P 12 QB 296 U5 1925 c.2 34 80888 CEM

ANNUAL REPORT

OF THE

DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

TO THE

SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1925

LIBRARY
Recataloged
JAN 29 1996
N.O.A.A.
U.S. DEPT. OF COMMERCE

PRICE 50 CENTS
Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

ERRATA NOTICE

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

Discolored pages
Faded or light ink
Binding intrudes into the text

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

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

Persons on a regular mailing list of the Department of Commerce should give prompt notice to the "Division of Publications, Department of Commerce, Washington, D. C.," of any change of address, stating specifically the form of address in which the publication has previously been received, as well as the new address. The department should also be advised promptly when a publication is no longer desired.

CONTENTS

	Page
Introduction	1
Retirement of civil-service employees	3
Value of printed matter and other data to the public	4
What two years of modern vessels have meant in money saved	5
Special surveys requested by Army and Navy and other sources	6
Excellent advance in Alaska hydrographic surveys	6
Other important hydrographic surveys accomplished in continental waters	7
Recent results of Philippine Islands surveys	8
Progress in Hawaiian Islands	8
Progress in Virgin Islands	8
Geodetic work accomplished	8
Cooperation with other organizations	10
Progress in magnetic surveys	14
Seismology to date	15
What the completed Delaware Bay current and tide surveys will mean to shipping	16
What modern instruments have meant to the bureau's work	17
Part I.—THE BUREAU'S GREATEST NEEDS	
Chapter I. A modern building is a money saver	19
Chapter II. Three new tenders vitally needed	20
Modern vessel needed on Atlantic coast	21
Chapter III. Hydrography and topography	22
Pressing demands for hydrographic work	22
Importance of completing wire-drag survey along the Atlantic coast, especially the New England coast	22
Atlantic coast	23
Gulf coast	23
Virgin Islands	23
Importance of surveys on Pacific coast	23
Surveys in Alaska	23
Wire-drag surveys in Alaska	23
Outside coasts of southeastern Alaska	24
Charting western Alaska	24
Hawaiian Islands	24
Remaining work in Philippine Islands waters	24
Chapter IV. Geodesy	26
Demands from other bureaus for control surveys	26
Chapter V. Terrestrial magnetism and seismology	28
Necessity of additional compass information	28
Important seismological work of economic value to the country	29
Chapter VI. Tides and currents	30
Need of a current and tide survey in Boston, Portland, and Portsmouth Harbors	30
Current survey, inside passage of Alaska	31
Chapter VII. Charts	32
Their value	32
Coast erosion and protection	35
Chapter VIII. Accounting division	37
Chapter IX. Instrument division	38
Vital to the bureau's progress and efficiency	38
Part II.—THE WASHINGTON OFFICE	
Chapter I. Accomplishments of the Washington office during the fiscal year	40
Chief clerk	40
Division of hydrography and topography	41
Division of geodesy	43
Division of charts	44
Division of terrestrial magnetism and seismology	44
Division of tides and currents	47
Division of accounts	49
Instrument division	50
New charts issued during the year	51

Page

Chapter II. Program for the current fiscal year in the Washington office 53
Chief clerk 53
Division of hydrography and topography 53
Division of geodesy 53
Division of charts 54
Division of terrestrial magnetism and seismology 54
Division of tides and currents 55
Division of accounts 56
Instrument division 56

Part III.—IN THE FIELD

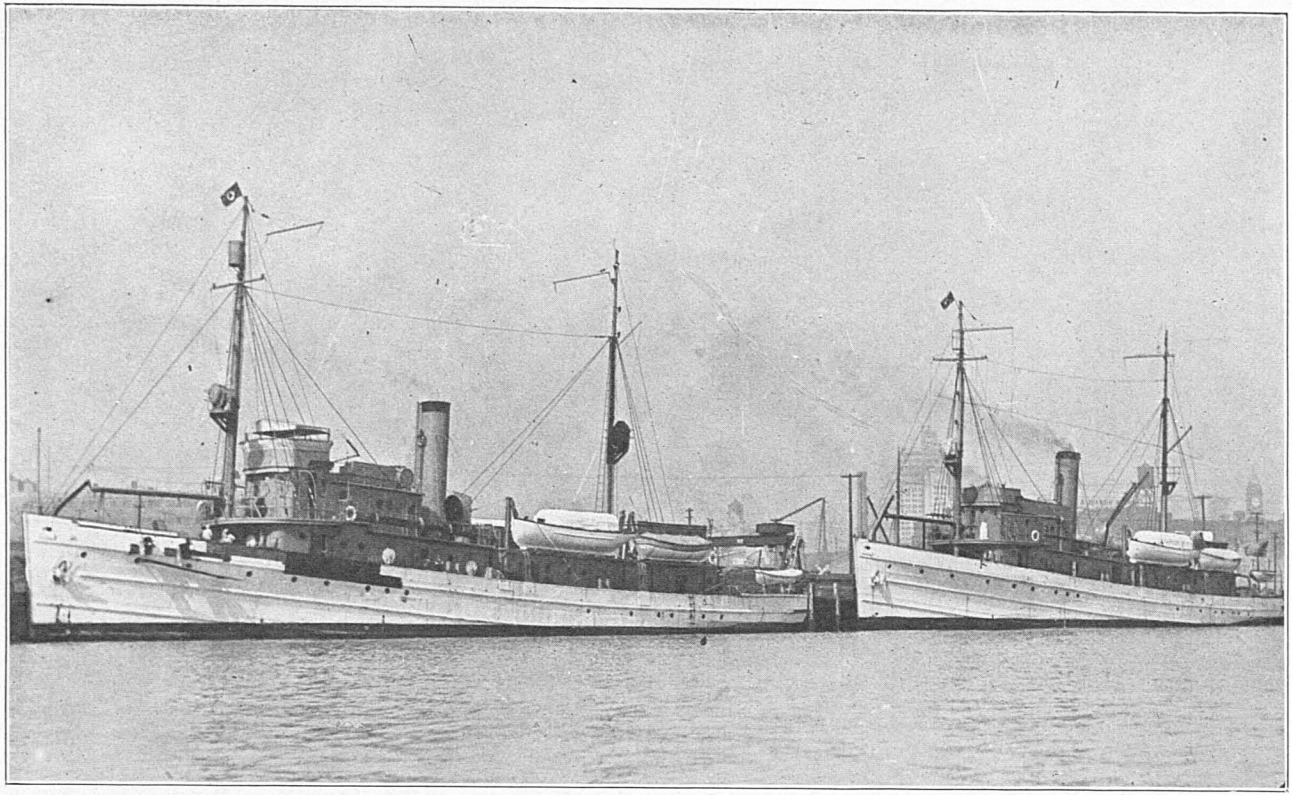
Chapter I. Accomplishments in the field during the fiscal year 57
Hydrographic work 57
Geodetic work 59
Magnetic and seismological work 62
Tide and current work 63
Chapter II. Brief summary of hydrographic, geodetic, magnetic, and tide and current surveys 66
Chapter III Program for the current fiscal year in the field 68
Hydrographic and topographic work 68
Geodetic work 69
Magnetic and seismological work 70
Tide and current work 70

Part IV.—DISTRIBUTION OF PARTIES OF THE COAST AND GEODETIC SURVEY DURING THE FISCAL YEAR ENDED JUNE 30, 1925

Division of hydrography and topography 72
Division of geodesy 76
Division of tides and currents 78
Division of terrestrial magnetism and seismology 79

ILLUSTRATIONS

Frontispiece 1
1. Old wooden library shelving 3
2. Modern steel library shelving 4
3. Graphic diagram, Colorado 6
4. Changes in geographic position in California 11
5. Organization chart 40
6. Graphic diagram showing issues of charts, 1899 to 1925 52
7. Graphic diagram showing annual distribution of Coast Pilots and inside route pilots, 1904 to 1925 52
8. Graphic diagram showing receipts from sales of charts and nautical publications, 1897 to 1925 52
9. Triangulation and traverse in United States, to 1925 59
10. Magnetic work in United States, accomplishment and cooperation, June 30, 1925 62
11. Condition of magnetic surveys in United States, June 30, 1925 62
12. Field operations, United States, triangulation, precise traverse, precise leveling, tide and current harbor surveys, wireless stations, azimuth stations, tide stations, and current stations, 1925 66
13. Progress sketch, Alaska topography, to June 30, 1925 67
14. Progress sketch, Alaska, gravity stations, latitude and longitude determinations, azimuth and tides, to June 30, 1925 67
15. Progress sketch, Alaska magnetic observations, to June 30, 1925 67
16. Progress sketch, Alaska triangulation and precise leveling, to June 30, 1925 67
17. Progress sketch, Porto Rico and Virgin Islands, to June 30, 1925 67
18. Progress sketch, Hawaiian Islands, to June 30, 1925 67
19. Condition of field operations, Philippine Islands, to June 30, 1925 67
20. Condition of field operations, United States, 1925 follows 79
21. Condition of hydrographic surveys, Alaska, 1925 follows 79
22. Condition of hydrographic surveys, southeast Alaska, 1925 follows 79



COAST SURVEY STEAMERS "DISCOVERER" AND "PIONEER" PREPARING FOR DUTY ON THE PACIFIC COAST

REPORT

OF THE

DIRECTOR, U. S. COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, October 5, 1925.

SIR: There is submitted herewith my eleventh annual report. This report is for the fiscal year ended June 30, 1925, and is the ninety-fourth annual report of this bureau.

INTRODUCTION

The Coast and Geodetic Survey has just closed the one hundred and ninth year of its active existence, and it has been generally a most successful one. The results of our greatest efforts in carrying on the hydrographic work have demonstrated again the wisdom of providing modern vessels with up-to-date equipment. This is especially so in connection with our Pacific coast and Alaska work, where efficiency and large returns have been most marked. The greater strides in completing the survey of the Pacific coast and Alaska waters, much of it of a permanent nature, is gratifying and most marked in comparison with the slow progress of a few years ago.

Another interesting activity with the bureau was the visit of the chief of the division of hydrography and topography to the Philippine Islands, where he made an exhaustive study of the conditions of our hydrographic work. His trip was most helpful in that it has shown, first, that the work in our far-off possession is nearing completion as regards first surveys, and, second, he was able to study a program of a constructive nature looking toward the completion of the hydrographic work in Philippine waters.

It is interesting to know that the demand for our charts and other nautical publications has been the greatest in the history of the bureau. Coupled with this, the income from these sales has reached the greatest figures in dollars and cents since the bureau was organized.

Another outstanding effort of the bureau was the progress in instrument design and construction. So much has been done of an important nature that it has helped to expedite our work and greatly reduce certain unit costs.

With the many favorable things that are outstanding in the bureau's year of effort, which we recognize and fully appreciate, there are still some that should be looked to and provided for in the near future, as they are clearly matters involving economy and when provided will mean money saved to the Government, among which

are new tenders to replace the worn-out and dangerous craft that have been in the service for more than a quarter of a century and a new vessel for the Atlantic coast to replace two worn-out and uneconomic ships that have served the Government for more than 30 years. With the acquisition of this latter vessel the work on the Atlantic coast and Gulf will be expedited as well as the cost reduced. Another important item is the need of a modern building to house our Washington office. The administration of the present eight buildings, all unrelated to one another, is a serious waste of Government money, not to mention the fact that the bureau has outgrown the space that it now occupies, and necessarily the public interest will further suffer unless greater accommodations are soon provided.

The permanent good that has resulted from the reclassification act, which has now had a trial of over a year, has in many ways fulfilled the needs for which it was created, but emphasis should be laid on the fact that it is now time to rectify certain ambiguities in the legislation and so provide without delay certain increase in salaries of positions that so far have not benefited as deserved. The continuation of this situation is one of the outstanding causes of the turnover in the Federal service, which is quite the opposite of economy and makes the administrative cost of every bureau higher, as whenever an employee leaves the bureau the services of someone else are needed to train the new employee. It should be pointed out that the additional money needed to provide just and adequate salaries, which no doubt were intended in the legislation in question, would more than offset the high cost involved in this repeated turnover.

Another reason for this large turnover in the bureau, as well as throughout the Government generally, is that the present retirement law is unsatisfactory and not in line with the present idea of good business methods of making the future of sufficient interest to the employees, so that, after having served the Government faithfully, in their old age they may be adequately taken care of.

One of the questions that has much to do with our present-day problems is the change in the purchasing value of the dollar during the past 10 years—1915, par; 1920, 0.415; 1925, 0.644—and while our appropriation has increased in 10 years in so far as actual figures are concerned, the purchasing power is so much less that in reality this bureau has had little more actual money to work with than appropriated 10 years ago. Changes in methods of management, thereby increasing efficiency, are alone responsible for the bureau being able to get on as well as it has and to take care of increase in business, but I frankly see that without more space to house the bureau in Washington and additional personnel we can not take care of even the daily demands made on us and which are increasing each day, as any healthy business organization should grow.

Too much can not be said of the spirit in which the personnel have taken hold so that we could, in so far as it is humanly possible, care for the new calls made on us. The care of our mass of heterogeneous buildings and bringing them up to the greatest state of efficiency reflects unusual credit on the chief clerk of the bureau. Through his untiring efforts and those of the personnel under him, insanitary buildings have been made fairly livable in spite of a poor assortment of tools, and a saving in funds has been accomplished.

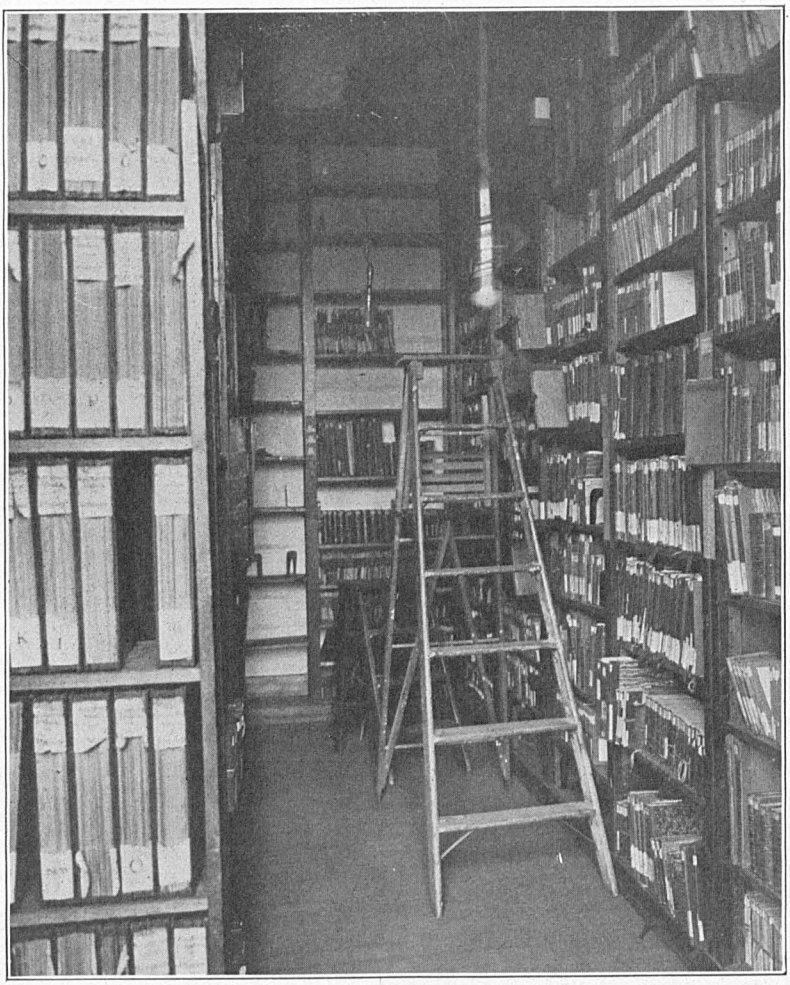


FIG. 1.—OLD WOODEN LIBRARY SHELVING

On shelves of this type were kept 40,000 technical books and pamphlets and 80,000 survey field records, gathered by expert workers and observers during 100 years. The shelves were dry as tinder and a fire hazard; impossible to keep clean; required the use of step-ladders to reach the higher spaces; and wasted the time of every library worker and many other persons who consulted the books and records

The most striking example of the latter is shown in illustrations Nos. 1 and 2. Not many years ago all the field notes of this bureau, representing a century of work and involving millions of dollars in actual worth, were protected only by ordinary care as they rested on dry pine shelves, the worst kind of fire traps. No money was forthcoming for vaults to store these records. The necessity of providing some means of protection became so obvious that this administrative officer worked out an economy plan covering several years whereby enough money would be saved from "office expenses" to install steel bookcases for the bureau's library. He accomplished what he started out to do, and now the valuable example of economy and thrift is a realty. These valuable records of the country are protected as never before. Furthermore, while the bureau now has a library which is fairly well protected from fire, with the changes other protection has been given our records which reflects credit and appreciation. The records are now readily accessible, made so by a fine system of reference cards. There are other things that are in keeping with the above saving policy which started before the war, and, as I have said before, only such a general attitude throughout the bureau has made it possible to keep abreast of the larger demands made on us by a fast growing country.

