used, but to do that would require an expansion of the office personnel. All scientific work designed to discover new facts and fundamental principles is eventually put to practical use. For instance, the gravity data used formerly in only physical laboratories and for determining the shape of the earth are now used for discovering buried geological structure. This structure has a bearing on the search for underground waters, petroleum, and minerals. The Survey has to-day a vast quantity of geodetic data which, studied from a scientific viewpoint, might be of great assistance in fields of geology, mining, and oil development. With the limited force now available, it is not practicable to carry on these scientific investigations to any great extent.

The Congress, at its last session, eliminated a provision to pay the traveling expenses of delegates to the meetings of the International Research Council or its branches. The Coast and Geodetic Survey has profited tremendously during its existence by contacts with men working in similar fields in other countries. These contacts are made especially at international scientific meetings such as those of the International Geodetic and Geophysical Union. In this union are associations of geodesy, seismology, terrestrial magnetism and electricity, and oceanography; in all of which branches the Survey is vitally interested. Legislation is necessary to authorize an appropriation for traveling expenses of delegates. While the Coast and Geodetic Survey undoubtedly ranks high among similar organizations of the world, it must continue to keep informed of the work of others, otherwise it will suffer from a lack of prompt knowledge of new and improved instruments and methods devised by the workers of other countries. Attendance at international scientific congresses, at small expense, frequently results in great economies in carrying on the bureau work.

During the year the variation of latitude station at Gaithersburg, Md., was reopened for observations. There are now two such stations in the United States, the other being located at Ukiah, Calif. The work is international in character, with stations in other countries on the same parallel of latitude. The resulting data are used in connection with astronomical latitudes and longitudes employed in the horizontal control surveys and are of value to astronomical observatories in determining the positions and movements of stars.

TIDES AND CURRENTS

Basic tide observations were continued at 30 tide stations located at carefully selected points along the coasts of the United States and its possessions. The policy adopted in the operation of these stations makes use of part-time local observers, supplemented by periodic inspections of expert personnel. These tide observations are in this way secured at very low unit cost.

The observations from these primary tide stations serve directly a number of purposes underlying various functions of this bureau. Among the more important may be mentioned the control of hydrographic surveys, the determination of initial and tie-in points for precise leveling, the determination of datum planes, and the control of tide predictions. In addition to these direct purposes, they serve a number of collateral purposes, two of which deserve special mention. These are data with respect to coastal stability and data for the study of tides and tidal phenomena.

The coast is not a stable feature of our earth. There is indubitable evidence that the land and sea have changed in relative elevation at various places in the past. Whether such changes are going on now is not only an interesting scientific question but one of more than academic importance to our seaboard cities. The only means for answering this question is through the continuous tide observations being made at the Survey's primary tide stations.

While the tidal work is being carried on for definite practical purposes, the complex nature of the phenomena of the tides compels scientific research, that the technical purposes to be served may be accomplished in the most economical and efficient manner. The observations at the primary tide stations furnish the data necessary for such research. That such research has been successful is attested by the mechanical tide predictor, designed and constructed in this bureau, which does the work of many expert mathematicians.

In connection with the hydrographic surveys and with special surveys made in cooperation with various Federal, State, municipal, and private agencies, tide observations covering periods of a year or less were made at 164 other places. The tide and current survey of Buzzards Bay was completed and a similar survey of New York Harbor, in cooperation with the United States Engineer Office, was begun. These surveys form part of the program which looks to making thorough surveys of the more important waterways, the purpose of which is to provide detailed information for the mariner and the engineer regarding the continually varying characteristics of the tide, peculiar to particular areas.

During the year the increasing importance of accurate datum planes based on the tide has become more evident. Such datum planes are used to define title to land bordering tidal waters, and, with the growing importance and increasing value of such lands, the necessity for the accurate determination of such datums is becoming more widely recognized and required. Because of the limited appropriations available for this work, the Survey has adopted the method of cooperating with some responsible agency, wherever possible, in securing the tide observations necessary to determine the datum planes desired.

The datum planes used in defining title to land fronting tidal waters are generally some high-water or low-water plane. But both high water and low water vary from day to day, from month to month, and from year to year. In fact, to determine any tidal datum planr directly from the observations requires continuous observations foe a period of 19 years. However, research in this bureau has developed methods by which datum planes may be determined with considerable precision from series covering periods of a year or less.

TERRESTRIAL MAGNETISM

Every mariner's chart has one or more so-called compass roses for the purpose of making it easy to use the magnetic compass in steering desired courses. Maps for the aviator now carry similar information. The Survey is able to furnish this information as a result of its complete magnetic survey of the United States and the regions under its jurisdiction. The survey is a continuing function, since it must be possible to take into account changes in the earth's magnetism from year to year.

With magnetic observations at nearly every county seat in the United States and many other places, it is possible to meet the needs of the land surveyor who is often obliged to retrace lines run with the magnetic compass many years ago. Magnetic information is also essential in prospecting for oil and in the search for minerals by certain geophysical methods. It has been found that radio transmission difficulties are directly related to disturbances of the earth's magnetic field and the magnetic records of the observatories of the bureau are in constant demand in connection with these studies.

The Survey has made observations at 5,000 places in the United States and at numerous places in Alaska and the insular possessions. The change in magnetism is determined at 5-year intervals at selected places, known as repeat stations.

Since these and most of the other stations are in towns, they are subject to many contingencies which may destroy their usefulness.

During the past year, utilization of triangulation stations of this Survey was put into effect in the hope that these stations, since they are well marked and not located in cities, are more likely to be preserved.

Five magnetic observatories have been in continuous operation. At the Tucson Observatory, through cooperative arrangement, atmospheric, electric, and earth current observations have been in progress.

SEISMOLOGY

There has been steady increase in cooperation in the reporting of earthquakes. Records have continued to be obtained at eight seismological stations, six of which are cooperative. A seismograph has been installed at the International Latitude Observatory at Ukiah, Calif., which is operated by this bureau. In addition, a number of educational institutions have continued to send their records to the Survey for interpretation, an important aid in making the earthquake information complete for the entire country.

The outstanding accomplishment has been the development, with the cooperation of the Bureau of Standards and the Massachusetts Institute of Technology, of three types of instruments for recording strong earth motions. One type measures the acceleration, another the amplitude of the earth motions and the periods, while the third is a relatively inexpensive instrument which supplies valuable related information. In every case the operation is automatic. The earthquake starts the record which, after a period long enough to record the strong earth motion, automatically stops and does not start again unless the earthquake continues.

This is the first attempt with modern scientific instruments to measure strong earth motions elsewhere than in Japan and is expected to fill an important gap in information needed by architects and engineers in the design of buildings and other structures.

AIRWAY MAPS

The airway-mapping program embraces specialized maps with typical legends for the quick reading by the pilot in a rapidly moving plane. Legends, altitudes, etc., are further emphasized by printing these maps in colors. The strip map covers a section 80 miles wide between the terminals of established airway routes, while the sectional map embraces the area between 2° of latitude and 4° of longitude.

It is reasonable to believe that the series of strip maps, of which 31 have been published, may be regarded as coming to a close, for the reason that the sectional map comprehensively covers more ground area. Commercial airway routes are but one of the features shown. They likewise eliminate duplication, for the strip maps of air routes necessitate the duplication of terminal fields wherever the routes connect.

The sectional airway-map series will consist of a total of some 92 maps, and on them the bureau is commencing to get into its production stride. In a large way this is no doubt due to the use of a plane for flight checking, thereby insuring the prompt issuance of such maps after the completion of office compilation. The lack of a standard topographic map to serve as a base for aeronautical data continues to act as a handicap in some areas, making it necessary to secure the needed information from many and varied sources.

The first sectional map was issued in December of 1930, and two more were published before the end of the 1931 fiscal year. This year six were issued. Present progress indicates that the production of the combined two years may be increased by 30 per cent in 1933 in sectional maps alone.

This, of course, must be influenced by the very obvious fact that every map issued must be kept current. The accumulation of the many changes due to added and deleted airports, aids to navigation, etc., in this rapidly growing industry, make it of vital importance in the interests of human safety to publish revised editions containing the ever-changing information collected. These corrections are of practical value only when shown on the maps.

The pilots of aircraft, the individuals and companies operating them, and the insurance companies covering them, all have confidence in the accuracy of these maps.

While the airway-mapping program is progressing, the issuance of an increasing number, with the necessity for revised editions, must eventually slow up production, in spite of a well-organized and experienced staff, unless there is an appreciable corresponding increase in staff to meet the needs of the aircraft industry for maps.

FIELD OPERATIONS

HYDROGRAPHIC AND TOPOGRAPHIC WORK

During the year topographic and hydrographic surveys, including the triangulation necessary to control them, were made on the Atlantic, Gulf, and Pacific coasts of the United States, and in Alaska, Hawaii, and the Philippines. A brief outline of the various projects follows:

Atlantic coast.—The principal project on the Atlantic coast was the continuation of the survey of Georges Bank, undertaken in 1930 at the request of both shipping and fishing industries for more detailed charts of that region. Four of the Survey's vessels, the *Hydrographer, Oceanographer, Lydonia,* and *Gilbert,* participated in the work. Despite the difficulties encountered in surveying this important offshore area, remarkable progress has been made largely owing to the successful use of radio acoustic ranging methods as developed by the bureau. To meet the demands for advance information regarding the region, the results of the 1931 season's work were applied to chart 1107 and were available soon after the close of the season. Normally this project would have been completed in the summer of 1932, but the curtailment of appropriations may make this impossible.

During the winter months when work can not be economically prosecuted on Georges Bank, the four vessels were engaged on revision surveys in the vicinity of Norfolk and Yorktown, Va., and Annapolis, Md., for the purpose of constructing large-scale anchorage charts requested by the Navy.

The party on the *Natoma* made a resurvey of Pollock Rip Channel, Mass., and of the shoals in the vicinity necessary to chart properly that important and rapidly changing waterway. The same party then made a resurvey of Port Jefferson Harbor, N. Y., after which a survey of the Chowan River in North Carolina was made.

The party on the *Mikawe* was engaged throughout the greater portion of the year in making surveys of the Wicomico River, Md., and its approaches, for the purpose of constructing large-scale charts of that waterway. In connection with this project a second-order scheme of triangulation was extended from the old first-order arc in Chesapeake Bay to the new first-order Atlantic-coast arc in the vicinity of Salisbury, Md. The second-order scheme will serve to coordinate the numerous fragmentary schemes in the region through which it passes.

A wire-drag party operating in Long Island Sound until November and resuming operations in May, located a considerable number of rocks and wrecks dangerous to navigation. This party is also engaged in making new basic surveys of the region covered by chart 221, which has undergone many changes since last surveyed.

The control party working in New York Harbor and vicinity continued operations throughout the year. Second-order coordinating schemes of triangulation were extended through Jamaica Bay, Arthur Kill, Kill van Kull, and extended up the East and Hudson Rivers.

Work similar to that in New York Harbor was accomplished during the winter months by the party on the *Lydonia* in Norfolk Harbor and vicinity. The numerous small control schemes of triangulation of this bureau and of the United States Engineers were coordinated and provision made to connect the coordinating scheme with the first-order Atlantic coast and James River arcs.

A shore party was engaged during the winter months on the Florida coast in locating new airway beacons and coordinating surveys of the United States Engineers with those of the bureau. During the summer months this party conducted similar operations on the coasts of Rhode Island and Massachusetts.

Pacific coast.—The party on the ship *Guide* extended surveys on the Washington coast northward to the Canadian boundary and carried them eastward in Juan de Fuca Strait as far as Port Angeles. After completing this project, work was taken up on the California coast and at the end of the fiscal year surveys had been completed southward to the vicinity of Pigeon Point. To establish suitable control in advance of this project, a shore party had carried coastal triangulation southward from the vicinity of Monterey Bay to Point Sur at the end of the fiscal year.

A launch party completed topographic and inshore hydrographic surveys from Russian River southward to Point Reyes. These included a resurvey of Bodega and Tomales Bays. Near the end of the fiscal year a launch party took up surveys of Santa Barbara and San Nicholas Islands, to be used in the construction of large-scale charts of that region.

All the recently constructed airway beacons south of San Francisco were located during the latter part of the year. Control was established for the reduction of air photographs to be used in the construction of charts of the San Joaquin and Sacramento Rivers. The resurvey of the southern portion of San Francisco Bay, including the field inspection of the air photographs to be used in compiling the new charts, was completed.

Alaska.—The *Explorer* completed surveys in Behm Canal, required for the construction of new charts of that waterway, and extended them southward into Revillagigedo Channel. This project will be continued southward into regions embraced by chart 8075 which have not been adequately charted.

The *Surveyor*, continuing on the extensive project which calls for complete charting of the coast of Kodiak Island, extended work along the southeast coast from Sitkinak Strait eastward to a junction with previously completed surveys in Sitkalidak Strait. The surveys made by this party supply the information for charting the greater portion of the areas embraced by new charts 8536 and 8537.