I will now take up in this introduction in more detail some of the outstanding matters, and then following in Part I will briefly indicate the bureau's greatest needs.

RETIREMENT OF CIVIL-SERVICE EMPLOYEES

The question of a more appropriate retirement for civil-service employees should have serious consideration at this time. The present basis of retirement means but little to the average employee in the Government. The annuity is too low, and the law does not differentiate between any class of employees or their earning capacities during their period of Government service. It is now quite evident that unless the present law is much improved upon it will not accomplish what it was intended to do.

As I have mentioned before, there is a great turnover every year in the Government personnel, which is not only expensive and wasteful but proves conclusively that it lessens the attractiveness of Government positions largely because a man or a woman who enters the Government service must have more money to live on than is now paid by the Government if they are to be retired on a mere pittance after 30, 40, or 50 years of service. It is my belief that an equitable retirement system, based on length of service and earning capacity during active service in the Government, will immediately attract the ablest people, who will be brought into the service and remain there to the great advantage of the public welfare.

There are two outstanding factors in the present retirement law that are distinctly unsatisfactory. One is that the retirement age is too high. The other is that every employee has to contribute from his salary toward the small annuity (maximum $60) that he is to receive upon reaching the retirement age. While there is some merit in the employees contributing toward this annuity fund, the retirement law should be more liberal and provide for optional retirement on a basis similar to the military forces; that is, after 30 years of

service. As the law now exists, a young man entering the Government service at the age of 18 is retired at the age of 70 years, after 52 years of service on an annuity of $60 per month, providing his average annual pay for the preceding 10 years was $1,200 or more. This has the effect of employees generally asking to be continued after they have reached the age at which they should be legally separated from the Government service because of their realizing that their small annuity will not nearly pay for the actual necessities of life.

VALUE OF PRINTED MATTER AND OTHER DATA TO THE PUBLIC

The impression which the average man has of the Coast and Geodetic Survey is that of a bureau designed to serve the mariner alone. It is true that the production of charts for the guidance of our own and foreign vessels in our coastal waters is the primary purpose of the survey, but in recent years this bureau has found other important ways in which to serve the public.

One of the most important of these is in the dissemination of information to county surveyors and local surveyors in every State in the Union. Three years ago a state of extraordinary confusion in the matter of local surveys was brought to the attention of the bureau. Cities and sometimes counties were engaged in disputes as to their boundary lines, most of these disputes arising from the inability of city and county engineers to reestablish old lines which had served until the recent rapid growth of our country. Control points were seldom in harmony, boundary monuments had become lost or obliterated, and it was not uncommon for gaps or overlaps to develop between two areas in question.

This difficulty would have been eliminated had standard data been used for these surveys. Fortunately, such data were available in the shape of Coast and Geodetic Survey triangulation stations, magnetic stations, and precise level bench marks. It is strange that the existence of these reference marks should have been known to so few local engineers, but such was the case. In recognition of this situation, the bureau entered into correspondence with local surveyors in the county seats of every State, bringing to their attention the mass of information ready for their use.

The method of making this first contact has been by printed digests, one for each State. In each digest the counties are listed alphabetically, with the reference marks which have been established at each point. Accompanying the digests are base maps of the States, showing the nature and location of surveys. (See illustration No. 3, opposite p. 6.) These publications have been distributed for the following States: Alabama, Arkansas, Colorado, Florida, Idaho, Illinois, Iowa, Kansas, Kentucky, Maine, Massachusetts, Minnesota, Missouri, Montana, Nebraska, Nevada, North Dakota, Ohio, Oregon, Rhode Island, South Dakota, Texas, Utah, West Virginia, and Wyoming. Digests for the remaining States will be published as soon as possible.

The bureau serves the general public in other ways. Information on a great variety of subjects is furnished constantly to public and private organizations and individuals. Occasionally important legal decisions hinge upon some point which is decided by consultation of our records. Since seismological work was taken over by the

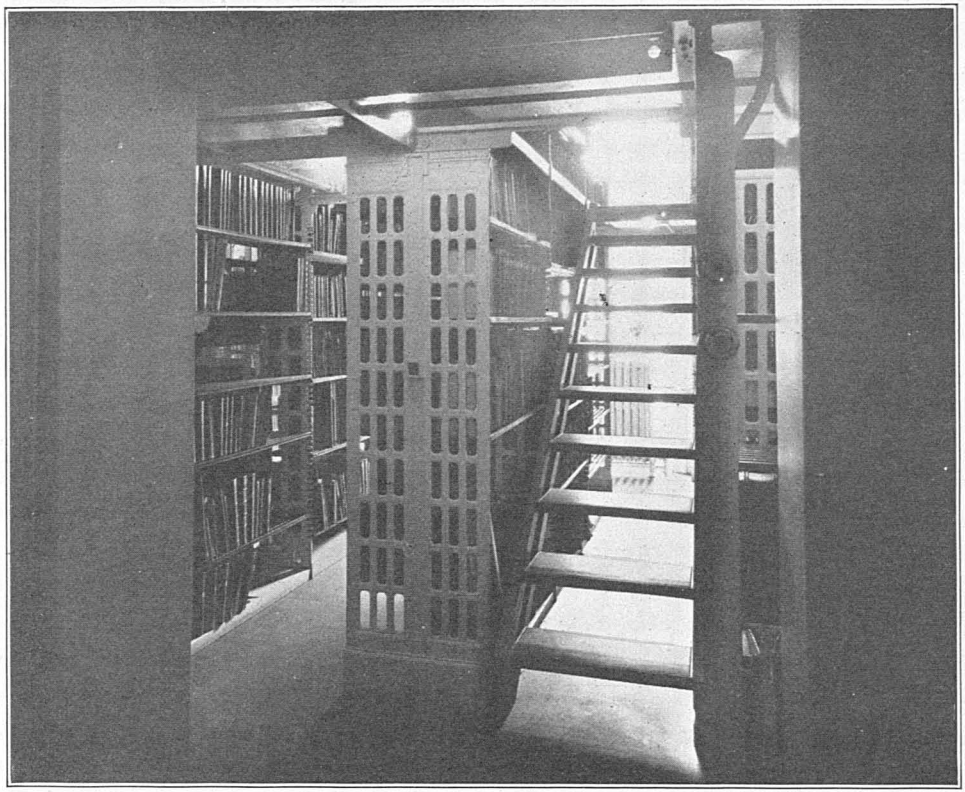


FIG. 2.—MODERN STEEL LIBRARY SHELVING

New steel shelving, with an upper deck to walk on instead of ladders to climb; absolutely fireproof; easy to keep clean; permits the librarians and others to spend their time and energy on useful work instead of shifting and climbing ladders to gain access to books and records

bureau, there has been a steady stream of inquiries concerning earthquakes and precautions to be taken against them in affected areas. Our special publications, such as The Portable Automatic Tide Gauge, are in regular demand by outside engineers.

The bureau has also forged ahead in its service to the maritime public. By means of judicious publicity and by the use of posters at chart sales stations, new charts and inside route pilots have been widely advertised. The new inside route pilots have in particular been brought to the attention of that growing class of motor-boat men, for whose special use they were designed.

WHAT TWO YEARS OF MODERN VESSELS HAVE MEANT IN MONEY SAVED

For years one of the greatest needs of this bureau, to enable it to accomplish the work expected of it, has been modern seaworthy vessels. Three such vessels were acquired from the Navy two years ago, which, with the vessel constructed by this bureau just prior to the war, formed a respectable fleet of ocean-going ships for surveying the waters of the Pacific coast of the United States and Alaska. The performance of these four ships during the last two years shows conclusively what the bureau can accomplish with adequate equipment and also how hopelessly it was handicapped by the old, weak, and underpowered vessels with which it was compelled to work prior to that date.

These new ships are larger and more powerful; they have larger and more powerful machinery, as well as larger hulls, than the ships which they replaced. Consequently, they are more costly to operate because of the greater quantity of fuel required to drive them, as well as the necessarily greater expense of caring for larger and more complete equipment. But these ships are able to accomplish so much more work during a working-day and, because of their greater seaworthiness, are able to work so many more days during a surveying season, that they can accomplish a job more cheaply than was possible for the older ships. The unit costs of taking a sounding and of surveying a square mile of sea area are less to-day with these ships than they were 10 years ago with the old ships, notwithstanding the higher wages and greater cost of all supplies at present, and if we make due allowances for the smaller purchasing power of the dollar of to-day we find that these ships have very materially reduced the cost of surveying.

While the reduced cost of surveying is an important consideration and one that will naturally appeal to everyone, it is not by any means the only gain that has resulted from replacing obsolete ships by modern ones. A glance at the progress maps in the back of this report will show how the unsurveyed and partly surveyed areas along the coasts of California, Oregon, and Alaska have been reduced during the last two years. In some of the areas, tinted blue on these maps, progress was being made with such equipment as we had, but the rate of progress was necessarily slow compared to recent advances, and in some of these areas weather conditions and lack of fuel bases and harbors of refuge so handicapped the old vessels that very little, if any, progress could be made. It is in such localities that the new ships have made their most pronounced gain over the old.

These vessels can carry on hydrographic surveys during conditions of wind and sea which heretofore we have regarded as unfit for work and, due to the fact that they need not seek shelter or sea room at the first indication of an approaching storm, they can hold on and work until the storm has fully developed. When we consider that heretofore much valuable time has been lost in getting to the working ground and away on the approach of a storm, and that the commanders of the old ships could not afford to take any chance of being caught on a lee shore, we understand how the new ships have reduced the cost and speeded up the progress of work in such areas.

An important factor also is the improved morale of the officers and men who man these ships. They are not only more comfortable than was possible on the older vessels, but they no longer need have any fear for the safety of themselves or their ships. They feel certain that with their own good seamanship and navigation they can take their ships through any storm. This new and favorable situation all goes to prove the wisdom of wise investment in modern equipment, for it means money saved and the work more quickly and better done.

SPECIAL SURVEYS REQUESTED BY ARMY AND NAVY AND OTHER SOURCES

Surveys in western Alaska, a two-year project, requested by the Navy Department, were completed last fall in accordance with the bureau's estimate. The completion of this job exactly on time is particularly gratifying because new vessels were employed on it, which at the time the estimate was made had not been tested as surveying tools, and also because the areas surveyed are in remote parts of the country, for which we had little dependable data on which to base the estimate.

In the Hawaiian Islands special work for the War Department was in progress throughout the past year and is still in progress. This is rather a large project, measured by the difficulties encountered, precision desired, and the facilities available for the work. It is probable that work will continue on that project throughout the present fiscal year.

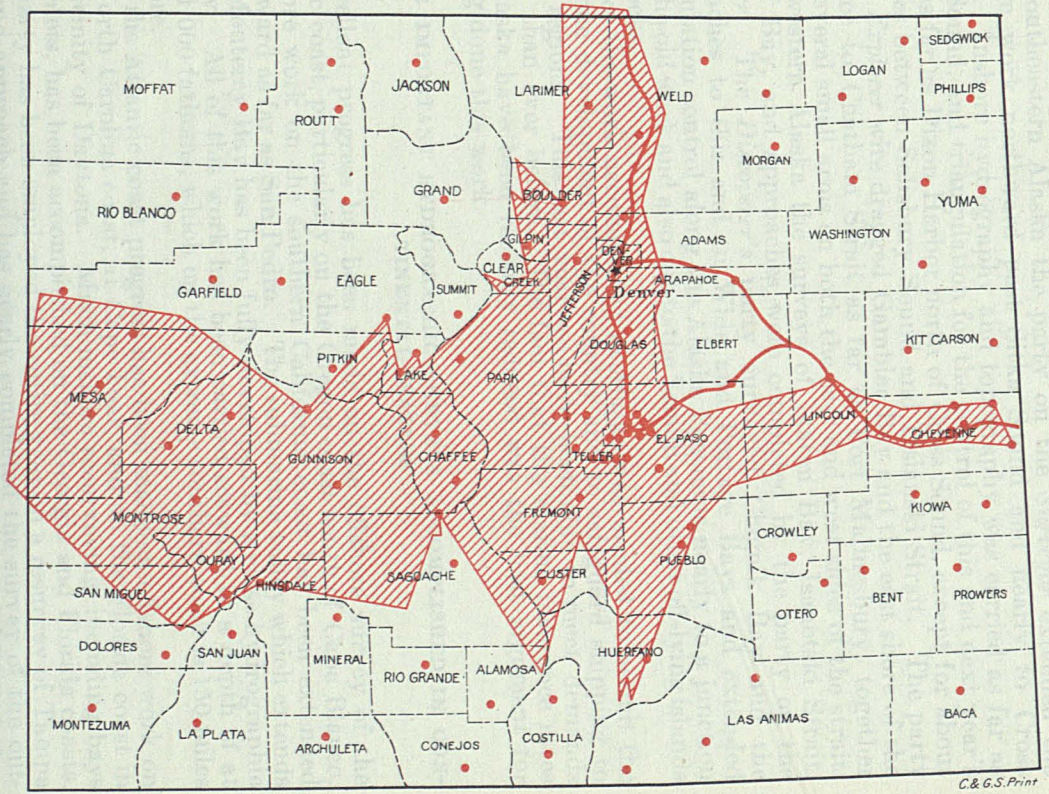
The hydrographic survey of the waters of the Virgin Islands, a necessary correlate to the land survey of those islands, requested by and made for the Navy Department several years ago, was still in progress at the close of the fiscal year. It is expected this survey will be completed during the present fiscal year.

In the Philippines confidential surveys were made for the use of the Navy Department. This work was begun in the latter part of the fiscal year and was nearly completed at its close. However, it seems probable that this work is the forerunner of more extensive work of the same sort for that branch of the Government.

EXCELLENT ADVANCE IN ALASKA HYDROGRAPHIC SURVEYS

Hydrography in Alaska during the past fiscal year has been confined almost exclusively to work on projects which were adopted two years or more ago and has been a continuation of the work of the

COLORADO



• Magnetic Stations Precise Leveling Triangulation

previous year. Marked progress has been made by all parties, due in no small measure to continuity of work, thereby eliminating in a large measure reconnaissance and preliminary work which must be done before starting each new project. The total water area completely surveyed during this last year was slightly more than double the area surveyed the year previous with the same vessels and practically the same personnel.

In southeastern Alaska the party on the *Surveyor* extended the offshore work northward past Sitka Sound and nearly to Cross Sound. Inshore hydrography and topography was carried as far as Sitka Sound, and triangulation for the control of this and next year's work as far as Dixon Harbor north of Cross Sound, except for about 30 miles between Salisbury Sound and Lisianski Strait. The party on the *Explorer* wire dragged Gambier Bay and the east shore of the entrance to Chatham Strait as far as Port Malmesbury, together with several small arms on both the east and west sides of the strait.

In western Alaska the surveys of Ikatan Bay, Isanotski Strait, Pavlof Bay, and approaches were completed by the party on the *Pioneer*. The *Discoverer's* party surveyed Chignik Bay and the approaches to this and to Wide and Portage Bays and extended triangulation control along the Alaska Pensinula nearly to a junction with the old work and also out to the Semidi and other off-lying islands and rocks.

All of the work accomplished in Alaska was needed to permit the economic development of the country and to safeguard shipping to those regions. This last year we have been able to meet demands better than ever before. The fact that the marine insurance rates for Alaska have been recently reduced was the best argument for having done this work.

OTHER IMPORTANT HYDROGRAPHIC SURVEYS ACCOMPLISHED IN CONTINENTAL WATERS

Excellent progress has been made on the offshore survey of the Pacific coast, particularly on the Oregon coast south of Cape Blanco. Offshore work on the southern California coast has been extended northward as far as San Pedro. The submarine valley which extends into Monterey Bay has been fully developed by a close hydrographic survey. All of this work has been carried seaward to a depth of at least 1,000 fathoms, which on the extreme southern coast is 150 miles offshore.

On the Atlantic coast progress has been made on offshore work on the North Carolina coast, at Cape Fear, and on the Florida coast in the vicinity of Daytona. Much inshore resurveying, including bays and inlets, has been accomplished on the Georgia and Florida coasts. One party has been employed the entire year on a resurvey of Tampa Bay and approach and has nearly completed the survey of the outside coast and entrance to the bay. The survey of Lake Okeechobee was completed early this summer and will be published soon in the form of a chart of the lake.