The *Discoverer* extended surveys southward from the Kenai Peninsula across the strait to Shuyak and along the north coast of that island. The surveys made by this party supply the information for the construction of chart 8532 and for the correction of chart 8531.

Hawaiian Islands.—The *Pioneer* continued on the project of surveying the chain of islets, reefs, and shoals that extend 1,200 miles westward from the main group of islands to Midway Island. Surveys were completed to and including Lisianski Island. This party was engaged on surveys south of Molokai, Lanai, and Kohoolawi Islands until the middle of March when, owing to curtailed funds, the vessel returned to the United States and was laid up during the remainder of the fiscal year.

Philippine Islands.—Three vessels, the *Pathfinder*, *Fathomer*, and *Marinduque*, the latter two owned and equipped by the Philippine government, continued survey operations on the north, east, and west coasts of Luzon Island, on the west coast of Palawan Island and in the Sulu Archipelago. A detailed resurvey of Manila Bay was also made during the year. Surveys necessary for charting the Philippine Islands, which require 150 charts, are now approximately 86 per cent completed.

Hydrography, topography, and triangulation accomplished

Locality	Hydrography			Topography		Triangulation (second and third order)		
	Miles of sounding lines	Area in square miles	Number of soundings	Length of shoreline surveyed in miles	Area surveyed in square miles	Length of scheme in miles	Area covered in square miles	Number of geographic positions determined
Georges Bank, Mass	9,055	4,123	70,810			4	6	2
Pollock Rip Channel, Mass	710	35	17,522	47	1			2
Port Jefferson Harbor and approaches, Conn	280	16	9,704	60	20	27	184	45
Long Island Sound, Conn., N. Y	[1] 262 164	[1] 72 21	[1] 881 3,990	31	3	22	43	35
New York Harbor, N. Y						124	500	543
Wicomico River, Md	377	12	16,723	102	25	13	70	20
Severn River and approaches, Md	586	32	32,819	93	17	28	137	75
York River, Va	123	6	5,016	17		14	32	48
Norfolk, Va						52	386	86
Chowan River, N. C	604	28	23,491	96	26	60	168	76
St. Augustine to Miami, Fla						27	46	12
Lake Ponchartrain, La						5	15	27
Santa Barbara and San Nicholas Islands, Calif				5	1	10	25	19
Southern California								36
Monterey Bay southward						52	123	94
Point Montara to Pt. Sur. Calif	2,118	1,008	25,525	18	10			4
San Francisco Bay, Calif. (Air photo reduction)				136	178			
San Joaquin-Sacramento Delta, Calif								44
Point Reyes to Pt. Steward, Calif	1,646	479	9,753					
Russian River to Pt. Reyes, Calif	940	66	28,953	56	36			

[1] Wire drag.

Hydrography, topography, and triangulation accomplished—Continued

Locality	Hydrography			Topography		Triangulation (second and third order)		
	Miles of sounding lines	Area in square miles	Number of soundings	Length of shoreline surveyed in miles	Area surveyed in square miles	Length of scheme in miles	Area covered in square miles	Number of geographic positions determined
Juan de Fuca Strait and approaches, Wash.	2,996	1,158	25,531	29	20	37	322	12
Behm Canal, Alaska	2,353	227	34,937	312	193	63	141	72
Kenai Peninsula to Afognak Island, Alaska	10,325	2,807	86,746	342	201	75	240	66
Kodiak Island, Alaska	7,751	2,907	98,925	259	187	77	110	89
Oahu to Lisianski Island, Hawaiian Islands	12,236	45,100	43,626	2	1			
Lanai, Maui, and Hawaii Islands, Hawaiian Islands	3,793	520	18,697	30	5	7	10	10
North, east and west coasts, Luzon Island	5,687	1,598	72,940	106	9	51	284	45
San Bernardino Straits	1,846	448	12,367			12	142	
West coast, Palawan Island	5,191	311	84,038	94	70	23	136	29
Sulu Archipelago	2,966	507	32,033	92	48	20	210	32
Manila Bay, Luzon	168	4	12,305	12				
Total	72,186	61,485	767,322	1,959	1,051	803	3,330	1,523

GEODETIC WORK

The fiscal year just closed marks the second year during which geodetic operations were carried on under the increased appropriations for this class of work. The results have been most gratifying, and the economy of having parties in continuous operation during the year has been demonstrated satisfactorily.

The arcs of triangulation necessary to prepare the triangulation net of the eastern half of the country for adjustment had been completed during the previous year. During the past year the arcs run were through areas selected to meet the needs of the United States Geological Survey, the Mississippi River Commission, the United States Lake Survey, and to provide control for the charts of the Survey along the Altantic coast.

At the beginning of the fiscal year a party was engaged in the extension of an arc of first-order triangulation along the Mississippi River, between Cairo, Ill., and St. Paul, Minn., which had been requested by the Chief of Engineers, United States Army. Upon the completion of this arc in August, the party moved to northern Michigan and worked southward along the eighty-fifth meridian to a connection with the United States Lake Survey triangulation in northern Indiana. The party was then transferred to Norfolk, Va., extending its work as far south as Brunswick, Ga., after which it was moved to Rhode Island to work southward along the coast to Norfolk. At the end of the fiscal year the party was in the vicinity of New York City.

Early in the year a triangulation party started an arc in Montana and worked southward along the one hundred and eighth meridian to a connection with the transcontinental arc in Colorado. The party then worked eastward along the northern boundary of the Texas Panhandle to connect with the northern end of the Texas-Oklahoma boundary triangulation along the one hundredth meridian. The party then worked southward through Texas, between the one hundred and first and one hundred and second meridians, connecting the El Reno-Needles arc with the Rio Grande arc. The arc along the Ohio-Indiana boundary was run next and at the end of the fiscal year the party was working on an arc along the eastern shore of Lake Michigan, requested by the United States Lake Survey.

Other arcs of triangulation completed extend from Reno, Nev., to Lakeview, Oreg., from Sacramento to Stockton, Calif., from San Luis Obispo, Calif., northeastward and in the vicinity of San Francisco Bay.

The total length of the arcs run during the fiscal year is 3,400 miles.

Lines of first and second order leveling were run in Arkansas, California, Delaware, District of Columbia, Maryland, Minnesota, Montana, Nevada, New York, North Carolina, North Dakota, Oregon, South Dakota, Texas, Virginia, Washington, and Wisconsin. The total amounted to 5,945 miles of first-order and 1,555 miles of second-order lines.

During the year observations were resumed at the variation of latitude station at Gaithersburg, Md., one of a group of stations established many years ago by the International Geodetic Association. Since the World War, these stations have been operated by the countries in which they are located. There are two stations in the United States, at Ukiah, Calif., and at Gaithersburg, Md. Other stations are at Carloforte, Italy; Mizusawa, Japan; and Kitab, Russian Turkestan. The latter, now in operation only about two years, replaces the old station of Tchardjui, near which it is located.

While the results of the variation of latitude are of importance in the determination of the astronomical latitudes and longitudes by the Survey, the data secured are of even greater value to many astronomers who are determining the positions and motions of the heavenly bodies. All extensive mapping and charting are based on the positions and motions of stars which are determined by astronomers.

Since inaugurating a few years ago the plan of establishing an azimuth mark near each occupied triangulation station, our data have been more widely used by local engineers. The azimuth mark or monument is placed about 400 yards from the station in a position which enables the engineer to see it from the ground at the station. The azimuths or true bearings to the marks are determined and published with the normal data for triangulation. The engineer can now start his traverse with a geographic position and an azimuth, and a land surveyor retracing boundaries of property originally based upon magnetic bearings can determine his local deviation of the compass needle at a near-by triangulation station.

Geodetic work accomplished

Locality	Length of scheme	Area covered
Triangulation, first-order:	*Miles*	*Sq. mi.*
Iowa, Illinois, Wisconsin, and Minnesota, Mississippi River arc	350	3,500
California, Nevada, and Oregon, Reno to Lakeview arc	175	4,500
California, San Joaquin Valley arc	325	9,500
Montana, Wyoming, Colorado, and Utah, Billings to Grand Junction arc	425	16,000
Michigan, Grand Traverse Bay to Sturgis arc	250	3,000
New Mexico, Texas, and Oklahoma, Texas-Oklahoma boundary arc	175	1,750
Texas, Amarillo to Del Rio arc	325	4,500
Virginia, North Carolina, South Carolina, and Georgia, Norfolk to Brunswick arc	575	6,000

Geodetic work accomplished—Continued

Locality	Length of scheme	Area covered
Triangulation, first-order—Continued	*Miles*	*Sq. mi.*
California, Sacramento, and San Joaquin Rivers	75	1,000
California, Suisun Bay to San Francisco Bay	125	1,500
Indiana and Ohio, Indiana-Ohio boundary arc	200	1,800
Michigan, East Shore Lake Michigan arc	160	2,000
California, San Luis Obispo arc	65	850
Rhode Island, Connecticut, and New York, Providence to New York City arc	175	3,200
Total	3,400	59,100
Base lines, first-order:		
Michigan, Sturgis	6.5	
Illinois, Ferris	5.0	
California, Palo Alto	6.8	
California, Santa Ana (remeasurement)	1.0	
Total	19.3	
Reconnaissance, first-order triangulation:		
Wisconsin and Minnesota, Mississippi River arc	120	1,200
North Dakota, Bottineau to Pierre arc	35	420
Colorado and Utah, Billings to Grand Junction arc	80	4,250
Colorado, Utah, Arizona, and New Mexico, one hundred and ninth meridian arc	400	17,000
Michigan, Grand Traverse Bay to Sturgis arc	250	3,000
Montana, Idaho, and Washington, Helena to Pasco arc	350	7,000
Indiana and Ohio boundary arc	200	1,800
New Mexico, Texas, and Oklahoma, Texas-Oklahoma boundary arc	175	1,750
Texas, Amarillo-Del Rio arc	325	4,500
Virginia, North Carolina, South Carolina, Georgia, and Florida, Norfolk to Jacksonville arc	635	6,500
South Carolina and Georgia, Beaufort to Lincolnton arc	110	1,100
Rhode Island, Connecticut, New York, Providence to New York City arc	175	3,200
Idaho and Oregon, one hundred and seventeenth meridian arc	80	2,500
Indiana, Kentucky, and Tennessee, Louisville to Nashville arc	170	1,700
Tennessee, Alabama, and Mississippi, Nashville to Corinth arc	140	1,400
Mississippi, Gulfport to Corinth arc	275	3,000
New Jersey, Sandy Hook to Delaware Bay arc	110	1,300
North Carolina and Virginia, Jacksonville to Richmond arc	210	2,100
California, Sacramento, and San Joaquin Rivers arc	75	1,000
California, Suisun Bay to San Francisco Bay arc	125	1,500
Alabama and Florida, Mobile to Jacksonville arc	430	3,900
Florida and Georgia, Tallahassee to Columbus arc	150	1,500
Virginia, Maryland, and Delaware, Norfolk to Delaware Bay arc	200	3,000
California, San Luis Obispo arc	65	850
Virginia, Gordonsville to Norfolk arc	160	1,600
Virginia and North Carolina, Virginia-North Carolina boundary arc	210	2,100
Kentucky and Indiana, Hopkinsville to Vincennes arc	135	1,800
Pennsylvania, Uniontown to Wellsboro arc	165	2,000
Michigan, East Shore Lake Michigan arc	275	3,500
New York and New Jersey, New York City to Sandy Hook arc	35	250
California, San Fernando to Bakersfield arc	50	700
West Virginia, Charleston to Bristol arc	35	500
Total	5,950	87,920
Leveling, first-order:		
Philadelphia, Pa., to Lewes, Del. (part) including numerous spur lines	48	
Winnemucca, Nev., to Crane, Oreg. (part)	154	
Kirk to Bend, Oreg	104	
Vicinity of Seattle, Wash	1	
Carlton to Aitkin, Minn	68	
Twin Rivers to Olympia, Wash	167	
Bemidji to International Falls, Minn	111	
Prineville to Dayville (Picture Gorge), Oreg	88	
Glendive, Mont., to Bismarck, N. Dak	223	
Bemidji to Crookston, Minn	78	
Forsyth to Malta, Mont	226	
Canyon City to Burns, Oreg	81	
McKenzie, N. Dak., to Glyndon, Minn	210	
Klamath Falls to Dairy, Oreg	20	
Vicinity of Wolf Creek, Oreg	2	
Twin Brooks to Roscoe, S. Dak	141	
Cle Elum to Molson, Wash	237	
Lakeview, Oreg., to Fernley, Nev	244	
Malone to Troy, N. Y	286	
Laurier to Spokane, Wash	133	
Utica to Weedsport, N. Y	78	
Great Falls to Mossmain, Mont	231	
Shirley to Hoxie, Ark	139	
Wilmington, Del., to Susquehanna Bridge, Md	39	
At Havre de Grace, Md	1	