It is interesting to note that in connection with some of the above activities we were able to furnish other Government bureaus as well as private institutions by-products of our work, such as samples

of water at great depths and bottom samples, all without extra work or cost.

RECENT RESULTS OF PHILIPPINE ISLANDS SURVEYS

The outstanding accomplishment for the year in Philippine waters was the determination of the exact position of each of the islands and rocks which lie north of the island of Luzon and which to some extent block the passage between the Philippines and Formosa. Work in this locality has been regarded as particularly difficult and dangerous because of the prevalence of typhoons during the only season when the sea is otherwise smooth enough to permit landing upon these islands and rocks. All islands, islets, and rocks have now been connected by triangulation with Luzon and can be accurately placed on charts. Excellent progress has been made in the Sulu Archipelago and on the west side of Palawan, where two ship parties have been employed during the year.

PROGRESS IN HAWAIIAN ISLANDS

One boat party has been continuously employed on a survey of the coast of Oahu in minute detail and has made good progress considering the difficulties of the job, particularly from surf. A second boat party surveyed six of the small harbors and anchorages on the islands of Molokai and Maui which are used by interisland steamboats.

PROGRESS IN VIRGIN ISLANDS

Good progress is being made in the hydrographic survey of the waters of the Virgin Islands. One ship party has been employed there throughout the year. The ship returned to the United States last winter for extensive repairs, but only such personnel accompanied her as was absolutely necessary, the remainder remaining to carry on work from shore bases during the absence of the ship. It is expected all work in these waters will be completed during the current fiscal year.

GEODETIC WORK ACCOMPLISHED

The geodetic work done during the fiscal year was almost entirely in the western part of the United States and in Alaska. Probably the most important work undertaken during the year was that along the boundary between the United States and Canada to the westward of Lake Superior. An agreement had been entered into between officials of the United States Coast and Geodetic Survey and the Geodetic Survey of Canada for the extension of an arc along the boundary west of Lake Superior, each organization assuming the responsibility of covering half of the line.

Another important piece of work was the triangulation in Dixon Entrance, Alaska, between British Columbia and southeastern Alaska, and the measurement of base lines along the arc of triangulation extending through southeastern Alaska. The purpose of this Alaskan work was, primarily, to furnish accurate control for the charts of the region, but another very important use is in the carrying of

North American datum, geographic positions from Puget Sound, Wash., northward to northwest Canada and Alaska. The Geodetic Survey of Canada has extended an arc of triangulation from Puget Sound to Dixon Entrance, and this, with the completed arc from the latter place to Skagway, will make it possible to place all of the charts of British Columbia and southeastern Alaska on the North American datum.

First order traverse and triangulation were extended from the vicinity of Salem to the Black Hills in South Dakota. The selection of stations for the entire arc was completed during the fiscal year 1925.

An arc of first-order triangulation was extended from the vicinity of San Antonio to Del Rio, Tex. The selection of stations for this arc had been made prior to the observing.

Work was begun late in the fiscal year on an arc of first-order triangulation running from the vicinity of Needles, Calif., northward into Utah.

Work was begun on the selection of first-order triangulation stations and their preparation for the observing party along an arc of triangulation which will extend from the vicinity of Umatilla, Oreg., northward to the vicinity of Oroville, Wash., near the Canadian boundary.

Longitude determinations for the purpose of furnishing Laplace azimuths at triangulation stations were made in California, Arizona, Texas, Oklahoma, Kansas, Colorado, South Dakota, and Nebraska. Radio time signals sent from the Naval Observatory in Washington, through the naval radio station at Annapolis, were used by the observers of the Coast and Geodetic Survey in determining the longitudes of the field stations. Most efficient cooperation by the superintendent and officials of the Naval Observatory made it possible to do this work at a low cost and with great accuracy. A specially designed receiving apparatus for radio signals, designed by Doctor Eckhardt and Doctor Karcher when they were members of the Bureau of Standards, was used in the field for the purpose of recording automatically the radio signals. This is another illustration of the practical benefits to be derived from the results of a piece of scientific research.

The longitude party determined the astronomic latitude and azimuth at a number of stations. This work was accomplished without any material increase in the cost of operation of the party.

The selection of first-order stations and observations on the arc of triangulation extending northward from Cook Inlet, Alaska, was continued during the first half of the fiscal year. This triangulation in the interior of Alaska is greatly needed at present by the General Land Office which wishes to establish land lines for settlement purposes. Without a triangulation extending in a connected system along the valleys in Alaska, it would be necessary to use a separate meridian and base line for each place where settlement begins. The Governor of Alaska conferred at Washington with the officials of the Coast and Geodetic Survey and made the most urgent appeals for the triangulation.

The selection of stations was made for traverse and triangulation extending northward from the vicinity of Houston, Tex., to Fort Smith, Ark. This is a part of the general control system of the

country. The selection of stations was also made near the mouth of the Red River with a view to connecting the triangulation along the Mississippi River and the first-order triangulation of the country.

At the request of the city engineer of Rochester, N. Y., engineers of the Coast and Geodetic Survey began in the spring of 1925 the extension of a first-order horizontal control system over the area covered by the city.

Triangulation of the second order was executed in Frederick Sound and Chatham Strait in southeastern Alaska.

Third-order triangulation was executed in the vicinity of Crescent City, Calif., in connection with surveys of the waters along the coast.

Triangulation of the second order was executed in lower San Francisco Bay. This work was made necessary by the destruction by man and nature of the monuments left when the triangulation was first done many years ago.

Triangulation and traverse of the second order were executed along the coast of South Carolina from the vicinity of Charleston to Winyah Bay.

Two hundred and seven miles of first-order leveling were run from Perth Amboy to Atlantic City, N. J.; from Pleasantville to Cape May, N. J.; and from Delair, N. J., to Philadelphia.

The testing of the stability of the earth in California was continued during the year. The work consisted of a redetermination of the angles at first-order triangulation stations from the vicinity of Los Angeles, Calif., eastward to the Colorado River, and along the coast in the vicinity of Santa Barbara Channel. The Coast and Geodetic Survey cooperated with the Carnegie Institution of Washington in the extension of first-order triangulation northwestward from the thirty-ninth parallel triangulation toward Ukiah, Calif. The field expenses were paid for by the institution, while the instruments and transportation equipment were loaned to the institution by the bureau. The urgent need for the study of earth movements led the officials of the institution to undertake the work.

One hundred and seventy-seven miles of first-order leveling were run in southern California for the purpose of determining whether vertical movements had taken place prior to the running of a line of first-order leveling some years ago and to establish some new leveling that can be repeated after a number of years or after an earthquake has occurred along the line.

The Ukiah Observatory for observations concerning the variation of latitude was kept in operation throughout the year. The records of the observations were sent to Professor Kimura, who is having the computations and reductions of the data made under his direction.

COOPERATION WITH OTHER ORGANIZATIONS

The geodetic operations of the Coast and Geodetic Survey are services rendered the Government and people of this country. While a large part of the results are essential to the accurate charting of our waters, the larger part forms the basis for surveys and maps made by other organizations of the Government and for various engineering and industrial activities of our people. Cooperation can be best carried on by executing geodetic surveys where they are most urgently

needed and by making the results available to the users in printed form.

Requests from other Government agencies for first-order triangulation and leveling, by which latitudes, longitudes, and elevations are established for map control, have accumulated to such a point that the condition is most unfortunate.

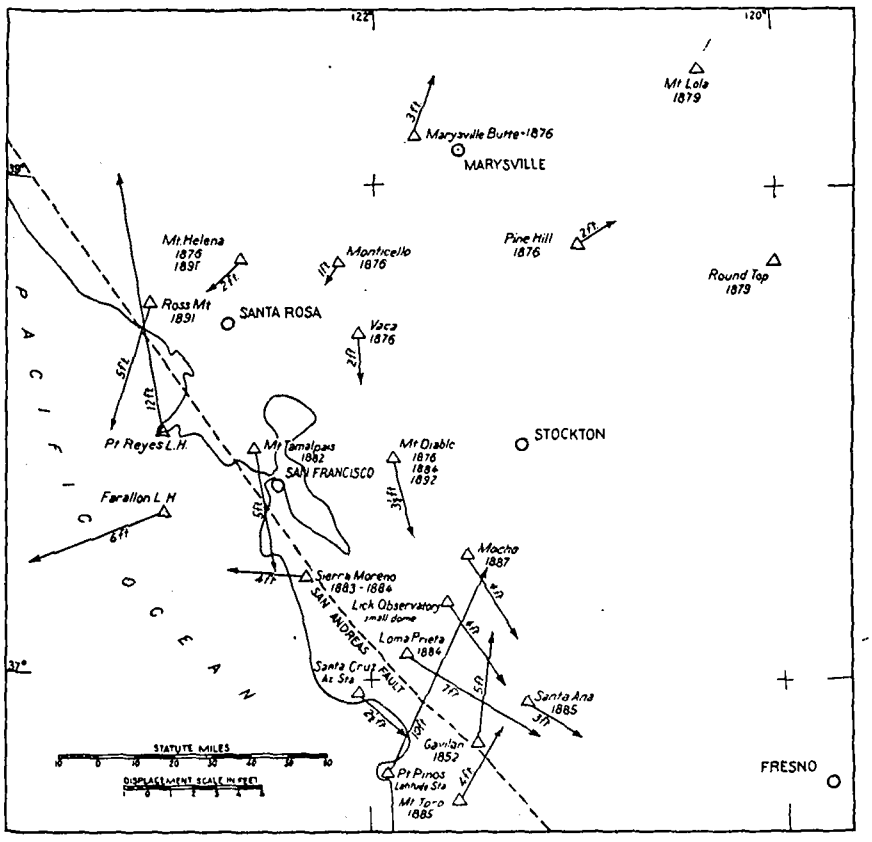


FIG. 4.—Changes in geographic position in California

These changes in geographic positions were brought out by reobserving an old scheme of triangulation in connection with earthquake investigations in California. The differences in geographic positions, as computed from the early observations and from the recent ones, are shown by arrows. The direction of each arrow indicates the direction of shift in geographic position during the interval between the two sets of observations. A part of the change in geographic positions is due to unavoidable accidental errors in making the angle observations, but most of the changes seem to indicate actual earth movements. In the computations it was assumed that no earth movements had occurred at stations Mount Lola and Round Top, on the Sierras. Those two stations form the base for the computation of the new geographic positions of all the other stations shown on the sketch.

Topographic surveying in some areas, even where the States pay half the expenses of the work, is delayed and stopped, because the engineers of the United States Geological Survey, charged with the topographic surveying of the country, refuse to do their work in any region ahead of the control surveys. Much of the topographic sur-

veying has in the past preceded the control, but that practice led to much confusion when maps extended from distant centers were finally joined.

The General Land Office was forced by necessity to carry on the division of the public lands ahead of the horizontal control. This unfortunate condition is being corrected so far as is practicable by a cooperative plan by which an engineer of the General Land Office accompanies each of the triangulation parties. Land corners which he recovers are tied into the triangulation, making it possible to give accurate latitudes and longitudes to the corners. Eventually a sufficient number of connections to the land corners will be made to coordinate the public land surveys with maps based on triangulation, but this can not be done now. The survey is cooperating with the Forest Service as far as possible, although only a small fraction of the work called for can be accomplished. That bureau needs accurate locations of the boundaries of national forest reservations, and these can be made only when the basis of the boundary surveys is triangulation. The work requested of the survey by the United States Geological Survey alone would require an expenditure several times the present annual appropriation.

Before planning each year's work officials of the survey and of the Geological Survey confer as to where the field operations should be carried on. Invariably the decision is based on the most urgent needs of the Government and the public.

Surveying and mapping the interior of the country is not very romantic, nor does it appear necessary to those who have not been fortunate enough as to have been trained in the using of accurate maps. We are not very far in time from the period when the land of this country was scarcely worth the cost of accurate surveys. When the West was a wide-open range, it made no difference to the banker or manufacturer of the financial and industrial centers. They cared not whether the cattle and sheep grazed on prairies or mountain sides.

They care now, and they are beginning to demand that the topographic mapping of the country be completed. These maps will show accurately all topographic features such as highways, railroads, bridges, cities, towns, and villages, forests, swamps, and the hills, ridges, and mountains. From the map the exact slope of the ground can be obtained, power and irrigation projects can be accurately planned, and, in fact, any one of many industrial activities can be executed with economy and with a degree of certainty as to costs and output from the completed project which are impossible without the data furnished by the topographic map.

The forest area in the Rocky Mountains, the cotton field of Texas, the mine in Montana, the drainage projects of Minnesota, the irrigation of California, the power projects of the Atlantic States, have something to do with our daily lives. We use their products and thus pay for their operation and the interest on the costs of their installation or development. Our money is invested in their bonds or capital stock. Should we not therefore be interested in where all these activities are, what they cost originally, their cost of upkeep and operation? We are, and we are also interested in the mapping of the area around such projects in order that they may be run more economically.

To the purchaser of State and county securities, an accurate map of the political unit involved is of importance, for it shows the character of the surface within the bounds of the unit, it gives accurately the size of the unit, and from the data made available may be obtained some idea of the future industrial condition of the area. It is really difficult to overexaggerate the importance and value of the topographic map in the activities of a nation.

It is the duty of the officials of a Government bureau, charged with certain duties, to set forth the true condition in their field to those higher in authority, and it is in carrying out this responsibility that the above analysis of the topographic mapping situation is made. This mapping is dependent on the horizontal and vertical control work of this bureau for its framework.

The engineering organizations of other countries than the United States are facing acute mapping problems. In the July (1925) number of the Journal of the Royal Geographic Society of London is a review of the 1924 Annual Report of the Director of Surveys of Sudan. The reviewer calls attention to the small amount of triangulation in the Sudan, and then said in part:

> Outside the above-mentioned areas the primary positions in the Sudan rest on the latitudes and longitudes obtained by the ordinary methods of field astronomy, most excellent and valuable as long as the country remains almost undeveloped, but liable to produce endless confusion as soon as questions of accurate boundaries arise. The Sudan Government, like so many others, demands and obtains maps sufficient for its present purposes without appreciating that, as a country develops, no amount of astronomical or other short cuts can replace a proper framework of triangulation, * * * and that to delay the preparation of this control until its need is apparent to the layman, involving as it does innumerable adjustments and complications and much resurvey, is no true economy.

The above is an accurate, forceful, and timely summary of the mapping situation in each of many countries.

While the surveys in the United States are in better shape than in the Sudan, yet as compared with other great countries which are highly developed industrially and commercially the United States is about the most backward of them all in so far as its surveys and maps are concerned. This situation should be speedily remedied. Surveying and mapping are now carried on by engineers having large projects to put through, but only such work is done as will meet their immediate needs, and the data secured are not available to the public. In the same general area many private surveys and maps are made, and the cost of each is included in the capital accounts of the companies performing them. The public pays for the work in increased price charged for the manufactured goods or services rendered. The necessity for most of the private surveying and mapping will be eliminated when the country is covered by what is known as the standard topographic map of the United States Geological Survey.

The Coast and Geodetic Survey and the Geodetic Survey of Canada continued their cooperation during the year in the establishment of an arc of first-order triangulation along the boundary from Lake Superior to Point Roberts on the west coast. It is expected this arc will be completed during the fiscal year 1926. The two surveys also continued their cooperative work on the arc of first-order triangulation which extends from Point Roberts northward along the coast

of British Columbia and through southeast Alaska to the head of Lynn Canal. This arc will make it possible to coordinate the United States and also the Canadian maps and charts of the vast areas involved in western and northwestern Canada and in southeast Alaska and in Alaska. These operations could only have been accomplished by combined effort. The results will be of great benefit to each of the countries.

The Bureau of Standards continued its active cooperation by standardizing base tapes and level rods, as has been customary since the organization of that bureau many years ago. Officials of the Bureau of Standards and of the division of geodesy of the Coast and Geodetic Survey have frequent conferences on geodetic instruments and methods for testing and standardizing them.

The United States Naval Observatory at Washington, D. C., has been of great assistance to field parties of the Coast and Geodetic Survey in the extension of the longitude net of this country and Alaska. Special time signals sent after midnight have been forwarded from the Naval Observatory through the Annapolis station for the use of the observers of the survey operating in Alaska and in the western part of the United States. During the summer months the regular 10 o'clock time signals from the Naval Observatory are too early for use in the far West. For the best results the time signals by radio and the local time observations in the field should be as near simultaneous as possible.

The Coast and Geodetic Survey has cooperated with the engineering department of the city of Rochester, N. Y., in the extension of the first-order horizontal control system over the area of the city. The city of Rochester is paying all expenses connected with the survey except the salaries of the commissioned officers assigned to the work in question. The instrumental equipment, record books, and other forms were furnished by the survey.

Close cooperation has been maintained between the officials of this survey and the Committee on Seismology of the Carnegie Institution of Washington. Conferences have been held by them from time to time looking toward the most effective methods of testing the stability of the earth in regions of seismic activity. The field work connected with the operation consists of first-order triangulation and leveling. During the year this work was done within the State of California.

PROGRESS IN MAGNETIC SURVEYS

In 1899 the Coast and Geodetic Survey started a magnetic survey of the United States, with the aim of establishing a well-marked magnetic station at each county seat in the United States where magnetic declinations, dip, and intensity had been carefully measured. This project was practically finished some years ago, though each year there remain about 100 unoccupied county seats, as subdivision of counties goes on just about as fast as the previous unoccupied county seats are reached.

As a result we know at each of these places the values of the magnetic elements on a given date. Unfortunately for the possibility of finishing a magnetic survey, the earth's magnetism is continually changing. This does not make the old survey useless if sufficient observations are made each year in various parts of the

United States, so that the entire area is covered by "repeat observations" every five years. Furthermore, the marked stations are subject to many accidents which render them useless for reoccupation, the chief cause being changes due to progress in development of towns and cities where the stations are placed. An important part in keeping the old surveys available is played by the five well-distributed magnetic observatories which are scattered throughout the United States and the regions under its jurisdiction where continuous observations are made.

For the United States, then, it may be said that the first survey has been practically completed, but that this survey will remain useful only by continued maintenance of observatories and occupation of repeat stations. There is urgent need for replacement of stations which have been rendered useless, and the hitherto unoccupied county seats should be occupied.

For Alaska the previous survey is inadequate. Observations have been made along the coast and along the Yukon River, but repeat observations are inadequate, and there are vast regions in the interior without a single useful observation. The needs of the Aleutian Islands are being met by a party engaged in general reconnaissance. The work of the observatory at Sitka is an important part of this program.

For the present the surveys of the Philippine Islands, Porto Rico, and the Hawaiian Islands are in good condition, as repeat observations have been made within two years, so that activity outside the United States can be concentrated on Alaska. In both the Hawaiian Islands and Porto Rico the work of the observatories makes it unnecessary to occupy repeat stations except at long intervals.

SEISMOLOGY TO DATE

Legislation authorizing seismological investigation by the Coast and Geodetic Survey placed a difficult task upon the bureau because of the inadequacy of previous work. The Weather Bureau had maintained instruments for a period of years and had collected useful reports of felt and visible effects of earthquakes. The Coast and Geodetic Survey had operated seismographs for about 20 years as a part of its magnetic work, inasmuch as earthquakes affect the recording of the earth's magnetism. No special effort had been made to study the earthquake records.

Various organizations such as universities throughout the country had operated seismographs, but with few exceptions the work was treated as a side issue.

The great need for earthquake studies for the United States as a whole could obviously be met only by a Government agency with continuous functioning, whose work would proceed without regard to the interest stirred up by earthquakes at any particular time. The application of precise methods was especially needed.

There is a great deal of work in seismology which only the Government can do. Accurate reports of visible and felt earthquake effects can be obtained only by a Government agency which has no preju-

Delaware Bay Tide &
Current Survey
p. 16
1925

(for dock location)

dice toward any special theory. This has been proved many times in this country.

Since the earthquake activity of the present calendar year has stirred up interest, there are numerous organizations taking up different phases of earthquake investigation, but all of this work is local and applied to local problems. Invariably it neglects certain areas. The important function of the Coast and Geodetic Survey in this work is to operate high-grade instruments at its magnetic observatories and do its full share in coordinating all the other activities.

The earthquake question has already become such a vital national issue that the National Board of Fire Underwriters is giving the matter most serious consideration.

WHAT THE COMPLETED DELAWARE BAY CURRENT AND TIDE SURVEY WILL MEAN TO SHIPPING

The detailed current conditions at different depths along the dock line and over other areas of a port are of vital importance to the safe berthing of large, deep-draft vessels in restricted harbors. It is obvious that considerable damage may result in the berthing of a large vessel when an unseen and unknown contrary current at a depth of 25 or 30 feet is running with considerable velocity in the opposite direction from that on the surface, which is the only one seen by the navigator. Such currents, however, do exist in many of our harbors, particularly in those into which large fresh-water rivers empty. This condition is due to difference in density between the river water and the tidal water entering from the ocean.

To bring out these local peculiarities for the guidance and safety of the mariner, a comprehensive current and tide survey of Delaware Bay and tributaries was made during the fiscal year 1925, and definite knowledge of the tidal and current phenomena for those waters is now available. The general information of the current conditions in this waterway obtained from this survey has been incorporated in the Current Tables, Atlantic Coast, for 1926, recently received from press. For the purely local and detailed information for the berthing of vessels many current stations unessential to a knowledge of the general current flow are required in a practical survey. A considerable number of such stations were occupied in the current survey of Delaware Bay. The data are now being computed, and after they have been correlated with various scattered observations made in previous years the results and conclusions will be issued for the mariner in a publication similar to those which now cover New York Harbor and San Francisco Harbor. From the data in this publication, together with the predictions of the general slack water which are issued each year in the current tables, advance information will be furnished the navigator of the conditions of the current flow at different depths at the time he expects to berth his vessel. It is difficult to estimate the value of such advance information.

Aside from the value of such a survey to the mariner, the by-products, obtained at no increased cost, are of invaluable aid to engineers in and outside the Federal Government engaged on marine work, sewage problems, and harbor improvement.

WHAT MODERN INSTRUMENTS HAVE MEANT TO THE BUREAU'S WORK

The great progress of this bureau as a whole is in no small measure due to the development of new and improved instruments, as they are the tools with which the basic work is performed. Failure to make use of the most modern and efficient equipment and materials would be analogous to a carpenter attempting to build a house with poor lumber and worn-out tools and would be immediately reflected in the efficiency of the bureau.

An accurate instrument in the hands of an unskilled operator may give inaccurate results, but a poor instrument can only give poor results regardless of how skillfully it is handled. The bureau obtains its instruments from the four quarters of the globe, and these are the products of the best minds trained for this type of work. Every effort is made to increase the accuracy and decrease the size and weight of the equipment. As an instance, many years ago our triangulation surveys were made with theodolites having an 18-inch circle and which weighed 68 pounds. To-day we have an instrument of much greater accuracy, having a circle but 9 inches in diameter and weighing less than 40 pounds. Many other instruments have been similarly redesigned.

Such increases in accuracy and diminution of weight result in a variety of economies. In the first place, fewer observations need be made at a given point, so that more stations can be occupied each season; secondly, decrease in size and weight facilitates the carrying of the instrument to the station and its subsequent installation—no mean item where all material must be back packed through dense forests and up steep mountains; and third, transportation charges have been greatly reduced.

The survey has always been on the alert to adopt new ideas and material. It was one of the first to make practical use of the Morse telegraph, and in later days has promptly taken up the radio for longitude determinations and for communication. The observer, 3,000 miles away on the Alaskan Peninsula, can now instantly obtain the exact time from the Annapolis radio station, instead of being compelled to rely upon a delicate chronometer which may have been carried many miles over rough country and whose failure would result in days or weeks of delay for repair or replacement or, in the more remote regions, might necessitate abandoning the work until another season.

Adoption of modern materials has resulted in lighter and more rugged instruments, less likely to be damaged or to become out of adjustment, and certain substances, such as invar, have permitted the construction of instruments of precision having an accuracy far beyond the possibilities of former times.

Instruments have now been designed, built, and perfected in the Coast Survey instrument shop which will measure the angular position of a point on the earth's surface within one second of arc, which means that a point 40 miles distant can be located within the space of 1 foot, which will determine the difference in elevation between two points 100 miles apart within three-fourths of an inch, and which will measure time to the one one-millionth part of a second.

The survey's work has increased manyfold during the past few decades and especially in the last few years. There are now about

three times as many field parties as there were 15 years ago. There has, however, been no increase in the instrument shop personnel to handle the increased work necessary to outfit these parties. As a result their efforts are now confined almost wholly to repairs, new instruments being obtained through commercial channels and usually at increased cost. Such instruments have also proven almost universally unsatisfactory, either lacking the necesssary accuracy or being of an inefficient design for the type of work to which we put them.

During the past year a number of new instruments were designed and built by the bureau, foremost of which was the sounding engraving machine. This machine will take the place of expensive handwork by engraving figures, legends, etc., on plates used for printing charts. Besides being of permanent economic benefit, it is interesting to note that the cost of designing and construction by the bureau's instrument division was over $4,500 less than a bid from an outside institution, another evidence of the wisdom of doing such work within the bureau.

Part I.—THE BUREAU'S GREATEST NEEDS

CHAPTER I

A MODERN BUILDING IS A MONEY SAVER

It has been mentioned in my previous annual reports that the present quarters of the survey consist of eight separate buildings, only one of which was intended for the use of the bureau. Even to one only slightly familiar with these unsymmetrical, poorly connected structures it must be evident that their replacement by an especially designed modern building is inevitable. Constant minor alterations must be made to the present quarters in order to keep the work of the survey from falling behind, and these alterations are often both costly and unsatisfactory. It would seem that the continuing of appropriations for the temporary upkeep of these buildings is a direct waste in view of their ultimate abandonment, and that it would be the part of wisdom to make the replacement mentioned as soon as possible.

A modern building will be a money saver in more than one way. It will permit the grouping of similar classes of work, so as to conserve the time now spent in transportation of material and travel of personnel between outlying units. An instance of this is found in the method now in use for delivering copper printing plates to the engravers. These plates, weighing 60 pounds each, are now carried by laborers up five flights of stairs from the storeroom to the engraving section. In a building carefully planned for the bureau this extra labor would be eliminated by the installation of an elevator and by placing these sections closer to their supplies.

In some of the rooms where accurate work is essential the lighting is poor, which tends to reduce the quality of the work and also to strain the eyes of valuable trained personnel. While the bureau is not behind in its work, it is not up to the standard which could be realized under better conditions. Chart production and the manufacture of instruments could be expedited through up-to-date methods which at present are not attainable because of the awkward arrangement of rooms and shops.

The elimination of distances between division and section offices would have the effect of reducing the messenger force, inasmuch as half of their time is consumed by long journeys to remote sections.

Sanitation would be improved, for it would be much easier to keep a new building clean than the timeworn ones now in use. The matter of appearance is also a big factor, for the existence of cheerful and attractive surroundings will unquestionably promote a better morale among the entire personnel, with an attendant increase of efficiency.

Every one of the elements I have enumerated will result in a lowering of unit cost by reason of the greater amount of work done. Close cooperation between the various divisions of the bureau is steadily becoming more difficult because of the initial handicap under which we work. In the last 10 years every effort possible has been put forth to make our buildings as durable and efficient as possible, but the limit has been reached, and unless relief is soon forthcoming the public's interest will most certainly suffer, and I therefore urge that early legislation be enacted which will permit the erection of a suitable headquarters for the survey.

CHAPTER II

THREE NEW TENDERS VITALLY NEEDED

The most urgent need for floating equipment on the Pacific coast is for three power tenders for the three largest surveying ships. These are splendid ships for the work in hand, but they can not develop their full potential efficiency unaided by smaller craft to act as tenders.

Much of the coast is rugged, broken, and strewn with offlying rocks and other submerged dangers. Hence, the surveyors must exercise the greatest possible care when approaching the coast and when entering and exploring the inlets and bays. But even with such vigilance it is too much to expect that they will not occasionally find a rock with the keel of their surveying ships if they have no means for exploration but these ships and their small boats. Hydrographic surveying is dangerous work at its best, as a surveying ship must go where others have no business. If, however, accompanied by a tender (a small, decked, power vessel of 50 or 60 tons displacement), the surveyor gets such advance information as will enable him to navigate his ship with reasonable safety.

Furthermore, the operating expenses of such tenders are small compared with the expenses of the ships, and there is much work on the coast which can not be done from open power boats such as are carried on the deck of surveying ships but can be done as well from these tenders as from the ships. It is a well-established fact that the smaller the craft that can operate continuously on a hydrographic survey the lower will be the cost of that survey. Hence, the only justification for employing large instead of small vessels on such work lies in the condition of the weather and sea that may be expected to prevail during the working season and the facilities, or lack of facilities, for maintenance of personnel and equipment. In other words, the necessary cost of making a hydrographic survey of any waters is governed by these factors; the actual cost depends largely upon how nearly the surveyor has selected a type and size of vessel that will just permit him to overcome these obstacles.

Conditions along the coast are favorable for the operation of such tenders, but, except in a few localities, the tenders could not be maintained efficiently apart from the larger ships because of the long distances to supply bases and the absence of local facilities for making repairs. The surveying ships provide for both of these needs.

At one time the bureau had three such tenders, but two of them, worn out and dangerous to operate, had to be scrapped, and the third has already outlived its usefulness and should right now follow the others. They proved to be good investments, having paid for themselves many times over in reduced cost of work. They should be replaced as early as possible. Until these three new tenders are available the unit cost of operating our large vessels will be larger than otherwise; also there will always be danger of some disaster coming to the larger ships until such tenders relieve them of the dangerous first exploration of the waters of unknown inlets and bays.

MODERN VESSELS NEEDED ON ATLANTIC COAST

Replacement of old, worn-out, and obsolete types of ships by modern vessels, such as has been accomplished on the Pacific coast and proven to be a great economy to the Government, has as yet been impossible on the Atlantic. Here we have two small wooden steam vessels which have deteriorated through age and hard service to such extent that they are uneconomical to repair and are unsafe in heavy weather. Every effort has been made to keep the maintenance cost as low as possible and to limit annual repairs to those items absolutely necessary to keep the vessels running, but even so the maintenance cost of these vessels is steadily rising, and without extensive repairs, which are unwise, they must soon be retired. It is considered that they do not warrant such an outlay, but they must be kept in service or the work on this coast seriously curtailed.

What the bureau needs to replace these two old vessels is one small able vessel of modern design and equipment, with ample power to take her anywhere along this coast. She need not be as large as the Pacific coast ships, because there are many more harbors and possible supply bases at no great distance from any part of the Atlantic and Gulf coasts. Hence, she can be of a size and type that can be operated more economically than the larger ships on the Pacific surveys. A modern steel vessel of about 600 tons displacement, designed especially for low operating cost when surveying, could perform the work of these two old vessels and at a considerable saving. Furthermore, this vessel could be employed on work which neither of these old vessels can undertake because of their lack of seaworthiness. Such work is being done now by one other vessel, the only one on this coast fit to undertake it, and the quantity of work needed to keep the charts up to date is beyond the capacity of one vessel.

CHAPTER III

HYDROGRAPHY AND TOPOGRAPHY

PRESSING DEMANDS FOR HYDROGRAPHIC WORK

The invention of different instruments for measuring depth by sound will have a great effect on modern navigation. That such instruments are practicable has been proven beyond the question of a doubt, and it is only a matter of time before these instruments will be in general use on all vessels of the world. Their general use in navigation necessitates the early increase in detailed hydrographic work to develop more closely the character of the bottom. As the aviator can tell his approximate location by the terrain over which he is flying, so characteristic submerged valleys, peaks, plateaus, etc., will serve as landmarks for the navigator. Increased information on charts became necessary to meet the requirements for safely navigating vessels of increased size, so additional hydrographic work has become necessary to meet the requirements of modern navigation made possible by the use of these instruments for measuring depth by sound in order that all the smaller characteristics, such as depressions, elevations, etc., of the bottom, may be accurately determined and located on the chart, instead of a generalization of the ocean bottom. It is not enough to know that there is a submerged peak or valley in the approximate area, but the accurate location of such a characteristic is essential, so the navigator, in using the chart, can determine accurately, when such a characteristic is discovered with the sounding apparatus, the course to be steered to reach his desired destination. The Coast Survey has three of its vessels equipped with these sonic instruments for measuring depth, and on the Pacific coast the position of the vessel is being determined by the use of subaqueous sound ranging which recently has been used successfully for a distance of 206 miles.

IMPORTANCE OF COMPLETING WIRE-DRAG SURVEYS ALONG THE ATLANTIC COAST, ESPECIALLY THE NEW ENGLAND COAST

The waters of the New England coast are strewn with large bowlder-type rocks which are extremely difficult to locate by ordinary hydrographic methods using the sounding lead or even by the sound method. The only sure way of determining that a certain water area is free from danger is to drag this area by use of a wire drag. The importance of this drag work along the New England coast and in the coral areas along the Florida coast has been mentioned repeatedly in my past reports, but with the limited moneys available for surveys it has been impossible during the last two years to continue work on this extremely important project. This method of wire-dragging the waters of New England is largely completed, and with adequate appropriations two seasons' work will complete the survey for all times and furnish charts that will assure the mariner of the safety of these waters.