Geodetic work accomplished—Continued

Locality	Length of scheme	Area covered
Leveling, first-order—Continued.	*Miles*	*Sq. mi.*
Sioux Falls, Junction, S. Dak., to La Crosse, Wis	320	
Kensett to Little Rock, Ark	52	
Brady to San Antonio, Tex	147	
Portsmouth, Va., to Southport, N. C	311	
Navassa to Chadbourn, N. C	50	
Suffolk to Old Point Comfort, Va	40	
Richmond to Clarksville, Va	104	
Clarksville, Va., to Manson, N. C	27	
Suffolk to Richmond, Va	86	
Orange to Tenaha, Tex	145	
San Jacinto to Aguanga, Calif	34	
Re-leveling—Los Angeles Area, Calif	378	
Ukiah to Marysville, Calif	123	
Palestine to Houston, Tex	152	
Eureka to San Francisco and San Jose, Calif	378	
Lampasas to Brownwood, Tex	104	
Fort Smith to Lewisville, Ark	231	
Bureau of Standards to Geophysical Laboratory, D. C	1	
Vicinity of Goldsboro, N. C	21	
Sterling to Cayuga, N. Y	42	
Ithaca to Elmira, N. Y	29	
Salida to Bishop, Calif	60	
Total	5,945	
Leveling, second-order:		
Medford to Chinchals, Oreg. (part)	66	
Valley Falls to Lapine, Oreg	127	
Klamath Falls to Klamath Junction, Oreg	60	
Dillard to Coquille, Oreg	65	
At Little Rock, Ark	14	
Pine Bluff to Camden, Ark	84	
Chadbourn to Fayetteville, N. C	64	
Roseboro to Plymouth, N. C	169	
Rocky Mount to Weldon, N. C	32	
Longvale to Dos Rios, Calif	14	
Crossett to Montrose, Ark	96	
Grady to Hazen, Ark	78	
Mammoth Springs to Shirley, Ark	96	
Willow Creek to Hornbrook, Calif	163	
Forest City to Newport, Ark	71	
Mount Ida to Russellville, Ark	80	
Helena to Wheatley, Ark	73	
Smithton, to Boles, Ark	115	
Harriston to Clarksville, Ark	88	
Total	1,555	
Summary:		
First-order triangulation	3,400	59,100
First-order base lines	19.3	
First-order triangulation, reconnaissance	5,950	87,920
First-order leveling	5,945	
Second-order leveling	1,555	

TIDE AND CURRENT WORK

During the fiscal year 1932 the work included the operation of a number of primary tide stations for the purpose of furnishing general tidal control for the various regions, numerous secondary tide stations for use in connection with hydrographic surveys, a comprehensive tide and current survey of Buzzards Bay, and additional current observations at a number of localities.

Primary tide stations.—Throughout the fiscal year, 30 primary tide stations were in operation, namely, 17 on the Atlantic coast, 3 on the Gulf of Mexico coast, 6 on the Pacific coast, 2 in Alaska, and 2 in the Hawaiian Islands. These stations furnished the data for the determination of accurate datum planes, for reducing the results of short series of observations to mean values, for answering inquiries in regard to the stage of the tide at particular times, and for the determination of secular changes in relation of land to sea.

Two new stations were established during the year—one at Miami Beach, Fla., in cooperation with the Army Engineers of that city, and one at Bridgeport, Conn. The tide stations at Daytona Beach, Fla., and Hilo, Hawaii, were discontinued, and the tide gage at Savannah, Ga., was destroyed by fire. Through the cooperation of the engineer office at Wilmington, N. C., a gage will be established at Southport, N. C. A gage will also be installed at Woods Hole, Mass., in cooperation with the Woods Hole Oceanographic Institute, and will begin functioning in the near future.

Eleven of the primary tide stations were operated on a cooperative basis with other Federal agencies, eliminating the expense for observers. The following is a list of the primary tide stations and their locations, the cooperative stations being marked with an asterisk (*):

Eastport, Me.
Portland, Me.
Bridgeport, Conn.
Boston, Mass.
Newport, R. I.*
New York, N. Y.
Atlantic City, N. J.
Philadelphia, Pa.
Washington, D. C.
Baltimore, Md.
Annapolis, Md.*
Hampton Roads, Va.*
Charleston, S. C.
Miami Beach, Fla.*
Mayport, Fla.*
Daytona Beach, Fla.
Jacksonville, Fla.*
Key West, Fla.
Pensacola, Fla.
Galveston, Tex.
San Diego, Calif.*
La Jolla, Calif.
Los Angeles, Calif.*
San Francisco, Calif.
Astoria, Oreg.
Seattle, Wash.
Ketchikan, Alaska.
Seward, Alaska.
Honolulu, Hawaii.*
Hilo, Hawaii.*

Secondary tide stations.—During the year tide gages were established at Willets Point, N. Y.; New Bedford, Mass.; Marshfield, Oreg.; Calaveras Point, Calif.; Oyster Bay, N. Y.; Santa Ana, Calif.; Oakland, Calif.; and Nassau, Bahamas. The stations at Cordova, Alaska, Santa Barbara, Calif.; and Rockland, Me., were discontinued, sufficient information having been obtained from them for the present.

Records were received from Rockland, Me.; New Bedford, Mass.; Willets Point, N. Y.; Marshfield, Oreg.; Astoria (Youngs Bay), Oreg.; Friday Harbor, Wash.; Cordova, Alaska; Nassau, Bahamas; Balboa and Cristobal, Canal Zone; and the following places in California: Santa Barbara, Newport Beach, Richmond, Santa Ana, Alameda, Calaveras, and Point Isabel.

Basic bench marks.—A basic bench mark was established at New York, N. Y., during the year. Basic bench marks are now located at the following places:

Boston, Mass.
New York, N. Y.
Atlantic City, N. J.
Baltimore, Md.
Norfolk, Va.
Charleston, S. C.
Key West, Fla.
Pensacola, Fla.
La Jolla, Calif.
San Francisco, Calif.
Seattle, Wash.

Inspection of tide stations.—The following tide stations were inspected and levels run between tide staff and bench marks:

Annapolis, Md.
Baltimore, Md.
New York, N. Y.
Atlantic City, N. J.
Philadelphia, Pa.
Willets Point, N. Y.
New Bedford, Mass.
Hampton Roads, Va.
San Diego, Calif.
La Jolla, Calif.
Santa Barbara, Calif.
Long Beach, Calif.
Los Angeles, Calif.
Newport Beach, Calif.
San Francisco, Calif.
Richmond, Calif.
Astoria, Oreg.
Seattle, Wash.

Tide and current surveys.—The tide and current survey of Buzzards Bay was completed during the year. Current observations were obtained with both pole and meter at 94 stations for periods of one to three days in order to obtain data for determining the time, velocity, and direction of the current. Density and temperature observations were taken at each current station. Twenty-three tide stations were occupied for periods of a week or more. Sixty-three new bench marks were established and 14 old bench marks recovered. The data derived from this survey are now being tabulated, reduced, and correlated for publication as one of the series of harbor publications.

During the last of the fiscal year, a comprehensive tide and current survey of New York Harbor, in cooperation with the United States Army Engineers, was begun. Current observations will be obtained at 64 stations, and tide observations at 17 stations by parties of this Survey, while the engineer office will observe at about 20 current stations and about 80 tide stations.

Miscellaneous current observations.—During the year hourly current observations were made on the Hen and Chickens and Vineyard Sound Lightships from July to December, 1931, and on the Brenton Reef Lightship during July. Short series of observations were made off Cape Canaveral, Fla.; Juan de Fuca Strait, Wash.; Pollock Rip Channel; Georges Bank; Anau and Kalohi Channel, Hawaii; Chugach Passage and Sitkinak Strait, Alaska; Balboa (Canal Zone); and south San Francisco Bay.

Density and temperature observations.—Daily density and temperature observations were taken at 21 primary tide stations by the tide observer. Observations were also taken at each of the current stations in connection with the tide and current survey of Buzzards Bay.

Records received	Stations	Months	Days
Automatic tide gage	194	1,128	----------
Current	308	----------	1,092
Density and temperature	88	247	238

Cooperation.—The mutual benefits derived from cooperation with other organizations in carrying on tide and current work are recognized and continuously encouraged. At several of the tide stations, the instruments and instructions for operating the station are furnished by this office, and the shelter and observer furnished by the cooperative agency. These stations are subject to the usual inspection. Copies of the records are available to both organizations, the original usually being retained in the archives of this office. Another form of cooperation consists in the exchange of tide and current data obtained independently from different organizations.

Because of the need for tide and current data by this office and the United States Army Engineers, cooperation has been especially valuable to both organizations. During the past year, the stations at Jacksonville, Miami Beach, and Mayport, Fla., were so maintained.

Valuable assistance was also received from the Navy Department and stations were maintained cooperatively at Portsmouth, N. H., Newport, R. I., Annapolis, Md., Hampton Roads, Va., and San Diego, Calif.

Other cooperative tide stations are at Hilo, Hawaii, maintained by the United States Geological Survey; Honolulu, Hawaii, by the surveyor of the Territory of Hawaii; Marshfield, Oreg., by the Port of Coos Bay authorities; Calaveras Point, Calif., by the Arden Salt Co.; Oyster Bay, N. Y., by the town authorities; Oakland, Calif., by the county surveyor; Nassau, Bahamas, by the Public Works Department; and two gages at Santa Ana, Calif., by the Orange County authorities.

MAGNETIC AND SEISMOLOGICAL WORK

Magnetic stations occupied during the fiscal year

Alabama	3	Massachusetts	2
Alaska	32	Minnesota	6
Arizona	1	Mississippi	3
Arkansas	2	Missouri	7
California	5	North Carolina	9
Florida	11	Oklahoma	1
Georgia	3	Philippine Islands	16
Hawaii	5	Puerto Rico	1
Illinois	1	South Carolina	3
Iowa	5	Washington	5
Louisiana	3		
Maryland	1	Total	125

The magnetic work during the year has been chiefly the occupation of repeat stations to determine the changes in the earth's magnetism with lapse of time. Experience has shown that the monuments set to mark stations in or near cities or large towns and the objects of which the true azimuth has been determined tend to disappear for various causes within a few years. For this reason the plan has been developed of observing at triangulation stations of this bureau which are less likely to be disturbed and where the azimuth of a suitable monument has been determined by triangulation.

In starting this plan it has been necessary to observe both at a triangulation station to be used for future reoccupation and at a magnetic station with earlier observations in the general vicinity so that the series of observations may be connected. Observations have been made at repeat stations in the Hawaiian Islands. In addition to the repeat work, the replacement of missing and defective stations in North Carolina was completed.

Continuous photographic record of the variations in magnetic declination, horizontal intensity, and vertical intensity has been made at the five magnetic observatories, with the necessary observations to convert the readings to absolute values. Atmospheric electric and earth current observations have been made at the Tucson Observatory in cooperation with the Carnegie Institution of Washington and the Mountain States Telephone & Telegraph Co. At Sitka improved variometers compensated for temperature have replaced those formerly in use. At Honolulu temperature compensation was provided for.

Seismology.—Seismographs have been operated at the observatories at San Juan, Tucson, and Sitka. Cooperative observations have been carried on as follows: Columbia, S. C., University of South Carolina; Chicago, Ill., University of Chicago and United States Weather Bureau; Bozeman, Mont., Montana State College; and Honolulu, Hawaii, University of Hawaii. Observations have been started at the International Latitude Observatory at Ukiah, Calif.

Systematic collection of reports of earthquakes has been extended, especially in the western part of the United States and Alaska, and this service is beginning to meet present needs. Strong-motion seismographs are in progress of installation, chiefly in California. Information regarding seismic sea waves is now being systematically collected by all agencies of the bureau along the coasts.

WASHINGTON OFFICE

CHIEF CLERK

This office continued general supervision over all matters relating to personnel work; expenditures for office expenses, including purchase of supplies for the Washington office and to some extent for the field; care and custody in the library and archives of most of the original field survey records, as well as printed publications acquired; maintenance of mechanical equipment of the Washington office; and the custody and accounting for receipts from sales of nautical charts, airway maps, nautical publications, old property, etc.

The number of persons in the service of the Coast and Geodetic Survey at the close of the fiscal year ended June 30, 1932, is shown in the following table:

Staffs	Commissioned	Civilian				Total
		Classified	Unclassified			
			Laborers	Seamen	Hands	
Washington office	15	247	4			266
Field service	156	70		525	263	1,104
Total	171	317	4	525	263	[1] 1,280

[1] These figures do not include the 40 civilian employees on duty at the Manila field station and the 102 members of the crews of the ships *Fathomer* and *Marinduque* who, while paid by the insular government, operate under the jurisdiction of officers of the Coast and Geodetic Survey. There is therefore a total of 1,422 actually serving with the Survey.

There were received in the library and archives 88 hydrographic and 61 topographic sheets, representing new surveys accomplished by the Survey. Other additions included 2,688 charts; 2,875 maps; 1,271 blue prints (mostly of surveys by engineers of the United States Army); 6,417 field, office, and observatory records; 190 photographs and negatives; 378 prints; 104 lantern slides; and 590 books.