ATLANTIC COAST

In order to meet the requirements of navigation, hydrography from the beach to the 100-fathom curve along the entire Atlantic coast should be executed at as early a date as practicable. This work has been in progress for a number of years and will be continued until completed. The entrances to the many bays and inlets along this coast from New York south to Florida are continually changing in depth as a result of storms, tides, etc., which necessitates constant revision work so the charts will represent existing conditions.

GULF COAST

The inshore area of almost the entire Gulf coast is changeable, and a great amount of important work in this area is necessary, as most of our present charts are based upon old surveys.

VIRGIN ISLANDS

During the entire fiscal year one of our vessels has been engaged upon the hydrographic survey of the Virgin Islands. Since these islands have been procured by the United States this service has made a complete topographic survey based upon new control, and the hydrographic survey now in progress will make available to the public a completed chart of this area meeting all modern requirements. As numerous coral shoals exist, most of the water area has been examined by the wire drag.

IMPORTANCE OF SURVEYS ON PACIFIC COAST

The work along the Pacific coast, so long neglected owing to inadequate vessel equipment, has been executed vigorously during the last two years. In 1918 the vast importance of surveying this area was brought out in the publication The Neglected Waters of the Pacific Coast. Survey of these waters is not only of importance for the safe navigation of vessels, but also, in extension of the work to the 1,000-fathom curve, all fishing banks will be thoroughly developed and accurately shown on charts.

SURVEYS IN ALASKA

No section of the United States is more dependent for its development upon correct charts than is the Territory of Alaska, as it is entirely dependent upon water-borne transportation. The early development of the Territory was retarded by the wrecking and stranding of many steamers, incurring much loss of life and property. The results of modern surveys have been reflected directly by the lack of serious accidents during the last few years and a material reduction in the insurance rates of vessels plying the Alaska waters.

WIRE-DRAG SURVEYS IN ALASKA

Alaska, like the New England coast, is strewn with rock of the pinnacle or spire type rising out of vast depths to near the surface of the water. The location of these rocks can be determined only by the

use of the wire drag. The ordinary hydrographic method can be compared to an aviator dropping a weight attached to a measuring line from his plane as he flies over a city. It can readily be realized that the chances are very small for the weight to hit the top of steeples or monuments, such as the Washington Monument, but if a horizontal wire were towed between two planes at a fixed distance below the planes it would be sure to hit these obstructions if they protruded above the wire. Already the main inside passages of southeastern Alaska have been wire-dragged and permanently made safe for life and property, but there are other important channels, bays, and harbors waiting to be dragged.

OUTSIDE COASTS OF SOUTHEASTERN ALASKA

One of the most important survey projects being carried on in the Territory is a survey of the shore to the 1,000-fathom curve on the outside coast of southeastern Alaska. This work has been continued northward from the boundary line and has made available many bays and harbors which were shown on previous charts from sketches made by very early explorers; also as a great deal of fishing is done in this area the location of all fishing banks by this work is extremely important and of commercial value.

CHARTING WESTERN ALASKA

The work of this service in western Alaska has the characteristics of exploring as well as surveying, as this country is little known and very inadequately charted. The surveys are necessary for the future development. The period during which survey operations can be carried on is short, but full advantage has been taken of each season.

HAWAIIAN ISLANDS

Considerable work has already been accomplished in the Hawaiian Islands, but much more is absolutely necessary so that our charts will meet commercial requirements. Some of the surveys along the main steamship routes need supplemental work. Many roadsteads and harbors need detailed surveys, and the trans-Pacific route lying north of numerous islands and shoals west of the Hawaiian group needs development.

REMAINING WORK IN PHILIPPINE ISLANDS WATERS

Most of the commercially important water areas of the Philippine Islands have been surveyed. The areas remaining unsurveyed are as follows:

1. All islands north of Luzon and the waters from Luzon to Bashi Channel; north shore of Luzon eastward of Buguey; coastal waters of the west coast northward of Currimao.
2. East coast of Luzon from Cape Engano to the latitude of the northern end of Polillo.
3. West coast of Palawan southward of Malampaya Sound. The sound is unsurveyed, but work there is now in progress.

4. Balabac Island and Strait and waters northeastward of Balabac as far north as Bugsuk Island.

5. Sulu Sea south of latitude 8° 17′ except along the coast of Mindanao, Basilan, and Jolo.

6. Sulu Archipelago southward from Jolo.

7. United States islands and waters adjacent to the coast of Borneo.

8. Coast of Mindanao from Sarangani Islands northward to Tabalan Head in Davao Gulf.

9. Several small surveys, resurveys, and additional developments, such as Fitzgerald Bank, north of Samar, and some small bays.

If the bureau has the funds to properly repair the *Pathfinder*, our largest vessel in the Far East, it is hoped the first survey in Philippine waters will be completed in 10 more years.

CHAPTER IV

GEODESY

DEMANDS FROM OTHER BUREAUS FOR CONTROL SURVEYS

For years the horizontal and vertical control data obtained from field operations of the Coast and Geodetic Survey have been used by a number of other Government organizations for the control of their surveying and mapping operations. The data furnished have been so valuable that frequent written and oral requests by officials of other bureaus have been made on the survey for data in areas not now covered by the control systems. As rapidly as possible the data are printed and made readily available to those wishing to use them. It seems unfortunate that triangulation and leveling which must ultimately be extended over the country should have to wait, while other Government organizations as well as the public are being handicapped by the lack of such data. The requests from the Geological Survey alone for leveling and triangulation data made during the past fiscal year would, if complied with, require more money than now appropriated for such work. In fact, the officials of the Geological Survey have announced that they can not undertake topographic surveying in areas which have not been covered by the first order horizontal and vertical control of the Coast and Geodetic Survey. A number of the States working with the Geological Survey on cooperative basis as far as funds are concerned have requested surveys in certain areas which have been refused by the Geological Survey because of lack of control data.

The Forest Service has made requests on the Coast and Geodetic Survey for the extension to their forest areas of the precise horizontal control system. This has not been possible on account of lack of funds. The data are used by the forest officials in the accurate location of the boundaries of the several forests and also for the control of their highway, grazing, and other maps. Without such control the maps of the forests will not fit into the general map system of the country which will eventually be extended over our whole area. The General Land Office, seeing the advantage of having geographic positions for land corners, has utilized all of the existing triangulation data in the construction of their State maps, and officials of that bureau have expressed the earnest hope that the horizontal control system of the Coast and Geodetic Survey may be completed in the public-land States in the near future.

It was inevitable that the United States should have laid out its public lands for settlement prior to the extension of first order triangulation over our area, but this condition should not be allowed in the laying out of the public lands of the Territory of Alaska. Just prior to his being sworn in as Governor of Alaska, Governor Parks, then in charge of the Alaska branch of the General Land Office, had a conference with officials of the Coast and Geodetic

Survey in which he pleaded for the rapid extension of a first order triangulation over those parts of Alaska which are likely to have settlers in the near future. If the triangulation is executed ahead of the laying out of land lines, one coordinate system can be used for all of Alaska. This will make the work of the General Land Office much easier and far less expensive, and the deeds to the property can be handled much easier and more accurately than if there is a separate system for each of the valleys or portions of valleys in Alaska.

Wherever geodetic data are available, they are used by the Bureau of Soil Surveys in connection with their studies of the character of the soil.

The United States Army, whenever it makes military surveys and maps, whether for defense purposes or purposes of construction, uses the triangulation and leveling data furnished by the survey. It is frequently the case that data requested can not be furnished because the field work has not been done in the area where the operations were to be executed.

The topographic branch of the Post Office Department makes use of the triangulation data of the Coast and Geodetic Survey which it finds of the greatest benefit in laying down accurately on the post-route maps the State and county boundaries and the post offices of the country. Officials of the topographic branch have frequently expressed the hope that the horizontal control system of the country should be completed at an early date.

Outside of the Government service there are innumerable calls for data by the officials of cities, States, counties, railroads, power companies, and individual surveyors and engineers for triangulation and leveling data. Their wants are met as far as it is practicable to do so, but many areas for which control data are desired have not yet been covered by the first order triangulation and leveling.

The coasts of continental United States are quite well cared for inasmuch as horizontal control data are concerned. This, however, does not apply to Alaska, for there are stretches of that coast along which triangulation has not yet been extended.

A study of the situation would seem to indicate that it would be a wise business policy for the Government to furnish the data needed in so many lines of activity by the bureaus of the Government, States, counties, cities, and by private corporations and individuals. The United States Government is not competing with any private concern in the extension of first order control systems over the country. The total expense of completing the first and second order control systems is only a few millions of dollars, and it is sure that this amount would be saved the people of the country every year if we had completed systems. Surely a 100 per cent dividend makes an attractive investment. The wisest economy is the one that brings the largest return, not the one that means minimum expenditure or minimum investment of capital.

CHAPTER V

TERRESTRIAL MAGNETISM AND SEISMOLOGY

NECESSITY OF ADDITIONAL COMPASS INFORMATION

Although the first magnetic survey of the United States is practically complete, there is a great deal of work which must be done each year. Repeat stations must be occupied at five-year intervals in all parts of the country, and this means practically continuous work by one party. Without this information, and that obtained at the magnetic observatories, it would be impossible to keep track of the changes in the earth's magnetism and to supply the demand for information for the mariners' charts; also to meet the needs of local surveyors and others by furnishing correct data would soon become impossible. It should be understood that the changes in the earth's magnetism are so irregular that it has not been found possible to predict them. It is only by continued observations at the magnetic observatories that it can be finally determined whether there is such a possibility. It is now known, by means of reports from local surveyors who have been sufficiently interested to take the trouble to investigate, that at least 500 of the magnetic stations are no longer useful but yet are needed. Many of these stations also have to be replaced to serve as repeat stations. A number of them are along the seacoast, where they should be kept available for mariners to use in connection with the compensation of their magnetic compasses aboard ship. The stations are also being used in connection with magnetic surveys to determine geological formations with which oil is associated. Recently a magnetic survey was made by this bureau in a part of Texas where most of the county seats were heretofore unoccupied. Within a year an expert found all of these stations useful in a search by magnetic methods for oil formations.

With reference to replacement of stations, the State of North Carolina was not satisfied with the partial replacement of stations which was the most to be expected from this bureau and provided funds so that all stations could be put in first-class condition, which work was completed during the last fiscal year. The replacement of stations is fairly complete in California, Florida, and Texas.

The absolutely essential work is, then, the maintenance of observatories and the occupation of repeat stations. Of almost equal importance is the replacement of stations and the occupation of county seats where no previous observations have been made. In the northwestern Mountain States observations should be made at other places in addition to the county seats, so that the distribution of stations shall be sufficiently dense.

IMPORTANT SEISMOLOGICAL WORK OF ECONOMIC VALUE TO THE COUNTRY

During the present year the amount of earthquake insurance taken out has been very large. Neither the companies nor the insured have any clear idea of a proper basis for such insurance. The only adequate basis for both parties is to have as definite knowledge of the conditions as possible. Otherwise the insurance is likely to be dropped after a short period of absence of earthquake activity and there is neither profit nor protection.

There are several things that the Government can do in this connection to benefit the people. One is to collect with great care all the information that is possible and publish it in the best form for all concerned. Even though earthquake prediction may not be possible, it is certain that various regions can be designated; as, for example, regions definitely subject to severe earthquakes, regions of moderate earthquake activity, and regions practically exempt from earthquakes. When this can be done, construction, fire protection, and other important problems can be worked out according to the conditons.

The outstanding consideration is that parts of the United States where former earthquakes did little harm are now subject to considerably larger quakes. The fast growth of cities and towns is also a factor. The Santa Barbara earthquake would have been of no significance in parts of eastern California, but since it occurred directly under a city it did serious damage. Even in Montana, where the country is comparatively thinly settled, the earthquake of June 27 was felt in a large number of towns, and railroad operation was interfered with to some extent.

The future of the study of earthquakes, both from the practical and scientific viewpoints, will be one of steady progress in solving this important problem if this bureau is provided with sufficient funds to enable it to carry out the important part of the Government program—a part which can be taken by no other organization, however effective in its operations.

62975—25†——3

CHAPTER VI

TIDES AND CURRENTS

NEED OF A CURRENT AND TIDE SURVEY IN BOSTON, PORTLAND, AND PORTSMOUTH HARBORS

With the increase in size and cost of the deep-draft vessels of modern commerce it has become more and more necessary for the mariner to have definite knowledge of the state of the tide and current in our harbors. In the docking of these large vessels an accurate knowledge of the state of the current is of considerable importance. Likewise important is the knowledge of the peculiar local conditions of the tide and current in various portions of these harbors.

To bring out this detailed knowledge, comprehensive tide and current surveys are absolutely necessary, and the cost of such surveys are unusually small in comparison with the return in dollars and cents to shipping and engineering operations in a harbor. Such surveys have recently been made in New York Harbor, San Francisco Bay, Delaware Bay, and at present one is being made in the inside passages of southeastern Alaska. For the coming year it is proposed to take up the comprehensive tide and current survey of the important harbors of Boston, Portland, and Portsmouth. These harbors are important not only commercially but also from the civil and military point of view, and it is to be noted, too, that while these surveys are made primarily for the purpose of navigation the information obtained is of very great value to the civil and military engineer engaged in harbor improvement and marine construction of all kinds.

In admiralty cases, especially in cases involving the Federal Government, this bureau is constantly being called on for certified statements of tide and current conditions at the time of collisions and strandings. With accurate tide and current surveys of a harbor these statements can be furnished for all time to come; without them the bureau can furnish nothing but an approximation. Without data upon which to base the predictions no definite information can be furnished.

In the matter of sewage disposal and sanitation in these centers of population the data from the current and tide surveys is of vital importance to the United States Public Health Service in its sanitary surveys for the determination of pollution of the waters of the harbors. In these matters this bureau is furnishing all available data along these lines. At present final data can be furnished for only three harbors—New York, Delaware Bay, and San Francisco Bay. It is planned to extend the surveys to every harbor of importance, so that the information may be at hand when needed; and it must be emphasized again that the data needed in these various lines of work are all derived from a single survey made primarily for navigational purposes.

CURRENT SURVEY, INSIDE PASSAGES OF ALASKA

Through the inside route from the Pacific Northwest to Alaska, used extensively by American shipping, there are many narrow passages in which the velocity of the current at strength is of danger to shipping, even to the larger vessels. It is therefore necessary to know the time of slack water in these passages when the vessel can go through safely. If the mariner can know in advance the time of slack water, he will save valuable time which is otherwise wasted awaiting the time of slack water on arriving at some unfavorable phase of current; and for smaller craft it is imperative that the mariner may be able to time his arrival so as not to enter at the strength of current and become dangerously involved. For the fiscal year 1926, therefore, a current survey is being made of these narrow passages on the inside route to Alaska.

The need for the current and tide survey of these narrow passes has been long felt by shipping, as it will supplement the very meager data at hand now and will permit very close predictions of the time of slack water to be made which will be incorporated in the current tables published annually in advance by this office.

This current survey is in line with the current surveys made of our principal waterways which are taken up in the order of importance from both the civil and military standpoint with special reference to the needs of the mariner. The first current survey was made in New York Harbor in 1923; this was followed in 1924 by a survey of San Francisco Bay, and in 1925 by a survey of Delaware Bay.

CHAPTER VII

CHARTS

THEIR VALUE

The Coast and Geodetic Survey holds constantly in mind the fact that its usefulness to the public it was created to serve is measured chiefly by the character of the nautical charts which are its principal product and by the extent to which those charts are placed within reach of the people requiring them. In spite of that constant vigilance it is well from time to time to pause in the daily routine for a comprehensive survey of the existing situation in order to make sure that no possible avenue of better service has been overlooked. Such a survey has just been completed, and the picture it reveals deserves more than the brief mention which can be given it here.

A chart, to be completely adequate to serve its purpose, must be constructed on correct cartographic principles, must be a simple, legible, and absolutely correct picture of the physiography of the area it portrays, and, finally, must be accessible to the people who have occasion to use it.

In the matter of cartographic practices the Coast and Geodetic Survey has continued to maintain the leadership which has characterized its entire history. As a single instance of that leadership it may be noted that in consequence of it the map-making bureaus of the Federal Government have recently undertaken a complete reconstruction of all United States and State maps produced for general public use, in order to eliminate certain objectionable details of mathematical cartography to be found in the present series. The constant, painstaking thought and study upon which that leadership is based has been applied to our own products, and in respect to such qualities in the published chart as mathematical framework, accuracy of compilation, legibility, simplicity of treatment of minute and intricate detail, and quality of drafting and of reproduction we have no occasion to fear a comparison of our product with that produced by any organization in this or any other country.