Receipts from the sale of nautical charts, airway maps, and nautical publications prepared by the Survey totaled $59,541.88. Funds from all other sources deposited in the Treasury as miscellaneous receipts amounted to $3,031.42.

DIVISION OF ACCOUNTS

The regular annual appropriation for the United States Coast and Geodetic Survey for the fiscal year ended June 30, 1932, totaled $3,023,933. This amount was supplemented by transfers from other departments, special appropriations, etc., to the extent of $103,700, making a grand total of $3,127,633.

The actual disbursements during the period of the fiscal year amounted to $2,977,885.77, distributed among the various appropriations as follows:

Party expenses, 1930	$6. 60
General expenses, 1930	26. 56
Salaries, 1931	40. 50
Party expenses, 1931	124, 192. 51
General expenses, 1931	10, 162. 45
Pay and allowances, commissioned officers, 1931	66, 303. 57
Pay, officers and men, vessels, 1931	124, 905. 88
Repairs of vessels, 1931	15, 768. 95
Repairs of vessels, 1931–32	42, 076. 80
Aircraft in Commerce Department, 1931	2, 210. 07
Air navigation facilities, 1931	2, 020. 17
Salaries, 1932	540, 528. 03
Party expenses, 1932	690, 453. 38
General expenses, 1932	47, 202. 88
Pay and allowances, commissioned officers, 1932	594, 857. 18
Pay, officers and men, vessels, 1932	564. 686. 58
Repairs of vessels, 1932	70, 157. 59
Air navigation facilities, 1932	47, 469. 66
War transfer to Commerce Department	24, 817. 24
Topographic survey of United States, contributions	9, 999. 17
Total	2, 977, 885. 77

DIVISION OF INSTRUMENTS

The division of instruments supplies all instrumental equipment and the major portion of the general property used by the Survey's vessels and field parties, and maintains the property records incident to the issuance, transfer, and accounting for this material. The division is subdivided into three sections.

The accounting section has charge of all records of issuance and transfer, the auditing of property accounts, and clerical work incidental to the purchase of new equipment and materials.

The woodworking shop constructs all the Survey's patterns for the castings of its instrumental parts, graduates level and stadia rods, builds the elaborate carrying cases for instruments of a delicate nature, makes such wooden parts of the instrumental equipment as may be necessary, and, in general, handles all fine cabinet work which activities of this sort necessitates, and prepares the equipment for shipment to parties in the field.

The mechanical laboratory constructs all new instruments and apparatus designed in the bureau, develops improvements incorporated from time to time, tests new instruments procured from commercial sources, and repairs and adjusts instruments returned after field service.

The more important work carried on by this division during the past year includes—

The construction of several first-order theodolites in which are incorporated a number of new features, making the instrument more convenient and speedy to operate;

The standardization of as many elements of its various instruments as possible, a feature of the work which is to be pressed vigorously in order to reduce cost and unnecessary duplication;

The development of a sensitive reversing element for deep-sea thermometers, to permit of more accurate determination of subsurface temperatures;

Construction, in conjunction with division of geodesy, of a portable gravity apparatus; and

Research in collaboration with the Bureau of Standards and a steel-manufacturing concern, into the cause of instability in the nickel-steel alloy commonly known as invar, with a view to elimination, from the standpoint of service, of this extremely objectionable characteristic.

Costs of production of various instruments were reduced by virtue of improvements in design and manufacturing methods. During the previous year, the division had put a great deal of effort into the apparatus for, and the reconditioning of, the precise level rods used in geodetic leveling, in an effort to make them interchangeable in so far as each pair of rods is concerned, and to increase the over-all accuracy of each rod.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

This division has charge of planning the Survey's marine operations. For internal administration at this office, the division is composed of four sections: Vessels and equipment, field work, coast pilot, and training.

The section of vessels and equipment has general supervision over the construction of new vessels and launches and of the ordinary repairs and maintenance of existing floating equipment. During the past year, in addition to ordinary repairs and maintenance of vessels, this section purchased two hydrographic launches and six dinghies, the plans and specifications for which were prepared in the section. The following equipment, valued at $9,000, was obtained without cost from surplus stock of other departments: 5 whaleboats, 4 oil pumps, and 2 lathes.

The coast-pilot section makes the field examinations and prepares manuscript based thereon for new editions of the various coast-pilot publications. During the past year a revised edition of Alaska Coast Pilot, Part I, was prepared and printed; the manuscript for the Hawaiian Coast Pilot was partly completed; and annual supplements for 12 Coast Pilots were compiled and issued.

The section of field work, in addition to carrying on its routine activities of preparing detailed instructions for hydrographic surveys and the supervision of field work, made a special study of surveys required for constructing larger scale charts of the South Atlantic coast; to the early completion of basic surveys on the Pacific coast; to the systematic advancement of surveys of uncharted regions in Alaska and the Hawaiian Islands; and to the development of methods to promote greater efficiency in the establishment of control, topographic, and hydrographic surveys in general.

An officer has been assigned for the compilation of aerial phototopography. In addition to special work in the development of methods and technique in this new field of topographic surveying and the preparation of specifications for a precision copying camera, he has supervised the compilation of the photographs of San Francisco Bay. Photographs were also obtained for the aerial phototopographic survey of the Sacramento-San Joaquin delta region.

One principal electrical engineer and one senior electrical engineer have been assigned to the practical work of keeping in operation the delicate instruments and devices used on shipboard on echo sounding and radio acoustic ranging on offshore hydrographic work. While the methods and technique of this work are now on a practical basis and have been used for several years in actual practice, much yet remains to be learned, especially as to the path taken by the sound from the exploded bomb at the survey ship to the hydrophone station on shore. The engineers have developed a photographic recording oscillograph to study the form of the sound wave in passing through the water, with which instrument time intervals can be measured to a thousandth of a second.

The training section is now attached to the ship *Oceanographer* where newly appointed officers are given intensive theoretical and practical instructions to supplement and expedite their training as civil engineers and fit them for ship's officers.

DIVISION OF GEODESY

The following important pieces of work were completed or in progress at the end of the fiscal year:

Computation and adjustment of triangulation.—

1. Completion of the adjustment of the first-order triangulation east of the ninety-eighth meridian on the North American datum of 1927. In this adjustment there were included 29 junction figures and 56 sections. The geographic positions of the main schemes stations of all but three sections were computed.

2. Computation of nine first-order base lines along the various arcs of triangulation included in the eastern adjustment, and two base lines in California.

3. California: Adjustment of the following pieces of triangulation to the North American datum of 1927: Santa Barbara Channel, north California coast, Fort Bragg and vicinity, Point Delgada to Rockport, Point Reyes to Fort Bragg, and Halfmoon Bay to Monterey Bay.

The adjustment of the following arcs was in progress: San Joaquin Valley, Lakeview to Reno, Sacramento to Stockton, and Newport to Lucerne Valley.

4. Washington: Adjustment of the following pieces of triangulation to the 1927 datum: Port Madison connection, Tacoma to Olympia, Puget Sound, Port Orchard, Riches Passage, Liberty Bay, Dogfish and Sinclair Inlets.

5. Earthquake regions: Adjustment of triangulation, Monterey Bay to Mariposa and vicinity of Point Reyes.

6. Completion of the adjustment of the triangulation along the Columbia River in Oregon and the triangulation from Cape Blanco to Fort St. George in California and Oregon.

7. Completion of the adjustment of the supplementary stations in Kansas for use in the special publication for that State.

8. Adjustment of the triangulation executed in 1931 for the purpose of connecting the triangulation arcs of Mexico and the United States in the vicinity of El Paso, Tex.

9. Adjustment of the triangulation executed by the Mississippi River Commission along the Mississippi River, from Cairo, Ill., to St. Paul, Minn.

10. Adjustment of the arc of triangulation from Riverside to the Colorado River which serves as first-order control for the Colorado River aqueduct.

11. Adjustment of traverse line, Mansfield-New Roads, La. Adjustment of several traverse connections to the Mississippi River Commission stations along the Mississippi River.

12. Southeast Alaska: Adjustment of triangulation in Walker Cove, Rudyard Bay, and Smeaton Bay.

Computation and adjustment of leveling.—

1. Computation of approximately 840 miles of first-order leveling run during the fiscal year 1931, the computation of which was not completed at the end of that year.
2. Computation of 3,900 miles of first and second order leveling run during the fiscal year 1932.
3. Distribution of corrections through about 3,000 additional miles of old leveling to fit it to the results of the 1929 general adjustment.
4. The study of the relation between old and new leveling in southern California in connection with earthquake investigations.
5. A final adjustment of leveling in Oregon and adjacent portions of Washington and California to fit new leveling to the results of the 1929 general adjustment.
6. Preliminary work on an adjustment of leveling in the lower Mississippi Valley for the purpose of fitting old leveling and new leveling by the second New Orleans district, Corps of Engineers, United States Army, to the results of the 1929 general adjustment.
7. Fitting new leveling to the 1929 general adjustment.

Computation of astronomical and gravity work.—

1. Azimuths: 34 stations in the United States.
2. Longitudes: Seven stations in the United States; one in Hawaii.
3. Latitudes: 22 stations in the United States; one in Hawaii.
4. Laplace azimuths: Computation of true geodetic azimuths at six Laplace stations.
5. Gravity: Computation of gravity at 17 stations in the United States and 12 in the Bahama Islands.
6. Isostatic reductions: Computation of the effect of topography and isostatic compensation at 5 stations in the United States, 12 in the Bahama Islands, and 54 gravity-at-sea stations in the waters of the West Indies.

Investigations were carried on during the year in the following subjects: Interior of the earth, earth tides, variation of latitude, and methods of reducing gravity observations.

The following publications were issued by the division of geodesy during the fiscal year:

Serial 529, Triangulation.
Special Publication 175, First and Second Order Triangulation in Oregon (1927 datum).
Special Publication 176, First-Order Leveling in Michigan.
Special Publication 177, Leveling in Oregon.

DIVISION OF CHARTS

At the close of the year 738 nautical charts and 39 airway maps were on issue. As over 65 per cent of this division's activity is the maintenance of existing charts, the large increase in chart-information data received from outside organizations has added a load difficult to carry.

A decrease in sale of charts has been accompanied by an increase for official distribution, leaving the total distribution below the past year but above the 5-year average.

Construction and maintenance

	Nautical charts	Airway maps		Nautical charts	Airway maps
New	12	8	Reprints	157	
New editions	149		Canceled	8	
New prints	390	4	Hand corrections	[1] 1,642,677	83,891

[1] Does not include Manila field station.

Charting material received

	1932	1931	1930	1929
Topographic field sheets	62	75	176	80
Hydrographic field sheets	102	102	134	146
Blue prints of surveys from other organizations	1,271	701	724	645
Letters containing charting data	894	651	722	668

Nautical charts, airway maps, and nautical publications distributed

Fiscal year	Nautical charts	Airway maps	Coast pilots	Inside-route pilots	Tide and current tables	Tidal-current charts
1928	241,880		7,019	1,849	34,774	
1929	249,499		6,288	1,756	37,378	[1] 1,453
1930	282,034	[2] 12,349	7,656	2,208	42,737	326
1931	286,168	18,138	6,480	1,909	50,306	1,784
1932	277,035	19,692	5,825	2,255	49,014	635

[1] First publication issued in 1929. Good for any year.
[2] Previously distributed by Aeronautics Branch.

DIVISION OF TIDES AND CURRENTS

The growing demand for tide and current information on the part of Federal, State, and municipal agencies, and the public generally, has resulted in an ever-increasing amount of work for the division of tides and currents. Not only must the data secured from the comprehensive tide and current surveys carried on each year since 1922 be reduced, correlated, and published, but the preparation of tidal bench mark publications and the compilation of the annual tide and current tables must be completed as well.

The manuscript of a special publication on tides and currents in the Hudson River was completed during the year. Work is now in progress on two additional publications of this series, one covering Narragansett Bay and the other Buzzards Bay. The publications of the series issued to date are listed below:

Tides and currents in harbors

New York Harbor, 1925.
San Francisco Bay, 1925.
Delaware Bay, and River, 1926.
Southeast Alaska, 1927.
Boston Harbor, 1928.
Portsmouth Harbor, 1929.
Chesapeake Bay, 1930.
Long Island and Block Island Sounds, 1932.

Work on the tide and current tables, which are issued annually, was continued during the year.

The tide tables, United States and Foreign Ports, for 1932, include daily predictions for 94 reference stations and tidal differences and constants for 3,864 stations. In the 1933 edition, daily tide predictions for The Battery and Hampton Roads have been substituted for Governors Island and Old Point Comfort.

In accordance with a cooperative arrangement for the exchange of tidal predictions, daily predictions for the annual tide tables are now exchanged between the Survey and the following organizations:

British Admiralty, 21 stations; Canadian Hydrographic Office, 4 stations; Deutsche Seewarte, 6 stations; Service Hydrographique, France, 4 stations; Geodetic Branch, Survey of India, 5 stations.

The stock of the tidal current charts, New York Harbor, having become exhausted, a new edition of the publication was prepared before the close of the fiscal year.

The manuscript of a tidal bench mark publication covering the States of Maine and New Hampshire was completed. The following list gives the publications of this series already printed and the year issued:

Tidal bench mark publications

New York, 1922.	California, 1928.
District of Columbia, 1925.	New Jersey, 1929.
Rhode Island, 1926.	Massachusetts, 1929.
Connecticut, 1927.	Oregon, 1930.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Terrestrial magnetism.—The preparation of magnetic observatory results for publication made good progress. The series for 1925–26 was completed and all but one published. The work on the series for 1927–28 was well advanced. The publications, Results of Magnetic Observations in the United States for 1930, Magnetic Declination in North Carolina in 1930, and Magnetic Declination in the United States in 1930, were published and the annual publication of 1931 results was completed. There has been continuous cooperation with various governmental and other organizations, and especially have the Bureau of Standards, Naval Research Laboratory, the Carnegie Institution of Washington, and others, including broadcasting companies, found the magnetic results useful in the studies of radio transmission. Members of the division have taken active part in the meetings of scientific organizations related to the work, both as officers and in the presentation of papers. They have also been active members of international scientific committees.

Seismology.—The publication Earthquakes in the United States for 1930 was published and that for 1931 was practically completed. Instrumental reports were distributed to cooperating organizations. Thirty-eight earthquake epicenters were determined during the year shortly after the occurrence and information sent west to Manila and east to Europe. In the case of three earthquakes within the United States, the areas were canvassed for special information. Advice and cooperation have been extended to universities installing seismographs and their records studied. With the cooperation of the Bureau of Standards, the Massachusetts Institute of Technology, and the University of Virginia, automatic instruments for the recording of strong earthquake motions intended to aid in the design of earthquake-proof buildings and other structures have been developed, constructed, and are now being installed.

DISTRIBUTION OF FIELD PARTIES

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

(Abbreviations used: L=length in statute miles; A=area, square statute miles; P=number of geographical positions; M=miles of sounding lines; S=number of soundings; W. D.=wire drag; sta.=stations; mag.=magnetic)

Locality and operation	Persons conducting operations
Massachusetts, Georges Bank: Hydrography, M2560, A1504, S18844.	Ship Hydrographer, July 1–Sept. 25, Capt. W. E. Parker, comdg.; Lt. R. D. Horne, exec.; Lt. E. B. Roberts; Lt. (j. g.) E. H. Kirsch; Lt. (j. g.) F. A. Riddell; Lt. (j. g.) Fred Natella; Ensign J. C. Tribble; Ensign J. C. Tison; W. E. Greer, ch. engr.
Massachusetts, Georges Bank: Hydrography, M1775, A600, S14755; tide sta., 2; current sta., 3.	Ship Hydrographer, May 23–June 30, Capt. W. E. Parker, comdg.; Lt. R. D. Horne, exec., to Apr. 9; Lt. W. D. Patterson, exec., from Apr. 9; Lt. E. B. Roberts; Lt. (j. g.) E. H. Kirsch; Lt. (j. g.) C. A. Schanck; Lt. (j. g.) F. A. Riddell; Ensign J. C. Tribble; Ensign E. B. Brown, jr.; Ensign O. B. Hartzog, jr.; C. G. McIlwraith; W. E. Greer, ch. engr.
Massachusetts, Georges Bank: Hydrography, M2910, A1309, S20612; current sta., 25.	Ship Oceanographer, July 1–Sept. 25, Comdr. L. O. Colbert, comdg.; Lt. R. F. A. Studds, exec.; Lt. B. H. Rigg; Lt. L. C. Wilder, chief of training section; Lt. T. B. Reed; Lt. J. C. Sammons; Lt. (j. g.) C. A. Burmister; Ensign E. B. Brown, jr.; Ensign J. E. Waugh, jr.; Ensign D. H. Konichek, from July 6; Ensign T. M. Price; J. K. Holloway, D. O., to Aug. 17; W. N. Martin, D. O., from Sept. 2 to Sept. 25; E. H. Proctor, D. O., from Sept. 13 to Nov. 24; J. L. McIver, ch. engr.
Massachusetts, Georges Bank: Hydrography, M1648, A700, S13695.	Ship Oceanographer, May 23–June 30, Comdr. L. O. Colbert, comdg.; Lt. H. W. Hemple, exec.; Lt. B. H. Rigg; Lt. L. C. Wilder; Lt. T. B. Reed; Lt. E. J. Brown; Lt. (j. g.) C. A. Burmister; Lt. (j. g.) Fred Natella; Ensign M. A. Hecht; Ensign E. L. Jones; Ensign R. H. Tryon; Ensign J. E. Waugh, jr.; R. H. Carstens, D. O.; J. L. McIver, ch. engr.
Massachusetts, Georges Bank: Serving as R. A. R. station in cooperation with ships Hydrographer and Oceanographer; planting and locating buoys; astronomic, current, magnetic, temperature, and salinity observations; current sta., 32.	Ship Lydonia, July 1–Sept. 25, Lt. Comdr. G. D. Cowie, comdg.; Lt. W. M. Scaife, exec.; Lt. L. S. Hubbard; Lt. W. H. Bainbridge; Ensign J. S. Morton; C. N. Conover, ch. engr.; R. C. Overton, mate.
Massachusetts, Georges Bank: Serving as R. A. R. station in cooperation with ships Hydrographer and Oceanographer; planting and locating buoys; astronomic, current, temperature, and salinity observations; current sta., 9.	Ship Lydonia, May 18–June 30, Lt. Comdr. G. D. Cowie, comdg.; Lt. J. A. Bond, exec.; Lt. K. G. Crosby; Lt. (j. g.) G. E. Morris; Ensign C. R. Reed; Ensign D. H. Konichek; C. N. Conover, ch. engr.; R. C. Overton, mate.
Massachusetts, Georges Bank: Serving as R. A. R. station in cooperation with ships Hydrographer and Oceanographer; current, salinity, and temperature observations. Hydrography, M162, A10, S2904; current sta., 14.	Ship Gilbert, July 1–Sept. 15, Lt. Charles Shaw, comdg.; Lt. K. G. Crosby; Ensign J. T. Jarman.
Massachusetts, Georges Bank: Serving as R. A. R. station in cooperation with ships Hydrographer and Oceanographer; current, temperature, and salinity observations; current sta., 4.	Ship Gilbert, June 6–June 30, Lt. H. P. Odessey, comdg.; Lt. W. H. Bainbridge; Lt. (j. g.) J. S. Morton.
Massachusetts, Pollock Rip Channel and approaches: Hydrography, M710, A35, S17522; topography, L47, A1; triangulation, P2; current sta., 1; tide sta., 1; mag. sta., 2.	Ship Natoma, July 27–Sept. 15, Lt. C. A. Egner, comdg.; Lt. (j. g.) G. R. Shelton, exec.; Ensign W. F. Deane; Ensign E. F. Hicks, jr.
Connecticut, Port Jefferson-Mount Sinai Harbors: Hydrography, M289, A16, S9704; topography, L60, A20; triangulation, L27, A184, P45; tide sta., 7.	Ship Natoma, Sept. 21–Nov. 12, Lt. C. A. Egner, comdg.; Lt. (j. g.) G. R. Shelton, exec.; Ensign W. F. Deane; Ensign E. F. Hicks, jr.; Ensign D. H. Konichek.
Connecticut, New York, Long Island Sound: Wire drag, M262, A72, S881; hydrography, M13, A.2, S1153; topography, L5; triangulation, L6, A18, P18; tide sta., 2.	Launches Ogden and Marindin, July 1–Nov. 23, Lt. H. E. Finnegan, in charge; Lt. (j. g.) S. B. Grenell; Ensign M. A. Hecht; Ensign C. R. Reed; F. E. Okeson, mate.
Connecticut, Long Island Sound: Hydrography, M151, A21, S2837; topography, L26, A3; triangulation, L16, A25, P17; tide sta., 2.	Launches Ogden and Marindin, Apr. 20–June 30, Lt. (j. g.) S. B. Grenell, in charge; Lt. (j. g.) J. C. Partington, from Apr. 25; Ensign W. F. Deane, from May 1; H. J. Seaborg, D. O., from June 8.
New York, vicinity of New York City: Triangulation, L124, A500, P543.	Shore party, July 1–June 30, Lt. R. W. Woodworth, in charge; Lt. (j. g.) J. C. Partington, July 29–Apr. 23; Lt. (j. g.) G. R. Shelton, from Apr. 18.
Maryland, Severn River and approaches: Hydrography, M586, A32, S32819; topography, L93, A17; triangulation, L28, A137, P75.	Ship Oceanographer, Mar. 5–May 17, Comdr. L. O. Colbert, comdg.; Lt. H. W. Hemple, exec.; Lt. B. H. Rigg; Lt. T. B. Reed; Lt. (j. g.) C. A. Burmister; Lt. (j. g.) Fred Natella; Ensign E. L. Jones; Ensign M. A. Hecht; Ensign J. E. Waugh, jr.; Lt. L. C. Wilder, chief of training section; Ensign T. M. Price; Ensign R. H. Tryon; Ensign J. C. Bull; W. N. Martin, D. O.; H. S. Seaborg, D. O; D. A. Sturmer, D. O.; R. H. Carstens, D. O.; J. L. McIver, ch. engr.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY—continued