One of the most essential requirements of the chart is that it shall correctly portray conditions as they exist to-day, not as they were half a century ago. The zone included between the deeps of the ocean and the head of tidewater in its tributaries is undergoing a constant and rapid evolution as a result of the operation of natural forces and of the works of man in adapting these waters to his use. Assuming a chart initially correct, its subsequent value is measured in large degree by the extent to which it is kept corrected to show these constant changes.

This task, not only of producing the original chart but also of constantly revising it, is a stupendous one. The charts of the Coast and Geodetic Survey probably contain more than a hundred thousand miles of shore line. Although the bureau has been at work on the

task for a century, the first complete survey is not yet finished, even for some parts of the United States proper.

In another chapter I have told of the situation with respect to our field work, and the story need not be repeated here. The disparity between the magnitude of the task with which we are charged and the inadequacy of the facilities provided for its execution is so obvious to everyone who reads it that I need offer no apology for the situation in which we find ourselves in this respect.

We also recognize that other Federal, State, and private agencies are making surveys and otherwise collecting data which can be used in keeping our charts up to date, and that to the extent that these data can be obtained and prove accurate enough for our purpose it would be a reprehensible waste of money to send our own parties to duplicate the work. Therefore, lines of communication stretch between our office and every agency doing work of this character with which unremitting effort has enabled us to establish contact. So extensive is this contact that more than 50 per cent of the material utilized in chart correction originates with agencies outside this service.

The Army Engineers are the principal contributors of this material. They are constantly engaged in survey work in connection with their projects for river and harbor improvements, and the resulting data are furnished for our use. It is a pleasure to testify to the completeness and cordiality of this cooperation and to the fact that in two such closely related fields, where a duplication of work might readily exist, none can be found.

The Bureau of Lighthouses keeps us informed of all changes made in aids to navigation. State and city engineers, port commissions, and harbor boards usually are glad to furnish data in response to a specific request. This last form of cooperation is defective in that in order to secure new information from these sources we must first know that there is something definite to ask for. In an effort to overcome this difficulty we have recently requested the chamber of commerce or similar civic organization of each port on the Atlantic and Gulf coasts to cooperate with us by selecting a qualified person to notify us of any change which should be shown on the charts, thus enabling us to take such steps as may be necessary to secure precise data.

The importance and magnitude of this constant task of chart correction can not be overemphasized. It constitutes the largest single problem with which the bureau has to deal. As an indication of its magnitude, whereas in printing an edition of a topographic map it would be appropriate to run off a supply for several years, our charts must be reprinted with much greater frequency, and before each printing all new data received must be applied. Charts of our important ports along the Atlantic and Gulf coasts are reprinted from four to six times a year. The average frequency of printing of all charts issued by the bureau is twice per annum.

Even this frequency of printing does not tell the whole story. The very day the chart comes off the press we begin to apply by hand further corrections from data received since the printing was begun. These hand corrections are limited to most important items, such as changes in aids to navigation or new dangers discovered, but their aggregate is very large. During the fiscal year 1925, 1,071,152

corrections were made by hand to charts issued from this office, and each chart so issued carried the information that it was corrected up to the very day issued.

The result of this combined effort by the survey and its collaborators to keep the charts corrected is productive of an excellent product with respect to those areas in which man is effecting improvements. It does not and can not, however, keep us adequately informed of the changes which nature makes, with the result that our charts are seriously in arrears in some localities with respect to changes of the latter character. Fortunately, the changes of human origin are made along the pathways of the commerce which utilizes our charts, whereas the changes which nature is permitted to make without interference by man are in areas of minor navigational importance. Adequate care, therefore, on the whole, is taken of the areas of greatest importance.

No matter what the excellence of the chart, its practical value to the public depends to some extent on its availability. Mariners who have used the chart for years know how to obtain it, but there is growing up along the eastern seaboard a very extensive group which looks to the sea for recreation. These people need the chart quite as much as the professional mariner but to a surprising extent do not know that such a thing is in existence or how to obtain it.

For this reason there has been paticular need within the past few years of a limited advertisement of our product. We have endeavored to meet this need by creating agencies at additional ports, by displaying a copy of the local chart in the post office, yacht club, or other conspicuous place, by distributing posters for similar display, and by impressing upon our agents the necessity of informing the public that they have charts for sale.

As a specific instance of the results of these efforts some complaints reached us last winter that yachtsmen and motor boatmen along the New England coast, for some one of the reasons mentioned, had been unable to obtain charts. Last spring, therefore, we carried on an intensive campaign along this coast to insure that an adequate stock of charts was available at each agency and to educate the public as to how to obtain them.

The result amply justifies the effort. Our record of charts issued shows that during the 1925 motor-boating season the demand for charts of the coast between New York City and Eastport, Me., increased 27 per cent over that for the same period of the preceding year.

While I do not say that this selling campaign was the sole cause of this increase, I consider that it was undoubtedly the major factor. In this generalization I am being conservative to an extent which compels me to discount other statistics. During 1925 the issue of all charts published by the bureau increased 1½ per cent over that for 1924. By eliminating the 27 per cent increase for the New England States we find that the issue for all the remainder of our coasts was practically identical during the two years. I believe that had it not been for this "selling campaign" the similarity would have extended to include the former group of States. I must conclude, therefore, that this experimental step outside the usual limits of bureaucratic functioning not only resulted in better service to the

public but also was productive of a direct financial return to the Government of about eight times its cost.

COAST EROSION AND PROTECTION

I am becoming more impressed each year with the increasing need for a thorough and comprehensive study of the fundamental principles which form the basis of this important subject. The frequent requests which we receive from engineers and others seeking data and advice as to the best means of protecting some particular section of the shore and the conditions which we observe as we carry on our work along the coast compel two conclusions. The first is that the engineering practice of to-day, as applied to the prevention of erosions from improved sections of the coast, is not established on an adequate basis of observed and correlated physiographic fact which permits of such work being undertaken with the same assurance as to the outcome as attends other engineering projects. The second is that the transformation of these beaches from desolate, uninhabited expanses of dunes and underbrush to populous resorts or extensive summer colonies will certainly be followed by a demand for protection from the inroads of the ocean, and that the protection demanded will be of the assured type which the engineer can not now furnish.

That transformation has now been in progress for some years, and its rate is a constantly accelerating one. Already the continued encroachment of the sea upon many of the earlier developments has necessitated protective treatment. These treatments have been of every conceivable kind. As we pass from one improved section of beach to another we see structures so radically different in design that we must deduce great variations in the extent to which they accomplish their purpose. Where the structures have been in existence a sufficient length of time to enable the beaches to adapt themselves to their presence, this deduction is confirmed by the visual evidence of their effect upon the strand. Some structures are seen to be functioning admirably; others have served no useful purpose or actually have had a detrimental rather than a beneficial effect.

We must not attribute this unfortunate situation simply to a lack of engineering skill. The trouble lies deeper than that. It results in large part from the fact stated in my first conclusion, that the engineer needs a scientific foundation upon which to build, and that if that foundation is inadequate, as it is in this case, his superstructure will be in danger.

This scientific foundation can be established only by careful analysis of a mass of data applicable to the shores to be protected. We can profit only in the most general way by what some European country has accomplished. A structure which worked admirably on the New Jersey coast might fail entirely in Florida or Texas because of differences in the fundamental conditions. The entire coast should be studied, both as a unit and section by section, in order to determine the basic principles applicable to a coast of this character and the variations from those principles caused by local conditions in different localities.

These studies can not be begun too soon. Even if undertaken to-day, their results would be urgently needed before they were available. In fact, one State, New Jersey, has already been com-

pelled to undertake just such studies of its coast and virtually to assume jurisdiction over its protection as the best means of insuring the permanence of one of the State's most valuable assets.

This development of the New Jersey water front increased the assessed value of this narrow strip from $57,000,000 in 1899 to almost $400,000,000 in 1924. Comparable developments may be expected in other States and are already in progress in some of them. If those States will only have the foresight to profit by New Jersey's experience, they may save themselves the millions of dollars which municipalities and individual property owners of the latter Commonwealth lost through unproductive efforts to save their beaches during the years before the State finally assumed jurisdiction.

Although this problem transcends the boundaries of any State, it is not my thought to urge that its solution should be undertaken by the Federal Government. In its aggregate it consists of a collection of local problems, and from the engineering point of view I believe that it can be solved most economically by the cooperative effort of State engineering agencies already in existence.

I am not, therefore, recommending that the Coast and Geodetic Survey undertake these studies. In spite of that fact, two considerations justify reference to the subject in this report. The Coast and Geodetic Survey, by reason of its contact with every part of these coasts and of its constant dealing with problems of navigation closely related to the one under consideration, has somewhat fortuitously gained a comprehensive picture of the situation, whereas each of those most directly concerned sees only his own small fragment. It is only by seeing the problem in its entirety—by getting a sort of bird's-eye view of it—that we can see the way to its solution. This consideration alone justifies me in pointing out what I believe to be the path to an objective for which many are now groping.

In addition, however, the Coast and Geodetic Survey is one of a number of Federal bureaus which, in the course of their normal activities, have collected a great deal of data which would be of great value to any studies made. Any agency set up by the States should have the benefit of these data, and, if necessary, congressional authority to that end should be provided.

CHAPTER VIII

ACCOUNTING DIVISION

Funds for the maintenance and support of the bureau having been appropriated by Congress, the accounting division, through the disbursing agent, is charged with the duty of procuring these funds from the Treasury, making direct payment of all proper claims, or indirectly through chiefs of party in the field, and rendering an account of all such transactions to the General Accounting Office.

The work of the bureau naturally divides itself into two forces—office and field. All claims on account of the office are, after proper examination and administrative approval, immediately paid by the disbursing agent, while claims incident to field operations are paid locally by the chief of party who incurred the indebtedness. Due to the peculiar nature of the survey's field work on both land and sea (it being distributed to all sections of the United States proper, as well as its insular and outlying possessions), it is primarily essential that its organization be such as to expedite its fiscal obligations with the least delay, and to do so it has some 60 or 70 duly designated and bonded chiefs of party in immediate charge of operations acting as special disbursing officers. This system, so different from most other Government activities, secures immediate, direct, and highly satisfactory results in dealing with Government creditors, with no annoying and long delays.

For so meeting these expenses, requisitions for funds (based upon previously submitted and approved estimates for the project in hand) are made, approved by the director, and funds immediately deposited by the disbursing agent under special authority of law in the Treasury to the credit of the chief of party's checking account. This method of advance produces direct results and eliminates the many and innumerable customary delays.

The accounts for expenditures made by these chiefs of party from such advances of funds are submitted monthly to the disbursing agent, promptly examined, approved by the director for all proper items, and then credited to the account of the chief of party on account of advances by the disbursing agent. The expeditious and prompt examination of these accounts submitted and credit therefor given results in the carrying of minimum balances.

Without any doubt the directness of the entire system is productive of more economy in Government expenditures and far greater satisfaction on the part of those with whom the bureau has business transactions than could possibly be attained by the more usual and indirect methods generally employed.

CHAPTER IX

INSTRUMENT DIVISION

VITAL TO THE BUREAU'S PROGRESS AND EFFICIENCY

The Coast Survey has the reputation of being among the world's foremost organizations for the scientific surveying and mapping of the earth's surface, and its methods and instruments have been widely copied. If it is to maintain that reputation, it is essential that it be provided with the additional personnel necessary to design and develop new instruments which will embody the latest and best methods and materials of the instrument-making art.

Development work in our shops is almost wholly at a standstill, and its effect is being felt most keenly. Various improvements, which we know would result in more accurate and economical observations, can not be taken up.

More specifically, several instruments of major importance are to be designed and built as soon as means are available for so doing. For instance, the necessary data is at hand by which it is proposed to design a new theodolite for first-order triangulation. This instrument will be smaller, lighter, more easy to operate and transport, and the improved design will permit the making of the necessary observations at a station in less time with equal or greater accuracy than is now possible, and the net result being a saving in time, transportation and installation charges, and reduction of sources of error.

An improvement in the tide-predicting machine, which will make it self-recording so that tide tables can be compiled directly from the printed record made by the machine itself, will be an important change in our equipment. With the proposed change, the record will be automatically prepared for the printer and all these errors eliminated, as well as speeding up the work and doing away with the major portion of the checking.

This type of work, as well as the higher grade of instrument repairing, is much more cheaply and satisfactorily performed in the survey's own shops. It is difficult to get such work done by commercial concerns, as they are not familiar with our special problems nor with the uses to which the instruments are put. Development work in particular needs constant supervision, as improvements are frequently suggested as the instrument is being built. The survey can not provide constant factory inspection, nor can contractors be expected to make changes in work they have agreed to perform unless properly repaid.

Our experience has been that all such construction is done much less expensively by our own force. As an instance, a sounding engraving machine was recently designed and built in our own shop at a cost of $965.58 as compared with a price of $5,500 quoted us for a machine to do similar work. As regards repairing, it can not only be done more cheaply in first cost in our own shop, but losses due

to stoppage of field work while repairs are being made are cut down or eliminated. Such work can not be done under contract except where there is ample time.

The above instances illustrate the need for an adequate force to develop and repair our instrumental equipment. To perform our work efficiently and economically, we should design new apparatus in which is incorporated the best methods and materials and should perform our own repairs to insure high quality and low cost. An increased personnel is necessary to bring this about.

Part II.—THE WASHINGTON OFFICE

CHAPTER I

ACCOMPLISHMENTS OF THE WASHINGTON OFFICE DURING THE FISCAL YEAR

The organization of the Washington office of the bureau is presented by the organization chart opposite. The accomplishments during the fiscal year by divisions and sections follow.

CHIEF CLERK

The principal duties of this division are the care, custody, and upkeep of the buildings occupied by the bureau; the supervision of the expenditures for office expenses, including the purchase of supplies for the office, for chart-printing work, and to some extent for the field, the care of most of the original records of the field surveys, as well as the library of printed publications; the general supervision of all matters relating to the personnel work, including reports of leaves of absence; the custody and accounting for the receipts from the sale of charts, publications, etc.; and the direction of the engineer, electrician, watch, messenger, labor forces, and other employees engaged in the care, maintenance, and protection of the buildings occupied by the bureau in the District of Columbia.

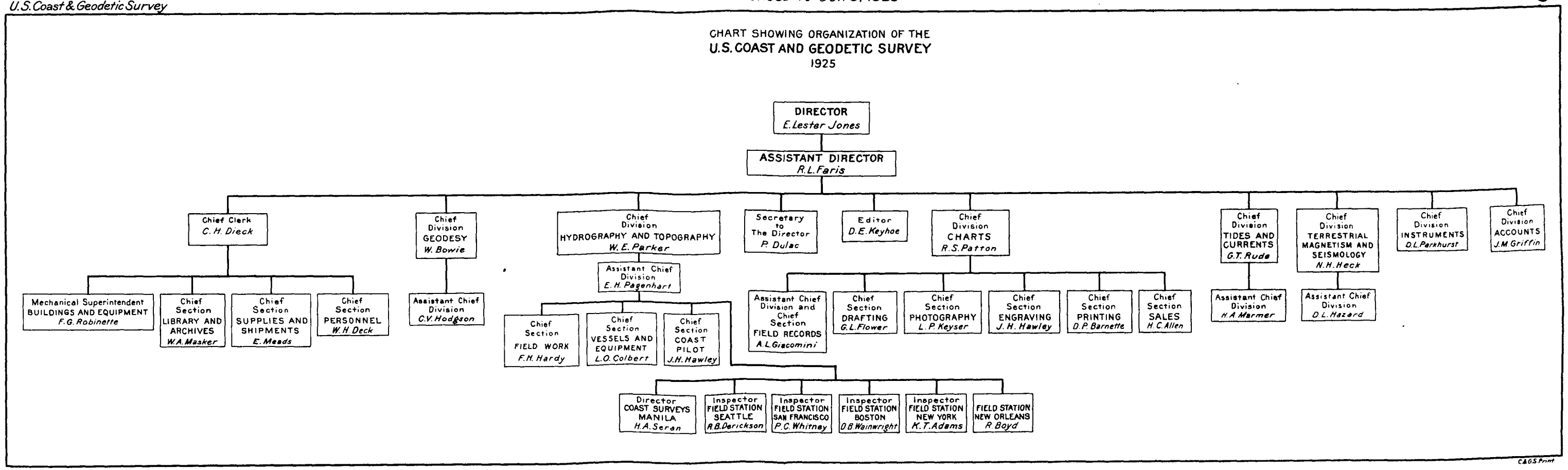
The more important accomplishments during the year have been a continuation of the thorough renovation of the buildings. While this work is still in progress, and it is a lengthy program with the small force of employees and funds available, the improvements and sanitation that are necessary, the present accomplishments in the way of painted rooms and modern fixtures offer a very pleasing contrast when compared with conditions and equipment previously existing. During the year the installation of all-metal storage racks in which to place the copper plates from which are printed navigation charts issued by the bureau and racks for one storage room was begun. The material for these racks is on hand. Due to shortage of labor force the complete installation will take considerable time. These racks are to replace old wooden racks that constitute a fire hazard, besides having become so weakened by necessary overloading, due to lack of other storage space, that they are collapsing under the load they are carrying.