Locality and operation	Persons conducting operations
Maryland, Wicomico River: Hydrography, M377, A12, S16723; topography, L102, A25; triangulation, L13, A70, P20; tide sta., 4.	Launch Mikawe, Sept. 1–June 30, Lt. E. H. Bernstein, comdg.; Lt. (j. g.) F. R. Gossett, from Jan. 24; C. H. Chenworth, D. O.; D. E. Sturmer, D. O., from May 14; K. R. Gile, ch. engr., to Apr. 18.
Virginia, York River: Hydrography, M123, A6, S5016; topography, L17; triangulation, L14, A32, P48; tide sta., 1.	Ship Gilbert, Apr. 13–May 28, Lt. H. P. Odessey, comdg. Lt. (j. g.) W. H. Bainbridge; Lt. (j. g.) J. S. Morton.
Virginia, Norfolk: Triangulation, L52, A386, P86.	Ship Lydonia, Jan. 16–May 16, Lt. Comdr. G. C. Cowie, comdg.; Lt. J. A. Bond, exec., from Jan. 19; Lt. K. G. Crosby, from Mar. 14; Lt. L. S. Hubbard, to May 14; Lt. (j. g.) W. H. Bainbridge, to Mar. 16; Lt. (j. g.) G. E. Morris, from Apr. 8; Lt. (j. g.) J. S. Morton, to Feb. 15; Ensign C. R. Reed, from Apr. 25; Ensign D. H. Konichek, from Feb. 12; C. N. Conover, ch. engr.; R. C. Overton, mate; F. E. Okeson, mate, Feb. 1–Feb. 10.
North Carolina, Chowan River: Hydrography, M604, A28, S23491; topography, L96, A26; triangulation, L60, A168, P76; tide sta., 3.	Ship Natoma, Feb. 18–June 15, Lt. C. A. Egner, comdg.; Lt. J. C. Sammons, exec.; Lt. (j. g.) G. R. Shelton, to Apr. 16; Ensign J. T. Jarman; Ensign W. F. Deane, to Apr. 30; Ensign E. F. Hicks, to May 15; Ensign J. C. Bull, from May 15; Ensign P. Taylor, from Apr. 19; A. Silva, ch. engr., to Apr. 9; K. R. Gile, ch. engr., from Apr. 19.
Florida, St. Augustine to Miami: Location of airway beacons; triangulation, L27, A46, P12.	Shore party, Dec. 2–Jan. 25, Lt. (j. g.) M. H. Reese, in charge.
Louisiana, Lake Ponchartrain: Triangulation, L5, A15, P27.	Shore party, Lt. Comdr. R. L. Schoppe, in charge.
California, southern: Location of airway beacons, P36.	Shore party, Apr. 1–June 30, Lt. G. L. Anderson, in charge.
California, Santa Barbara and San Nicholas Islands: Triangulation, L10, A25, P19; topography, L5, A1; tide sta., 1.	Shore party, May 23–June 30, Lt. R. W. Knox, in charge; Lt. (j. g.) W. F. Malnate; Lt. (j. g.) J. C. Mathisson.
California, Monterey Bay southward: Triangulation, L52, A123, P94.	Shore party, Apr. 15–June 30, Lt. C. Pierce, in charge.
California, Point Montara to Point Sur: Hydrography, M2118, A1008, S25515; topography, L18, A10; triangulation, P4; tide sta., 2; mag. sta., 3.	Ship Guide, Apr. 20–June 30, Lt. Comdr. F. L. Peacock, comdg.; Lt. R. F. A. Studds, exec.; Lt. (j. g.) H. J. Healy, to Apr. 26; Lt. (j. g.) J. H. Brittain; Lt. (j. g.) J. C. Mathisson, to Apr. 30; Lt. (j. g.) A. N. Stewart; Lt. (j. g.) J. N. Jones, to Apr. 26; Ensign H. C. Applequist; Ensign E. H. Sheridan; F. Seymour, ch. engr.
California, Russian River to Pt. Reyes: Hydrography, M940, A66, S28953; topography, L56, A36; mag. sta., 6.	Shore party, July 1–Nov. 23, Lt. (j. g.) L. C. Johnson, in charge; Lt. (j. g.) E. B. Lewey; Lt. (j. g.) K. B. Jeffers.
Washington, Juan de Fuca Strait and approaches: Hydrography, M2966, A1158, S25531; topography, L29, A20; triangulation, L37, A322, P12; current sta., 3; tide sta., 3; mag. sta., 5.	Ship Guide, July 1–Nov. 5, Lt. Comdr. K. T. Adams, comdg.; Lt. H. P. Odessey, exec., to Sept. 23; Lt. G. L. Anderson; Lt. (j. g.) J. C. Partington, to July 8; Lt. (j. g.) H. J. Healy; Lt. (j. g.) J. H. Brittain, from June 4; Lt. (j. g.) J. C. Mathisson; Lt. (j. g.) A. N. Stewart; Lt. (j. g.) J. N. Jones; Ensign E. H. Sheridan; F. Seymour, ch. engr.
Alaska, Behm Canal: Hydrography, M1813, A137, S27622; topography, L239, A123; triangulation, L38, A51, P62; tide sta., 2; mag. sta., 19.	Ship Explorer, July 1–Oct. 19, Lt. Comdr. E. W. Eickelberg, comdg., to July 20; Lt. Comdr. F. L. Peacock, comdg., from July 20; Lt. H. C. Warwick, exec.; Lt. C. M. Thomas; Lt. R. C. Rowse; Lt. (j. g.) H. O. Fortin; Ensign K. S. Ulm; F. L. Chamberlain, ch. engr.; Wilhelm Weidlich, mate.
Alaska, Behm Canal: Hydrography, M540, A58, S7315; topography, L73, A70; triangulation, L25, A90, P10; current sta., 3; tide sta., 2; mag. sta., 3.	Ship Explorer, Apr. 25–June 30, Lt. Comdr. G. C. Jones, comdg.; Lt. H. E. Finnegan, exec.; Lt. R. C. Rowse; Lt. (j. g.) H. O. Fertin; Lt. (j. g.) E. B. Lewey; Lt. (j. g.) G. C. Mast; C. R. Jones, ch. engr.; Wilhelm Weidlich, mate.
Alaska, Kenai Peninsula to Shuyak Island: Hydrography, M7234, A1972, S67642; topography, L243, A116; triangulation, L5, A50, P10; tide sta., 2; mag. sta., 10.	Ship Discoverer, July 1–Oct. 16, Lt. Comdr. H. B. Campbell, comdg.; Lt. G. L. Bean, exec.; Lt. L. D. Graham, in charge tender Westdahl; Lt. H. A. Karo; Lt. (j. g.) R. J. Sipe; Lt. (j. g.) F. B. Quinn; Lt. (j. g.) G. A. Nelson; Lt. (j. g.) L. W. Swanson; Lt. (j. g.) H. F. Garber; Lt. (j. g.) G. C. Mast; Lt. (j. g.) I. R. Rubottom; Lt. (j. g.) M. E. Wennermark; A. N. Loken, ch. engr.; W. R. Scroggs, surgeon.
Alaska, Kenai Peninsula to Afognak Island: Hydrography, M3091, A901, S19104; topography, L99, A85; triangulation, L70, A190, P56; mag. sta., 2; tide sta., 3.	Ship Discoverer, May 2–June 30, Lt. Comdr. H. B. Campbell, comdg.; Lt. G. L. Bean, exec.; Lt. W. M. Scaife, in charge tender Westdahl; Lt. (j. g.) R. J. Sipe; Lt. (j. g.) H. J. Healy; Lt. (j. g.) G. A. Nelson; Lt. (j. g.) J. N. Jones; Lt. (j. g.) H. F. Garber; Lt. (j. g.) I. R. Rubottom; Lt. (j. g.) M. E. Wennermark; Ensign K. S. Ulm; A. N. Loken, ch. engr.; W. R. Scroggs, surgeon.
Alaska, Kodiak Island: Hydrography, M6118, A1618, S81369; topography, L218, A162; triangulation, L64, A90, P73; current sta., 1; mag. sta., 4.	Ship Surveyor, July 1–Oct. 11, Comdr. F. B. T. Siems, comdg.; Lt. R. R. Moore, exec.; Lt. R. W. Knox; Lt. (j. g.) A. C. Thorson; Lt. (j. g.) G. W. Lovesee; Lt. (j. g.) E. C. Baum; Lt. (j. g.) G. M. Marchand; Lt. Lt. (j. g.) W. J. Chovan; Lt. (j. g.) M. G. Ricketts; Lt. (j. g.) R. A. Earle; Ensign C. J. Beyma; G. E. Johanson, ch. engr.; R. W. Healy, mate; F. J. Soule, surgeon.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY—continued

Locality and operation	Persons conducting operations
Alaska, Kodiak Island: Hydrography, M1638, A1289, S17556; topography, L41, A25; triangulation, L13, A20, P16; tide sta., 4; mag. sta., 1.	Ship Surveyor, May 2–June 30, Comdr. F. B. T. Siems, comdg.; Lt. R. R. Moore, exec.; Lt. (j. g.) J. Bowie, jr.; Lt. (j. g.) F. B. Quinn; Lt. (j. g.) W. J. Chovan; Lt. (j. g.) E. C. Baum; Lt. (j. g.) G. M. Marchand; Lt. (j. g.) M. G. Ricketts; Lt. (j. g.) R. A. Marshall; Ensign C. J. Beyma; Ensign H. G. Conerly; G. E. Johnson, ch. engr.; R. W. Healy, mate; F. J. Soule, surgeon.
Hawaiian Islands, Oahu to Lisianski Island: Hydrography, M12236, A45100, S43626; topography, L2, A1; tide sta., 1; mag. sta., 1;	Ship Pioneer, July 1–Nov. 20, Lt. Comdr. O. W. Swainson, comdg.; Lt. C. K. Green, exec.; Lt. E. O. Heaton; Lt. (j. g.) P. L. Bernstein; Lt. (j. g.) V. M. Gibbons; Lt. (j. g.) C. J. Wagner; Lt. (j. g.) R. A. Gilmore; Ensign J. C. Ellerbe; C. R. Jones, ch. engr.; D. R. Kruger, surgeon.
Hawaiian Islands, Lanai, Maui, Hawaii, and Kahoolawe Islands: Hydrography, M3793, A520, S18697; topography, L30, A5; triangulation, L7, A10, P10; tide sta., 1.	Ship Pioneer, Dec. 7–Mar. 31, Lt. Comdr. O. W. Swainson, comdg.; Lt. C. K. Green, exec., to Mar. 7; Lt. E. O. Heaton; Lt. (j. g.) P. L. Bernstein; Lt. (j. g.) V. M. Gibbens; Lt. (j. g.) C. J. Wagner; Lt. (j. g.) R. A. Gilmore; Ensign J. C. Ellerbe; C. R. Jones, ch. engr.; D. R. Kruger, surgeon.
Philippine Islands, west coast, Palawan Island: Hydrography, M3390, A191, S50943; topography, L94.4, A69.5; triangulation, L23, A136, P29; tide sta., 3; mag. sta., 4.	Ship Pathfinder, Oct. 1–Feb. 18, Lt. Comdr. G. C. Mattison, comdg.; Lt. C. M. Durgin, exec.; Lt. A. P. Ratti; Lt. J. M. Smook; Lt. J. C. Bose; Lt. (j. g.) P. A. Smith, from Jan. 23; E. G. Zimmerman, ch. engr.; M. F. Froyd, surgeon, to Nov. 30; W. J. Leary, surgeon, Jan. 4–Jan. 23; W. J. Wetzel, surgeon, from Jan. 30.
Philippine Islands, northwest coast, Luzon Island: Hydrography, M1143.1, A282.5, S14828; topography, L34, A8.5; triangulation, L51, A284, P44; tide sta., 1; current sta., 2; mag. sta., 3.	Ship Pathfinder, Apr. 1–June 30, Lt. Comdr. R. P. Eyman, comdg.; Lt. C. M. Thomas, exec.; Lt. P. A. Smith, from May 9; Lt. (j. g.) K. B. Jeffers, to May 9; Lt. (j. g.) C. A. George; E. G. Zimmerman, ch. engr.; J. W. Wetzel, surgeon.
Philippine Islands, west coast, Luzon Island: Hydrography, M526.5, A679.1, S3100.	Ship Fathomer, May 4–May 12, Lt. C. Shaw, comdg.; Lt. H. A. Karo, exec.; Lt. G. E. Boothe, from May 9; Lt. (j. g.) P. A. Smith, to May 8; Lt. (j. g.) G. W. Lovesee, to May 8; Lt. (j. g.) R. C. Bolstad; Lt. (j. g.) K. B. Jeffers, from May 9; G. W. Hutchison, ch engr.; W. J. Leary, surgeon.
Philippine Islands, Sibutu Islands: Hydrography, M1739.1, A421, S21536; topography, L101.7, A48.6; triangu'ation, L52.5, A1095, P41; tide sta., 3; current sta., 4; mag. sta., 1.	Ship Marinduque, Aug. 8–Dec. 19, Lt. Comdr. R. P. Eyman, comdg.; May 10–June 30, Lt. L. D. Graham, comdg.; Lt. P. C. Doran, exec.; Lt. (j. g.) F. R. Gossett, to Sept. 28; Lt. (j. g.) C. A. George; Lt. (j. g.) R. A. Earle; John Wyer, ch. engr.; J. W. Wetzel, surgeon.
Philippine Islands, Simo Banks, west coast Luzon Island: Hydrography, M193.9, A8.0, S2054.0.	Ship Marinduque, Apr. 18–Apr. 22, Lt. L. D. Graham, comdg.; Lt. P. C. Doran, exec.; Lt. (j. g.) R. A. Earle; John Wyer, ch. engr.

DIVISION OF GEODESY

Locality	Operation	Persons conducting operations
Mississippi River, Iowa, Ill., Wis., and Minn.	Triangulation, first-order; 350 mi., 3,500 sq. mi.; 1 Laplace and 1 first-order azimuth.	Lt. H. W. Hemple, chief; Lt. (j. g.) J. P. Lushene; Ensign W. C. Russell; P. A. Weber, jr. engr.; J. S. Bilby, chief signalman.
Reno to Lakeview, Nev., Calif., and Oreg.	Triangulation, first-order; 175 mi., 4,500 sq. mi.; 1 first-order azimuth.	Lt. (j. g.) J. Bowie, jr., chief; Lt. (j. g.) F. G. Johnson; W. R. Tucker, jr. engr.; O. S. Risvold, signalman.
San Joaquin Valley, Calif.	Triangulation, first-order; 325 miles, 9,500 sq. mi., 2 first-order azimuths.	Lt. (j. g.) J. Bowie, jr., chief; Lt. (j. g.) F. G. Johnson; W. R. Tucker, jr. engr.; O. S. Risvold, signalman.
Billings to Grand Junction, Mont., Wyo., Utah, and Colo.	Triangulation, first-order; 425 mi., 16,000 sq. mi.; 1 Laplace azimuth.	Lt. (j. g.) C. I. Aslakson, chief; Lt. (j. g.) W. F. Malnate; Lt. (j. g.) I. T. Sanders; Lt. (j. g.) W. R. Porter; W. J. Bilby, signalman.
Grand Traverse Bay to Sturgis, Mich.	Triangulation, first-order; 250 mi., 3,000 sq. mi.; 1 Laplace azimuth.	Lt. H. W. Hemple, chief until Sept. 18; Lt. C. D. Meaney, chief after Sept. 18; Ensign W. C. Russell; P. A. Weber, jr. engr.; M. Z. Braden, signalman.

DIVISION OF GEODESY—continued

Locality	Operation	Persons conducting operations
Texas-Oklahoma boundary, N. Mex., Tex., and Okla.	Triangulation, first-order; 175 mi., 1,750 sq. mi.; 1 Laplace and 2 first-order azimuths.	Lt. (j. g.) C. I. Aslakson, chief; Lt. (j. g.) W. F. Malnate; Lt. (j. g.) I. T. Sanders; Lt. (j. g.) W. R. Porter; W. J. Bilby, signalman.
Amarillo to Del Rio, Tex.	Triangulation, first-order; 325 mi., 4,500 sq. mi.; 3 Laplace and 2 first-order azimuths.	Lt. (j. g.) C. I. Aslakson, chief; Lt. (j. g.) I. T. Sanders; Lt. (j. g.) W. R. Porter; C. A. Schoene, jr. engr.; W. J. Bilby, signalman.
Norfolk to Brunswick, Va., N. C., S. C., and Ga.	Triangulation, first-order; 575 mi., 6,000 sq. mi.; 9 Laplace and 8 first-order azimuths.	Lt. C. D. Meaney, chief; Lt. H. C. Warwick; Ensign W. C. Russell; P. A. Weber, jr. engr.; M. Z. Braden, signalman.
Sacramento and San Joaquin Rivers, Calif.	Triangulation, first-order; 75 mi., 1,000 sq. mi.	Lt. (j. g.) J. Bowie, jr., chief; Lt. (j. g.) F. G. Johnson; Lt. (j. g.) J. Laskowski; W. R. Tucker, jr. engr.; O. S. Risvold, signalman.
Suisun Bay to San Francisco Bay, Calif.	Triangulation, first-order; 125 mi., 1,500 sq. mi.; 3 first-order azimuths.	Lt. (j. g.) J. Bowie, jr., chief; Lt. (j. g.) F. G. Johnson; Lt. (j. g.) J. Laskowski; W. R. Tucker, jr. engr.; O. S. Risvold, signalman.
Indiana-Ohio boundary, Ind. and Ohio.	Triangulation, first-order; 200 mi., 1,800 sq. mi.; 2 Laplace and 3 first-order azimuths.	Lt. (j. g.) C. I. Aslakson, chief until April 30; Lt. H. C. Warwick, chief after May 1; Lt. (j. g.) I. T. Sanders; Lt. (j. g.) W. R. Porter; C. A. Schoene, jr. engr.; G. W. Moore, jr. engr.; C. W. Clark jr. engr.; W. J. Bilby, signalman.
East Shore Lake Michigan, Mich.	Triangulation, first-order; 160 mi., 2,000 sq. mi.; 1 Laplace and 2 first-order azimuths.	Lt. H. C. Warwick, chief; Lt. (j. g.) I. T. Sanders; Lt. (j. g.) W. R. Porter; C. A. Schoene, jr. engr.; G. W. Moore, jr. engr.; C. W. Clarke, jr., engr.; W. J. Bilby, signalman.
San Luis Obispo, Calif.	Triangulation, first-order; 65 mi., 850 sq. mi.	Lt. (j. g.) F. G. Johnson, chief; Lt. (j. g.) L. C. Johnson; Lt. (j. g.) J. Laskowski.
Providence to New York, R. I., Conn., and N. Y.	Triangulation, first-order; 175 mi., 3,200 sq. mi.; 1 Laplace and 1 first-order azimuth.	Lt. C. D. Meaney, chief; Lt. R. D. Horne; Ensign W. C. Russell; Ensign A. L. Wardwell; P. A. Weber, jr. engr.; J. W. Stirni, jr. engr.; M. Z. Braden, signalman.
Base measurement, Michigan	Base measurement, first-order; 1 base, 6.5 mi.	Wm. Mussetter, chief; Lt. (j. g.) R. L. Pfau; L. G. Simmons, assoc. geod. engr.
Base measurement, Ill.	Base measurement, first order; 1 base, 5.0 mi.	J. S. Bilby, chief; Lt. (j. g.) J. P. Lushene.
Base measurement, Calif.	Base measurement, first-order; 2 bases, 7.8 mi.	Lt. (j. g.) E. B. Latham, chief.
Mississippi River, Wis. and Minn.	Reconnaissance for first-order triangulation 120 mi., 1,200 sq. mi.	Wm. Mussetter, chief; Lt. (j. g.) R. L. Pfau.
Bottineau, N. Dak.	Reconnaissance for first-order triangulation, 35 mi., 420 sq. mi.	M. Z. Braden, chief.
Billings to Grand Junction, Colo., and Utah.	Reconnaissance for first-order triangulation; 80 mi., 4,250 sq. mi.	Lt. (j. g.) C. A. Schanck, chief.
One hundred and ninth meridian, Colo., Utah, Ariz., and N. Mex.	Reconnaissance for first-order triangulation; 400 mi., 17,000 sq. mi.	Lt. (j. g.) C. A. Schanck, chief.
Grand Traverse Bay to Sturgis, Mich.	Reconnaissance for first-order triangulation; 250 mi., 3,000 sq. mi.	Wm. Mussetter, chief; L. G. Simmons, assoc. geod. engr.
Helena to Pasco, Mont., Idaho, and Wash.	Reconnaissance for first-order triangulation; 350 mi., 7,000 sq. mi.	Lt. (j. g.) E. B. Latham, chief
Indiana-Ohio boundary, Ind., and Ohio.	Reconnaissance for first-order triangulation; 200 mi., 1,800 sq. mi.	J. S. Bilby, chief.
Texas-Oklahoma boundary, N. Mex., Tex., and Okla.	Reconnaissance for first-order triangulation; 175 mi., 1,750 sq. mi.	Lt. (j. g.) R. L. Pfau and Lt. (j. g.) C. A. Schanck.
Amarillo to Del Rio, Tex.	Reconnaissance for first-order triangulation; 325 mi., 4,500 sq. mi.	Lt. (j. g.) R. L. Pfau and Lt. (j. g.) C. A. Schanck.
Norfolk to Jacksonville, Va., N. C., S. C., Ga., and Fla.	Reconnaissance for first-order triangulation; 635 mi., 6,500 sq. mi.	Wm. Mussetter, chief; L. G. Simmons, assoc. geod. engr.
Beaufort to Lincolnton, S. C., and Ga.	Reconnaissance for first-order triangulation; 110 mi., 1,100 sq. mi.	Wm. Mussetter, chief; L. G. Simmons, assoc. geod. engr.
Providence to New York, R. I., Conn., and N. Y.	Reconnaissance for first-order triangulation; 175 mi., 3,200 sq. mi.	Lt. F. L. Gallen, chief; E. R. Martin, jr. engr.
One hundred and seventeenth meridian, Idaho and Oreg.	Reconnaissance for first-order triangulation; 80 mi., 2,500 sq. mi.	Lt. (j. g.) E. B. Latham, chief.
Louisville to Nashville Ind., Ky., and Tenn.	Reconnaissance for first-order triangulation; 170 mi., 1,700 sq. mi.	Lt. (j. g.) C. A. Schanck, chief.

DIVISION OF GEODESY—continued

Locality	Operation	Persons conducting operations
Nashville to Corinth, Tenn., Ala., and Miss.	Reconnaissance for first-order triangulation; 140 mi., 1,400 sq. mi.	Lt. (j. g.) C. A. Schanck, chief.
Gulfport to Corinth, Miss.	Reconnaissance for first-order triangulation; 275 mi., 3,000 sq. mi.	Lt. (j. g.) R. L. Pfau, chief.
Sandy Hook to Delaware Bay, N. J.	Reconnaissance for first-order triangulation; 110 mi., 1,300 sq. mi.	E. R. Martin, chief.
Jacksonville to Richmond, N. C. and Va.	Reconnaissance for first-order triangulation; 210 mi., 2,100 sq. mi.	Wm. Mussetter, chief; L. G. Simmons, assoc. geod. engr.
Sacramento and San Joaquin Rivers, Calif.	Reconnaissance for first-order triangulation; 75 mi., 1,000 sq. mi.	Lt. (j. g.) J. Bowie, jr. chief O. S. Risvold, signalman.
Suisun Bay to San Francisco Bay, Calif.	Reconnaissance for first-order triangulation; 125 mi., 1,500 sq. mi.	Lt. (j. g.) J. Bowie, jr., chief; O. S. Risvold, signalman.
Mobile to Jacksonville, Ala. and Fla.	Reconnaissance for first-order triangulation; 430 mi., 3,900 sq. mi.	J. S. Bilby, chief.
Tallahassee to Columbus, Fla., and Ga.	Reconnaissance for first-order triangulation; 150 mi., 1,500 sq. mi.	J. S. Bilby, chief.
Norfolk to Delaware Bay, Va., Md., and Del.	Reconnaissance for first-order triangulation; 200 mi., 3,000 sq. mi.	E. R. Martin, chief.
San Luis Obispo, Calif.	Reconnaissance for first-order triangulation; 65 mi., 850 sq. mi.	Lt. (j. g.) E. B. Latham, chief.
Gordonsville to Norfolk, Va.	Reconnaissance for first-order triangulation; 160 mi., 1,600 sq. mi.	L. G. Simmons, chief.
Virginia-North Carolina boundary, Va., and N. C.	Reconnaissance for first-order triangulation; 210 mi., 2,100 sq. mi.	L. G. Simmons, chief.
Hopkinsville to Vincennes, Ky. and Ind.	Reconnaissance for first-order triangulation; 135 mi., 1,800 sq. mi.	Lt. (j. g.) R. L. Pfau, chief.
Uniontown to Wellsboro, Pa.	Reconnaissance for first-order triangulation, 165 mi., 2,000 sq. mi.	E. R. Martin, chief.
East Shore Lake Michigan, Mich.	Reconnaissance for first-order triangulation, 275 mi., 3,500 sq. mi.	Wm. Mussetter, chief.
New York to Sandy Hook, N. Y. and N. J.	Reconnaissance for first-order triangulation, 35 mi., 250 sq. mi.	Lt. F. L. Gallen, chief.
San Fernando to Bakersfield, Calif.	Reconnaissance for first-order triangulation, 50 mi., 700 sq. mi.	Lt. (j. g.) E. B. Latham, chief; Lt. G. L. Anderson.
Charleston to Bristol, W. Va.	Reconnaissance for first-order triangulation, 35 mi., 500 sq. mi.	E. R. Martin, chief.
Iowa, Missouri, and Wisconsin	3 latitudes and 3 longitudes	Lt. (j. g.) J. P. Lushene, chief.
California	4 latitudes and 4 longitudes	Lt. (j. g.) E. B. Latham, chief.
Bahama Islands	12 gravity determinations	Lt. (j. g.) J. P. Lushene.
District of Columbia and Maryland.	2 gravity determinations	Lt. Edwin J. Brown.
District of Columbia	3 gravity determinations	Lt. (j. g.) J. P. Lushene.
Maryland, Pennsylvania, Virginia, and West Virginia.	15 gravity determinations	Lt. A. J. Hoskinson.
Alabama	4 gravity determinations	Lt. A. J. Hoskinson.
Philadelphia, Pa., to Lewes, Del. (part) including numerous spur lines.	First-order leveling; 48 mi	Two parties; Ensign A. L. Wardwell, chief; Lt. A. J. Hoskinson, chief; Lt. (j. g.) W. M. Gibson; Lt. (j. g.) G. R. Fish; Jr. Engr. J. C. Bull; Lt. (j. g.) J. Laskowski.
Winnemucca, Nev., to Crane, Oreg. (part).	First-order leveling; 154 mi	Lt. (j. g.) Curtis Le Fever, chief; Lt. (j. g.) H. J. Oliver.
Kirk to Bend, Oreg	First-order leveling; 104 mi	Lt. (j. g.) H. J. Oliver, chief; Ensign E. E. Stohsner.
Vicinity of Seattle, Wash	First-order leveling; 1 mi	Lt. Chas. Pierce, chief; Ensign R. H. Tryon.
Carlton to Aitkin, Minn	First-order leveling; 68 mi	Lt. A. J. Hoskinson, chief; Ensign John C. Bull.
Twin Rivers to Olympia, Wash	First-order leveling; 167 mi	Lt. Charles Pierce, chief; Ensign R. H. Tryon.
Bemidji to International Falls, Minn.	First-order leveling; 111 mi	Lt. A. J. Hoskinson, chief; Ensign John C. Bull.
Prineville to Dayville (Picture Gorge), Oreg.	First-order leveling; 88 mi	Lt. (j. g.) H. J. Oliver, chief; Ensign E. E. Stohsner.
Glendive, Mont., to Bismarck, N. Dak.	First-order leveling; 223 mi	Lt. (j. g.) G. R. Fish, chief; Ensign A. L. Wardwell.
Bemidji to Crookston, Minn	First-order leveling; 78 mi	Lt. A. J. Hoskinson, chief; Ensign J. C. Bull.
Forsyth to Malta, Mont	First-order leveling; 226 mi	Lt. (j. g.) Jas. D. Thurmond, chief; Ensign T. M. Price.
Canyon City to Burns, Oreg	First-order leveling; 81 mi	Lt. (j. g.) H. J. Oliver, chief; Ensign E. E. Stohsner.
McKenzie, N. Dak., to Glyndon, Minn.	First-order leveling; 210 mi	Lt. (j. g.) G. R. Fish, chief; Ensign A. L. Wardwell; Jr. Engr. C. A. Schoene.
Klamath Falls to Dairy, Oreg	First-order leveling; 20 mi	Lt. (j. g.) H. J. Oliver, chief.
Vicinity of Wolf Creek, Oreg	First-order leveling; 2 mi	Lt. (j. g.) H. J. Oliver, chief.
Twin Brooks to Roscoe, S. Dak	First-order leveling; 141 mi	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. A. Schoene.
Cle Elum to Molson, Wash	First-order leveling; 237 mi	Lt. Charles Pierce, chief; Ensign R. H. Tryon.
Lakeview, Oreg., to Fernley, Nev.	First-order leveling; 244 mi	Lt. (j. g.) Curtis Le Fever, chief; Lt. (j. g.) J. Laskowski,