During the year the installation of metal shelving and storage cases in the attic of the chart, instrument, and archives building was practically completed, so that records that are necessarily preserved but used somewhat infrequently are stored in space that is useless for any other purpose. The moving of these records to the attic has released over 900 square feet of desirable office space which is now being used for office purposes.

Cooperation with the division of terrestrial magnetism and seismology in stimulating interest of county surveyors and civil engineers

Effective Oct. 15, 1915
Revised to Oct. 5, 1925

CHART SHOWING ORGANIZATION OF THE
U.S. COAST AND GEODETIC SURVEY
1925



C&G.S. Print

in the inspection and maintenance of the magnetic stations already established by the bureau has continued throughout the year. So far reports have been made on approximately 50 per cent of the stations established by the bureau of which the present condition of preservation and usefulness was unknown. Illustration No. 10, opposite page 62, shows graphically what this cooperation has accomplished.

In the library and archives 140 hydrographic and 59 topographic sheets, each representing new surveys made by the bureau, were received. Other additions were blue prints (mostly showing surveys made by Army engineers), 2,217; maps, 1,611; charts, 2,171; field, office, and observatory records, 2,778; photographs (negatives and prints), 456; lantern slides, 203; books accessioned and catalogued, 702; books catalogued but not accessioned, 110. During the year the expenditures for general expenses of the bureau were $80,274.38.

The total number of permanent and temporary employees in the office and field forces, which includes commissioned officers and all employees appointed through civil-service certification, is: Office force, 225; field force, 192; total, 417. These figures do not include the persons engaged as rodmen, chainmen, heliotropers, and others in the field parties nor any enlisted men on vessels.

The statistics in regard to leave of absence during the calendar year are: Annual leave, 7,302 days; sick leave, 1,356 days; without-pay leave, 766; and accrued leave, 2,210 days. While the number of employees naturally varied on account of resignations and vacancies, calculated on the number actually in the service on June 30, 1925, as a basis of computation, the average annual leave taken during the year by each employee was approximately 17.51 days and sick leave 3.25.

The receipts from the sale of charts and nautical publications prepared by the bureau amounted to $49,850.02, and the funds realized from the sale of old property, work done, and miscellaneous sources amounted to $2,088.29.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

As the administrative office of a field organization this division, in addition to carrying on the routine duties necessary for the successful operation of its field units, has endeavored to maintain and to improve general efficiency. The close contact between office and field, highly essential in a widely scattered organization, is being strengthened by frequent inspections of field parties by administrative officers or, as occasion permits, by the temporary detail of chiefs of parties to office duty. Plans for the completion of the original surveys of the Philippine Islands have been prepared as a result of a field inspection. These plans outline the order in which the surveys will be executed with a view to an early completion of the entire project. In an effort to improve instrumental equipment, a policy undertaken in previous years, in conjunction with the instrument division, has been consistently followed during this year, so that at this time there has been sufficient increase and improvement of that equipment to permit prompt replacements of all instruments sent to the office for repairs. It is highly desirable that the ships, which are expensive field units, be continued upon field operations as much as possible, and an experiment is being tried whereby

these units will be relieved to a considerable extent of the final completion of field records and the time thus saved devoted to field production. Considerable time has been given to the special problems of the International Hydrographic Bureau.

A new publication, entitled "The Construction and Operation of the Wire Drag and Sweep," was prepared during the year. This publication will supersede the present description of the wire drag and will include changes in the standard wire drag and its operation that have been made and will contain description and details of the wire sweep and light wire drag recently developed by the bureau.

The compilation, proof reading, and indexing of Coast Pilot, Alaska, Part I, were completed and the volume was in the hands of the printer at the end of the year.

The compilations of Coast Pilot, Gulf Coast, and Inside Route Pilot, Key West to the Rio Grande, were started and were well in hand at the end of the year.

Supplements to the following coast pilots were prepared and issued: Atlantic Coast, Section A, St. Croix River to Cape Cod; Atlantic Coast, Section B, Cape Cod to Sandy Hook; Atlantic Coast, Section C, Sandy Hook to Cape Henry; Atlantic Coast, Section D, Cape Henry to Key West; Porto Rico and Virgin Islands; Pacific Coast, California, Washington, and Oregon; Alaska, Part II; Philippine Islands, Parts I and II.

The vessels of the bureau have been maintained in proper repair for carrying on field work. Extensive repair work has been done on the *Pathfinder* and the *Ranger*. The cost of this work on the former amounted to one-sixth and on the latter to one-fourth of the entire appropriation for repairs.

Improvements in surveying equipment have been effected by the installation of sonic devices for depth sounding on the *Lydonia* and *Pioneer;* by the design of a short wire drag which can be compactly stowed aboard ship for use in the examination of dangerous shoals and harbor channels; by the construction of a light submarine cable with high tensile strength for radio acoustic ranging; and by the assembly of a standard drag buoy capable of retaining a 20-pound pressure

Preliminary estimates have been made for the construction of new surveying vessels. Inspection has been made of Diesel driven and Diesel electric-driven tenders, and a study has been made of a more suitable type of engine for use on the small hydrographic launches. Specifications have been written for the purchase of special equipment needed on the vessels.

Alterations have been made on the *Natoma* to furnish additional accommodations.

A saving of funds has been effected through the transfer of material reported surplus by other Government bureaus. Radio equipment, an electric generator, and four launches have been obtained in this manner at a nominal cost.

DIVISION OF GEODESY

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

The computation and adjustment of the following pieces of triangulation:

1. South Carolina.
2. San Antonio to Del Rio, Tex.
3. Puget Sound.
4. Namakan Lake to Basswood Lake, Minn.
5. Scituate Harbor, Mass,
6. California earthquake.
7. Alaska.
8. Lake Okeechobee, Fla.
9. Maryland.
10. Hawaii.
11. El Reno, Okla., to Needles, Calif.
12. North Carolina.

In connection with the triangulation listed above, the computation of the following base lines:

1. Wall, S. Dak.
2. Holkham Bay, Alaska.
3. Dry Strait, Alaska.
4. Luck Point, Alaska.
5. Metlakatla, Alaska.
6. Namakan Lake, Minn.
7. Des Moines, Wash.
8. Conesus, N. Y.
9. Lakeville, N. Y.
10. Kimball, S. Dak.
11. Broad Pass, Alaska.

The computation of the following lines of first and second order traverse:

1. Warroad to Fort Frances, Minn.
2. Rainy Lake, Minn.
3. Salem to Chamberlain, S. Dak.
4. Myrtle Beach to Winyah Bay, S. C.
5. Charleston to Beaufort, S. C.
6. Duluth, Minn., to Green Bay, Wis.

The computations of the following lines of first-order leveling:

1. Riverside to Ontario, Calif.
2. Santa Ana to Barstow, Calif.
3. Burbank to Fernando, Calif.
4. Perth Amboy to Atlantic City, N. J.
5. Pleasantville to Cape May, N. J.
6. Delair, N. J., to Philadelphia, Pa.
7. Vicinity of San Francisco Bay.

The computation of the following astronomic work:

1. Azimuths: 73 stations in the western part of the country and in South Carolina, Alaska, and Canada.
2. Latitude: 23 stations in Alaska, Colorado, Kansas, New Mexico, Texas, and Wisconsin.
3. Longitude: 23 stations in Alaska, California, Texas, Wisconsin, and scattering.
4. Computation of variation of pole at 63 Laplace stations.
5. Computation of true geodetic azimuth at 115 Laplace stations.

The computation of the reduction for topography and isostatic compensation at 3 stations in the United States and at 31 sea stations determined on a submarine by Doctor Meinesz, of the Netherlands, on a trip from Holland to Java through the Suez Canal. Also the recomputation of the isostatic anomalies at all stations in the United States using Bowie formula No. 2 and a depth of compensation of 96 kilometers.

Investigations were carried on during the year in the following subjects:

1. Interior of the earth.
2. California earthquake.
3. Variation of latitude.
4. Least squares adjustment of triangulation.

DIVISION OF CHARTS

During the fiscal year ending June 30, 1925, the division of charts continued its task of furnishing to other branches of the Government and to the maritime public correct and up-to-date charts, on which were incorporated the data contained in the mass of information reaching this office in a constant stream from sources both within and without the service. It also made gratifying progress in the production of new charts resulting from the recent completion of surveys by our field parties or from the policy of replacing certain existing charts with others conforming to our present-day standards.

The issue of charts shows a gratifying increase. The total issue and condemnation for 1925 was 230,535 as compared with 221,543 for 1924. The number of charts actually sold to the public was 102,011 in 1925 as against 94,699 in 1924. The issue of charts is the principal single factor with which to measure the bureau's service to the public, and the increases noted are a matter of satisfaction to the survey.

As explained in previous reports, however, the number of charts issued does not afford an accurate measure of the task incident to their production. The true measure is obtained by consideration of the amount of data received in the office to be used in the construction or correction of charts. In this respect also the year has been a gratifying one. A study of the detailed statistics indicates that 1925 has been the biggest and most productive year in the history of the division. New information received, in spite of the increase in its amount and with no increase in personnel to handle it, has been given to the public more promptly than at any other time of which I have knowledge.

The program adopted for 1925 was a tentative one, subject to modification as future conditions might warrant. Sixteen new charts were contemplated. Of these, four were laid aside indefinitely to await the receipt of additional field data. Eleven were delivered during the year, and one, delayed to a less extent to await field data, was ready for printing on July 6. One additional chart not on the program was completed during the year and seven existing charts were reconstructed.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

MAGNETIC WORK

Special emphasis was placed during the year on furnishing information and improving instruments and conditions at the observatories as well as activity in preparing publications. The information service to local surveyors was continued upon the same basis as heretofore. The bureau is now in touch with 2,300 local surveyors who use magnetic methods and has obtained information in regard to the usefulness to the local surveyor of about 43 per cent of its magnetic stations.

Special magnetic information has been furnished for the manuals of the Army used in surveying. Information in regard to magnetic storms has been furnished to the American Telephone & Telegraph Co. and to the Carnegie Institution of Washington, which is making a special study of this subject. Magnetic declination tables have

been furnished for the World Almanac. An isogonic map of New England was prepared for a special publication by Doctor Keith, of the Geological Survey.

The method of preparation of publications has become fully standardized and permits of a very large part of the work being done by junior mathematicians or computers. Much of the effect of this method has been lost, however, by the fact that these positions have only been filled temporarily, and the progress in the reduction of observatory results is not satisfactory. The situation can not be remedied without an increase in personnel.

Special attention has been given to the improvement and replacement of observatory instruments. The absolute instruments are to be improved as rapidly as conditions permit. The instruments removed from the Porto Rico observatory are being put in condition before installation in the new observatory. The experimental work at Cheltenham is paving the way to further improvements which will be adopted. The effective cooperation of the instrument division in this matter has already greatly improved the condition of the instruments. Within a few years the equipment will be complete, and that with a very small expenditure of funds.

The new buildings of the Porto Rico observatory were designed in Washington, under the immediate supervision of the division, by the officer in charge of the construction. The design is based on that of other observatories of this bureau and of the Carnegie Institution of Washington, which cooperated by furnishing blue prints.

Some study has been given to the difficulties at the Honolulu observatory, which later may require a change of site.

Members of the division have taken part in the work of the American Geophysical Union and the International Geodetic and Geophysical Union. Some hold positions in these organizations. Contact with the work of other institutions and countries is particularly useful, as all of the work of the division is related to the study of the earth as a whole. Close cooperation has been maintained with the department of terrestrial magnetism of the Carnegie Institution of Washington.

The need for more study of the observatory results, with a view to obtaining full return from the expenditures made in obtaining them, is being borne in mind. It is hoped to carry on this study each year. An important preliminary work was the rewriting of the publication, The Earth's Magnetism, which appraises the present situation and affords an excellent basis for further progress.

The following publications were issued during the year:

Magnetic Declination in Florida. (This is the second of the series of publications of magnetic data by States.)

Magnetic Declination in North Carolina. (Third of the series.)

Observatory Results for all the observatories for 1921–22. (Permanent record of changes in the earth's magnetism.)

Results of Observations made by the bureau in 1923–24. (This makes available in convenient form the results of the year's work.)

Magnetic Surveys. (A small publication for the use of those interested in the subject.)

Terrestrial Magnetism in the United States (published by The Military Engineer).

The following publication was in the hands of the printer but not issued at the close of the fiscal year:

The Earth's Magnetism, to supersede Principal Facts of the Earth's Magnetism, first issued in 1902 and reprinted from time to time. This is a history and appraisal of the present state of our knowledge of the earth's magnetism.

The following publication was in preparation and nearly ready for the printer:

Magnetic Declination in Missouri, 1925.

Work was done on publications for Texas and California.

The cooperation with the chief clerk's office in a campaign to get in touch with local surveyors was extended to Louisiana, Kentucky, Tennessee, West Virginia, Virginia, Maryland, Delaware, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Michigan, Kansas, Wisconsin, and Nevada. The contact with local users of magnetic data is now on a satisfactory basis in 30 States, and another year should complete the first campaign. It may be considered that the work has been completed in six States.

PERSONNEL.—The need for an additional mathematician, two computers, and one clerk to carry on the magnetic work is extremely urgent. The work is suffering at the present time from lack of personnel, and increased demand for information is rapidly making the situation very serious.

SEISMOLOGY

In previous years all earthquake records from the magnetic observatories were analyzed and the phases furnished to the Weather Bureau for publication. The passage of legislation making seismology a definite part of the work of this bureau resulted in immediate expansion of our program in order to meet the demands of the public and insure that the earthquake data accumulated after the discontinuance of this work by the Weather Bureau should not be lost. Special effort has been given to the study of the observatory records, to accumulation of reports of visible and felt effects of earthquakes, to the elaboration of a system for accomplishing this latter result, and to preparing results for publication. The first publication, which was for the first quarter of 1925, was nearly ready for the printer at the close of the fiscal year.

A great deal of time was required to meet the demands of the public for information in regard to the St. Lawrence Valley earthquake of February 28 and the Montana and Santa Barbara earthquakes near the end of June. Starting a proper program for this work included investigation of earthquake literature and consultation with various organizations. The aim is to coordinate the program of existing work for the benefit of seismology as a whole and to secure proper cooperation of all organizations interested in this subject.

There is a very strong demand for information of immediate practical value, such as earthquake maps, which can be made possible only through an increase in personnel. The bureau publication, Earthquake Investigation in the United States, sets forth the aims of the survey in taking up seismological work.

DIVISION OF TIDES AND CURRENTS

The work of the division of tides and currents is comprised under the following heads: Field work, reductions, datum planes, and predictions. The routine work of all sections is now practically up to date.

Tidal observations were made at nine primary stations on the Atlantic coast, four on the Gulf coast, six on the Pacific coast, three in Alaska, and one at Honolulu, Hawaii. The tidal marigrams as they are received at this office are tabulated as to hourly readings and high and low waters for the definition of all tidal planes. As a by-product of the tide work at these stations, these tabulations furnish a long-period sea-level datum for the use of engineers locally and for initial or "tie-in" points for the net of precise levels being extended to all parts of the country.

The predictions of the currents for the 1926 Pacific Coast Current Tables were made in the fiscal year 1925; all other predictions, both tide and current, for the 1926 tables were made the previous fiscal year. The predictions for all tide tables for the calendar year 1927 were begun November 1, 1924, and completed March 26, 1925. The predictions for all current tables for the calendar year 1927 were begun April 7, 1925, and completed June 30, 1925.

The predictions and submittal to printer of all tide and current table manuscripts have been advanced by degrees each year for the past five years with the intention of having all tables for any calendar year ready for issue by July 1 of the preceding calendar year. This schedule has now been attained for the first time, all tables for the year 1926 having been received from the printer by June 30, 1925. This schedule will be continued without difficulty in the future.