DIVISION OF GEODESY—continued

Locality	Operation	Persons conducting operations
Malone to Troy, N. Y.	First-order leveling; 286 mi.	Lt. (j. g.) W. M. Gibson, chief.
Laurier to Spokane, Wash.	First-order leveling; 133 mi.	Lt. Charles Pierce, chief; Ensign R. H. Tryon.
Utica to Weedsport, N. Y.	First-order leveling; 78 mi.	Lt. (j. g.) W. M. Gibson, chief.
Great Falls to Mossmain, Mont.	First-order leveling; 231 mi.	Lt. (j. g.) J. D. Thurmond, chief; Ensign T. M. Price.
Shirley to Hoxie, Ark.	First-order leveling; 139 mi.	Lt. (j. g.) G. R. Fish, chief.
Wilmington, Del., to Susquehanna Bridge, Md.	First-order leveling; 39 mi.	Lt. (j. g.) W. M. Gibson, chief.
At Havre de Grace, Md.	First-order leveling; 1 mi.	Do.
Sioux Falls Jct., S. Dak., to La Crosse, Wis.	First-order leveling; 320 mi.	Ensign A. L. Wardwell, chief; Ensign J. C. Bull.
Kensett to Little Rock, Ark.	First-order leveling; 52 mi.	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. W. Clark.
Brady to San Antonio, Tex.	First-order leveling; 147 mi.	Lt. (j. g.) J. D. Thurmond, chief; Ensign T. M. Price.
Portsmouth, Va., to Southport, N. C.	First-order leveling; 311 mi.	Lt. (j. g.) W. M. Gibson, chief; Jr. Engr. F. J. Bryant.
Navassa to Chadbourn, N. C.	First-order leveling; 50 mi.	Do.
Suffolk to Old Point Comfort, Va.	First-order leveling; 40 mi.	Lt. (j. g.) W. M. Gibson, chief;
Richmond to Clarksville, Va.	First-order leveling; 104 mi.	Lt. (j. g.) W. M. Gibson, chief; Jr. Engr. F. J. Bryant.
Clarksville, Va., to Manson, N. C.	First-order leveling; 27 mi.	Do.
Suffolk to Richmond, Va.	First-order leveling; 86 mi.	Do.
Orange to Tenaha, Tex.	First-order leveling; 145 mi.	Lt. (j. g.) J. D. Thurmond, chief; Jr. Engr. J. W. Stirni.
San Jacinto to Aguanga, Calif.	First-order leveling; 34 mi.	Lt. (j. g.) Curtis Le Fever, chief.
Releveling Los Angeles area, Calif.	First-order leveling; 378 mi.	Do.
Ukiah to Marysville, Calif.	First-order leveling; 123 mi.	Lt. (j. g.) H. J. Oliver, chief; Lt. (j. g.) A. C. Thorson.
Palestine to Houston, Tex.	First-order leveling; 152 mi.	Lt. (j. g.) J. D. Thurmond, chief; Jr. Engr. J. W. Stirni.
Eureka to San Francisco and San Jose, Calif.	First-order leveling; 378 mi.	Lt. (j. g.) H. J. Oliver, chief; Ensign E. E. Stohsner; Lt. (j. g.) W. F. Malnate.
Lampasas to Brownwood, Tex.	First-order leveling; 104 mi.	Lt. (j. g.) J. D. Thurmond, chief.
Fort Smith to Lewisville, Ark.	First-order leveling; 231 mi.	Ensign A. L. Wardwell, chief. Ensign J. C. Bull; Jr. Engr. G. W. Moore.
Bureau of Standards to Geophysical Laboratory, D. C.	First-order leveling; 1 mi.	Lt. (j. g.) J. P. Lushene, chief; Lt. (j. g.) J. D. Thurmond.
Vicinity of Goldsboro, N. C.	First-order leveling; 21 mi.	Lt. (j. g.) W. M. Gibson, chief; Jr. Eng. F. J. Bryant.
Sterling to Cayuga, N. Y.	First-order leveling; 42 mi.	Do.
Ithaca to Elmira, N. Y.	First-order leveling; 29 mi.	Do.
Salida to Bishop, Calif.	First-order leveling; 60 mi.	Lt. (j. g.) Curtis Le Fever, chief.
Medford to Chinchals, Oreg. (part).	Second-order leveling; 66 mi.	Ensign E. E. Stohsner, chief.
Valley Falls to Lapine, Oreg.	Second-order leveling; 127 mi.	Lt. (j. g.) H. J. Oliver, chief; Ensign E. E. Stohsner.
Klamath Falls to Klamath Jct., Oreg.	Second-order leveling; 60 mi.	Lt. (j. g.) H. J. Oliver, chief.
Dillard to Coquille, Oreg.	Second-order leveling; 65 mi.	Do.
At Little Rock, Ark.	Second-order leveling; 14 mi.	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. W. Clark.
Pine Bluff to Camden, Ark.	Second-order leveling; 84 mi.	Lt. (j. g.) G. R. Fish, chief.
Chadbourn to Fayetteville, N. C.	Second-order leveling; 64 mi.	Lt. (j. g.) W. M. Gibson, chief; Jr. Engr. F. J. Bryant.
Roseboro to Plymouth, N. C.	Second-order leveling; 169 mi.	Do.
Rocky Mount to Weldon, N. C.	Second-order leveling; 32 mi.	Do.
Longvale to Dos Rios, Calif.	Second-order leveling; 14 mi.	Lt. (j. g.) H. J. Oliver, chief; Ensign E. E. Stohsner.
Crossett to Montrose, Ark.	Second-order leveling; 96 mi.	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. W. Clark.
Grady to Hazen, Ark.	Second-order leveling; 78 mi.	Do.
Mammoth Springs to Shirley, Ark.	Second-order leveling; 96 mi.	Lt. (j. g.) G. R. Fish, chief.
Willow Creek to Hornbrook, Calif.	Second-order leveling; 163 mi.	Lt. (j. g.) H. J. Oliver, chief; Lt. (j. g.) A. C. Thorson.
Forest City to Newport, Ark.	Second-order leveling; 71 mi.	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. W. Clark.
Mount Ida to Russellville, Ark.	Second-order leveling; 80 mi.	Ensign A. L. Wardwell, chief; Jr. Engr. G. W. Moore.
Helena to Wheatley, Ark.	Second-order leveling; 73 mi.	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. W. Clark.
Smithton to Boles, Ark.	Second-order leveling; 115 mi.	Ensign A. L. Wardwell, chief; Jr. Engr. G. W. Moore.
Harrison to Clarksville, Ark.	Second-order leveling; 88 mi.	Lt. (j. g.) G. R. Fish, chief; Jr. Engr. C. W. Clark.

DIVISION OF TIDES AND CURRENTS

Locality	Operation	Persons conducting operations
Eastport, Me.	Tide observations	J. J. Murphy.
Rockland, Me.	do	G. E. Dunton.
Portland, Me.	do	C. H. Hudson.
Portsmouth, N. H.	do	U. S. Navy; C. A. Gerry.
Boston, Mass.	do	Lt. Comdr. K. T. Adams; H. F. Russell.
New Bedford, Mass.	do	M. H. Pelton.
Hen and Chickens Lightship, Mass.	Current observations	R. F. Norton, master.
Vineyard Sound Lightship, Mass.	do	R. Boman, master.
Pollock Rip Channel	do	Ship Natoma, Lt. C. A. Egner, comdg.
Georges Bank	Current observations, 39 stations	Ship Gilbert, Lt. Charles Shaw, comdg.; ship Lydonia, Lt. Comdr. C. D. Cowie, comdg.; ship Oceanographer, Comdr. L. O. Colbert, comdg.; ship Hydrographer, Capt. W. E. Parker, comdg.
Newport, R. I.	Tide observations	U. S. Navy; C. D. Warner.
Buzzards Bay	Current observations, 94 stations	Lt. G. E. Boothe.
Buzzards Bay	Tide observations, 23 stations	Do.
Brenton Reef Lightship, R. I.	Current observations	Theodor Anderson, master.
Willets Point, N. Y.	Tide observations	M. T. Myers.
New York, N. Y.	do	Lt. Comdr. H. A. Cotton; T. J. Lyons.
Atlantic City, N. J.	do	Samuel Deitch.
Baltimore, Md.	do	F. A. Kummell.
Annapolis, Md.	do	U. S. Navy; J. S. Stahura.
Philadelphia, Pa.	do	W. M. Miller.
Hampton Roads, Va.	do	U. S. Navy; G. I. Miller.
Washington, D. C.	do	C. F. Auffort.
Charleston, S. C.	do	L. C. Lockwood.
Fort Screven, Ga.	do	U. S. Engineers; W. J. Lynch.
Mayport, Fla.	do	U. S. Engineers; H. H. Williams.
Jacksonville, Fla.	do	U. S. Engineers; W. P. Tisdale.
Daytona Beach, Fla.	do	T. J. Wright.
Miami Beach, Fla.	do	U. S. Engineers; T. K. Hodges.
Cape Canaveral, Fla.	Current observations, 2 stations	Ship Gilbert, Lt. Charles Shaw, comdg.; ship Lydonia, Lt. Comdr. C. D. Cowie, comdg.
Key West, Fla.	Tide observations	S. M. Goldsmith.
Pensacola, Fla.	do	H. L. Collins.
Galveston, Tex.	do	L. T. Armstrong.
San Diego, Calif.	do	U. S. Navy; J. P. Huffsmith.
La Jolla, Calif.	do	G. F. McEwen.
Newport Beach, Calif.	Tide observations, 4 stations	City authorities of Newport Beach.
Santa Ana, Calif.	Tide observations	Orange County authorities.
Alimitos Bay, Calif.	do	Do.
Los Angeles, Calif.	Tide observations, 2 stations	Los Angeles Harbor Department; J. M. Hurley.
Santa Barbara, Calif.	Tide observations	M. N. Hicks.
San Francisco, Calif.	do	Comdr. T. J. Maher; H. S. Ballard.
South San Francisco Bay	Current observations, 153 stations	U. S. Engineers.
Alameda, Calif.	Tide observations	Alameda County authorities.
Point Isabel, Calif.	do	Berkeley Water Front Co.
Richmond, Calif.	do	Do.
Marshfield, Oreg.	do	Port of Coos Bay authorities.
Astoria (Youngs Bay), Oreg.	do	L. A. McArthur.
Astoria (Tongue Point), Oreg.	do	A. M. Coleman.
Seattle, Wash.	do	Comdr. F. H. Hardy; O. S. Hopper.
Friday Harbor, Wash.	do	Oceanographic Laboratory; University of Washington.
Juan de Fuca Strait, Wash.	Current observations	Ship Guide, Lt. Comdr. K. T. Adams, comdg.
Sitkinak Strait, Alaska	do	Ship Discoverer, Comdr. F. B. T. Siems, comdg.
Chugach Passage, Alaska	do	Ship Discoverer, Lt. Comdr. H. B. Campbell, comdg.
Ketchikan, Alaska	Tide observations	Adolph Anderson.
Seward, Alaska	do	Ida A. Leedom.
Cordova, Alaska	do	Cordova Chamber of Commerce.
Honolulu, Hawaii	do	Lt. Comdr. J. H. Peters; U. S. Territorial Survey.
Hilo, Hawaii	do	U. S. Geological Survey.
Anau and Kalohi Channel, Hawaii.	Current observations, 3 stations	Ship Pioneer, Lt. Comdr. O. W. Swainson, comdg.
Nassau, Bahamas	Tide observations	Public Works Department.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Locality	Operation	Persons conducting operations
Cheltenham, Md	Magnetic observatory	George Hartnell, S. G. Townshend, magnetic observers.
San Juan, P. R	Magnetic and seismological observatory.	Lt. Comdr. Eoline R. Hand.
Sitka, Alaska	do	F. P. Ulrich, magnetic observer.
Tucson, Ariz	do	A. K. Ludy, John Hershberger, magnetic observers.
Honolulu, Hawaii	do	Lt. Comdr. J. H. Peters.
Chicago, Ill	Seismological station	Jack Appel, seismograph tender.
Columbia, S. C	do	A. C. Carson, seismograph tender.
Bozeman, Mont	do	J. P. Parker, seismograph tender.
Ukiah, Calif	Variation of latitude and seismological station.	H. G. Wrocklage, extra observer.
North Carolina	Replacements	R. G. Ambrose, magnetic observer.
Minnesota, Iowa, Illinois, Missouri, Arkansas, Oklahoma.	Repeat stations and replacements	Do.
Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, Tennessee.	do	Do.

Very truly yours,

R. S. Patton, *Director.*