The following table, showing the number of copies of the tide tables issued each fiscal year for the 10 years 1915–1924, is indicative of the usefulness of these publications:

	United States and foreign ports tide tables	Atlantic coast tide tables	Pacific coast tide tables	Total
Tide tables for fiscal year—				
1915	2,425	2,050	10,775	15,250
1916	741	2,545	10,227	13,513
1917	1,598	3,852	13,346	18,696
1918	3,334	3,970	14,492	21,796
1919	4,217	4,398	14,768	23,383
1920	3,469	5,357	16,061	24,887
1921	3,577	5,678	14,957	24,212
1922	3,067	5,704	14,902	23,673
1923	2,479	5,440	15,054	22,973
1924	2,509	7,097	15,234	24,840

These statistics, however, do not indicate the full value of the tide predictions, for many thousands of privately printed tide tables, copied directly from our tide tables, are issued all over the country, appearing as separate tables for various localities and in almanacs and calendars, all reaching the public in useful form. The public also receives the benefit of these predictions through the medium of

local newspapers, a great many of which publish tidal data in their columns daily.

The following table shows the number of copies of the current tables issued for the fiscal years 1923 and 1924:

	Atlantic coast current tables	Pacific coast current tables	Total
Current tables for fiscal year—			
1923 [1]	2,029	1,786	3,815
1924	3,124	2,002	5,126

[1] Prior to 1923 information on currents was contained in the tide-table publications.

Heretofore the Current Tables issued by this bureau have given the mariner the times of slack water only and the mean current velocity. Due to the diurnal inequality in the currents on the Pacific coast, it is also of value to the mariner to know the velocity of each flood and ebb current at strength and the time of such maximum strength, since the velocity at strength on one flood or ebb current may differ materially from that of the next. During the past fiscal year constants have been prepared for the tide-predicting machine from all available data, and the additional information relative to the predicted time and velocity at strength of each flood and ebb current at the principal current stations for every day in the year have been included in the Current Tables, Pacific Coast, 1926.

Observations of currents were made at three light vessels on the Atlantic coast and one on the Pacific coast. Analyses of these observations have been made in such a way as to correlate wind and current for the formulation of general rules on coastal currents for the aid of the mariner. The first results of this current study appeared in the separate current tables for the calendar year 1923. These tables are being enlarged in scope each year.

Special Publication No. 98, A Manual of the Harmonic Analysis and Prediction of Tides, was received from the printer on August 12, 1924. This work is a manual of instruction for the tidal mathematician and comprises 410 octavo pages, consisting of 170 pages of text, 143 pages of tables, 97 pages of harmonic constants for the world, and 34 illustrations.

Special Publication No. 111, Tides and Currents in New York Harbor, was received from the printer March 9, 1925. This publication comprises 170 pages and 52 illustrations and constitutes the discussion and interpretation of the results from the current and tide survey made in 1923 in New York Harbor, correlated with scattered observations made at various times in the past.

During the year the manuscript of a special publication, Portable Automatic Tide Gauge, was prepared. The page proof has been received from the printer, and delivery is expected early in the next fiscal year. It is the purpose of this publication to give a description of the portable gauge recently developed by this bureau and to furnish the field engineers of the survey detailed instructions for its installation and operation.

The manuscript of a publication on the currents and tides of San Francisco Harbor was prepared during the year, and the galley proof was received from the printer June 2, 1925. This publication

constitutes the discussion and results from the current and tide survey of San Francisco Harbor made in the fiscal year 1924, correlated with scattered observations made at various times in the past.

The manuscript of a publication on tidal bench marks in the District of Columbia has been in preparation at intervals during the year. It is expected to be ready for press early in the next fiscal year.

The manuscript of a publication, Coastal Currents Along the Pacific Coast of the United States, was being prepared during the past fiscal year and will be ready for press early in the next fiscal year.

The manuscript of a publication, Datum Planes and Their Determinations, was partly prepared. It will be completed and will be ready for press near the end of the year.

The observations obtained from the current and tide survey of Delaware Bay have been partly analyzed. These analyses will be completed during the next year, the results discussed and interpreted, and the manuscript of a publication prepared similar to the ones for New York Harbor and for San Francisco Bay. In addition, the improvements to our present current predictions made possible by this survey are being incorporated in the present current tables for the use of the mariner.

The cooperative arrangement with the British Admiralty in connection with the exchange of tidal predictions has been continued and extended. This cooperation began with the exchange of predictions for six American ports for the predictions of six British ports. It has since been extended to the exchange of 16 American predictions for 16 British predictions. Since this constitutes about 20 per cent of our tide predictions, the economy effected for each country is obvious.

The Canadian Tidal and Current Survey has cooperated with the Coast and Geodetic Survey with considerable advantage to this bureau. At our request the Canadian survey recently maintained an automatic tide gauge at each end of Seymour Narrows, British Columbia, for a period of three months. The observations from these two stations were furnished the Coast Survey, analyzed at the Washington office, and the constants from this analysis used on the tide-predicting machine for the prediction of the times of slack water. The times and velocities of the current at strength in this important waterway are used by American shipping on the Seattle-Alaskan run. The predictions based on this observational data will appear for the first time in the Current Tables, Pacific Coast, for the calendar year 1926.

During the year a current diagram larger than heretofore published in the current tables and printed on heavy chart paper was issued for Nantucket and Vineyard Sounds. This is the first of a proposed series covering the inland waters of the United States.

DIVISION OF ACCOUNTS

From July 1, 1924, to June 30, 1925, the actual disbursements on account of appropriations for the Coast and Geodetic Survey amounted to $2,133,718.02. It must be understood, however, that this does not represent the actual expenses of the survey for the fiscal year 1925, but only the actual disbursements. In a separate report to Congress will be found an itemized statement showing disburse-

ments from each appropriation and subitems thereof with all detailed information as to the character of the expenditure.

These expenditures include the accounts of all chiefs of parties in the field located throughout the United States, Alaska, Hawaii, Porto Rico, the Philippine Islands, and the Virgin Islands. From 30 to 50 chiefs of parties were engaged on field duty at various times during the year, being financed through advances made to them by this division, and accounts arising under such advances were submitted to and through this division to the Treasury Department. The total appropriations for the fiscal year 1925 were $2,327,650.

INSTRUMENT DIVISION

The function of the instrument division is to provide the equipment used by the field parties of the survey, which involves the purchase and inspection of standard and special makes of various kinds of surveying and navigating instruments, numerous articles of general property, and the issuance of such instruments and equipment to the parties. The instrument division also designs special instruments, apparatus, and improvements, compiles specifications, makes drawings and repairs, and adjusts instruments returned after use in the field. It also maintains the property-record system which records the transference of equipment to and between the field parties.

During the past year a number of new instruments and improvements were designed and built, as follows:

Sounding Engraving Machine.—A machine was designed and built in the instrument division for the purpose of engraving the figures and legends indicating sounding depths on copper electrotype plates used for printing charts. This machine is also adapted to perform the same work on photographic negatives used in the lithographic process of printing. The machine is much more compact and convenient to handle than the type commonly used for this purpose and is a great deal less expensive, the total cost for its design and construction being $965.58 as compared with the price of $5,500 quoted this bureau for a machine of the usual type, a net saving of $4,534.42. The ability of this machine to engrave on a photographic negative is a great advantage, doing away with much tedious handwork and facilitating the altering of existing lithographic plates.

Portable Automatic Tide Gauge.—Several improvements were made in this instrument during the year, making it easier to adjust; easy to install new clocks, without sending the gauge back to the office, and an important change was made in the arrangement of the counterpoise spring which eliminates rusting and accidental disengagement from the shaft. The changes in design eliminated several parts, thus making the gauge simpler. A pen was used as a stylus instead of a pencil, giving a clearer and more permanent trace of the tidal curve.

Base Tape Thermometers.—These accurate and expensive thermometers are used in a small brass holder, the design of which has been the cause of frequent breakage of the bulb. The holder was redesigned, so that this fault was eliminated.

Plane Table.—The telemeter rods used with the plane-table outfit require a metal brace which is attached by two thumbscrews. Considerable annoyance and delay has been experienced, as these

braces were not interchangeable, and the design has been altered accordingly to remedy this defect. The thumbscrews whereby the board is fastened to the tripod are frequently lost. They have been made interchangeable, so that replacements can be furnished without delay.

WIRE-DRAG BUOY SPACER.—This instrument has been redesigned, so that the two sizes, large and small, are combined into one, thus reducing the quantity to be carried in stock.

GEODETIC LEVEL ROD.—The machine for graduating these rods, which was begun last year, was completed, and operates satisfactorily. This machine applies these graduations in such a manner that the matter of accurate location, width of mark, and sharpness of line is inherent in the machine and is not dependent to any marked degree on the personal element. Two rods were painted for the Geological Survey during the year, using this apparatus.

POCKET TAPES OF MONEL METAL.—There has always been a large loss in the ordinary steel pocket tapes, used by the survey for its rougher measurement, as these tapes rust easily and are also brittle and easily broken, if kinked. A number of similar tapes were procured of Monel metal, which is a material not readily corroded in ordinary use and is also tough and pliable. These tapes, while slightly more expensive in first cost than the steel, are expected to be a real economy by virtue of long life.

NEW CHARTS ISSUED DURING THE YEAR

8148. Central Part of Dall Island, southeast Alaska. July, 1924. Scale 1: 40,000; dimensions, 31 by 36 inches. This is one of the 1: 40,000-scale series of charts covering the western coast of Prince of Wales Island and the islands to the westward. The soundings are in fathoms at mean lower low water.

1255. Estero Bay to Lemon Bay, Fla. September, 1924. Scale 1: 80,000; dimensions, 32 by 42 inches. This is one of the new series of 1 : 80,000 scale charts on the Mercator projection. It is oriented with the meridian, and the soundings are expressed in feet instead of feet and fathoms, as on the old polyconic charts Nos. 174 and 175, which it supersedes.

8146. Southern Part of Dall Island, southeast Alaska. September, 1924. Scale, 1: 40,000; dimensions, 28 by 38 inches. This is one of the series of 1: 40,000 scale charts covering the waters on the west coast of Prince of Wales Island and of the islands off the west coast. It is constructed on the Mercator projection, and the depths are charted in fathoms at mean lower low water.

4113. Hana Bay, Maui, Hawaiian Islands. December, 1924. Scale 1:5,000 dimensions, 17 by 17 inches. This chart is published to meet the demand of the shipping interests of the port of Hana. It is based on surveys of 1924 and Territorial surveys of 1923.

4112. Hanamaulu Bay, Kauai, Hawaii. January, 1925. Scale, 1:2,500; dimensions, 21 by 27 inches. This chart is published to meet the urgent demand for a large-scale chart of this bay on which the harbor of Akukini is located. It was constructed from surveys made by local interests.

467. Sibuguey Bay, Mindanao, P. I. Scale, 1:100,000. Dimensions, 30 by 40 inches. The area covered by this chart is now shown on chart No. 4605, scale, 1:200,000 recently published.

1271. Mississippi River, Buras to New Orleans, La. January, 1925. Scale, 1:80, 000; dimensions, 30 by 37 inches. This is one of the new series of coast charts on a scale of 1:80,000. It is oriented with the meridian and is constructed on the Mercator projection from surveys by the Mississippi River Commission to 1924 and other sources, with control and earlier surveys by the United States Coast and Geodetic Survey. The soundings are in feet and refer to mean low Gulf level. This chart supersedes chart 195 of the old series.

1272. Mississippi River Delta. February, 1925. Scale, 1:80,000; dimensions 33 by 42 inches. This is one of the new series of 1:80,000 scale coast charts on the Mercator projection and replaces chart 194 of the old series. The topography of the delta was reduced from aerial surveys. The gulf soundings are from recent surveys by the United States Coast and Geodetic Survey and in the passes and river from late surveys by the United States Army engineers and by the Mississippi River Commission. The soundings are given in feet and refer to the plane of mean low Gulf level.

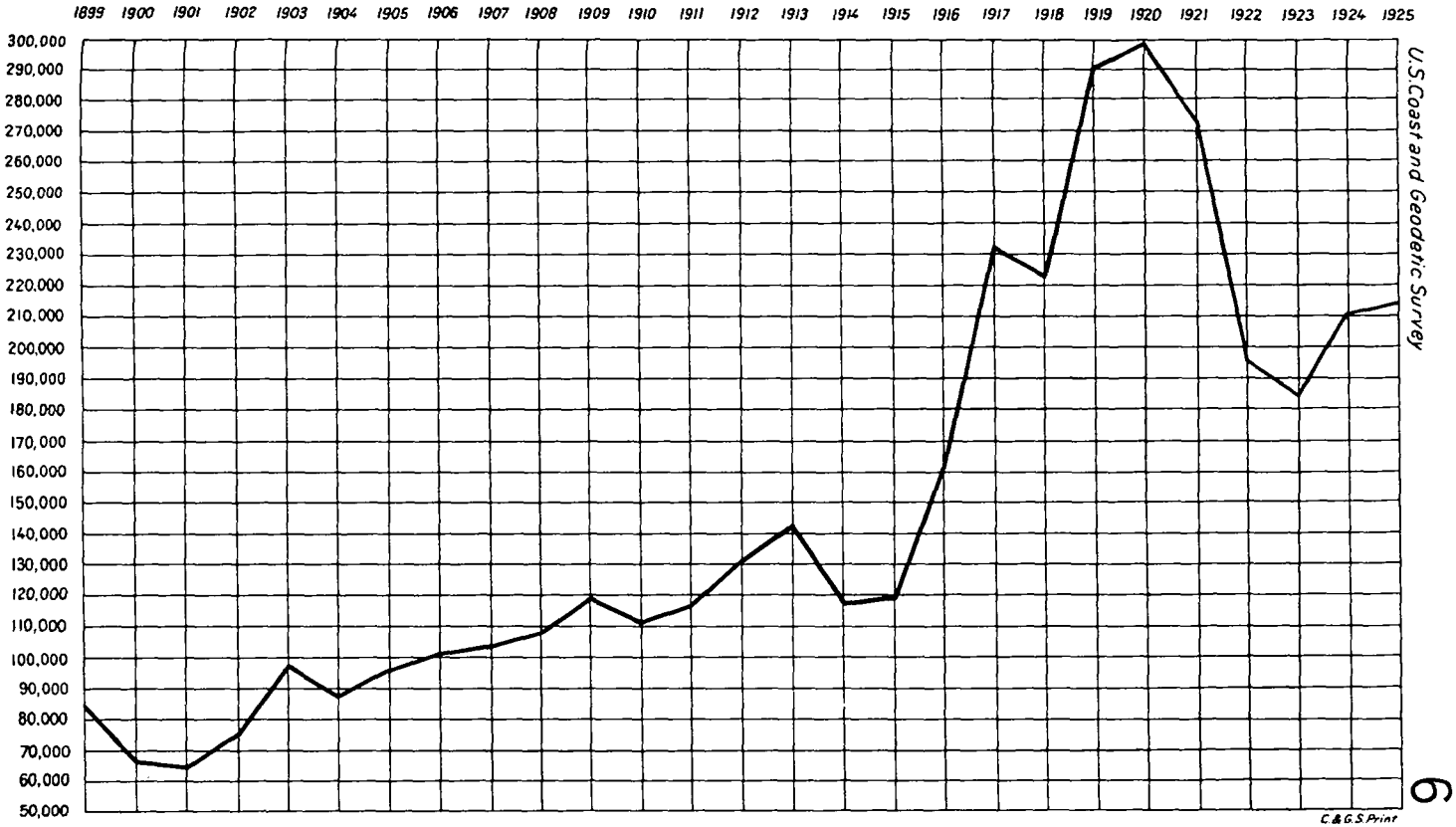
6155. Port of Portland, including Vancouver, Oregon, and Washington. February, 1925. Scale, 1:20,000; dimensions, 25 by 44 inches. This chart is published to meet the increasing demand for a large scale chart of the Port of Portland. It extends from the junction of the Willamette River with the Columbia River to above Rose Island on the Willamette and to Ryan Point on the Columbia. It is based on the Mercator projection, from surveys by the Port of Portland and United States Engineers, with control by the United States Coast and Geodetic Survey. The soundings are in feet at Columbia River datum, which is mean lower low water during the lowest river stages.

8172. Shakan and Shipley Bays and part of El Capitan Passage, Alaska. March, 1925. Scale, 1:40,000; dimensions, 26 by 40 inches. This is one of the series of 1:40,000 scale charts covering the west coast of Prince of Wales Island and joins chart No. 8171 on the south. It covers Shakan and Shipley Bays and the northern portion of El Capitan Passage, with a plan of El Capitan Passage from Dry Pass to Shakan Bay on a scale of 1:10,000. It is constructed on the Mercator projection and the soundings are charted in fathoms at mean lower low water. El Capitan Passage is from surveys made in 1922 and 1923, and the remainder of the chart is from older surveys.

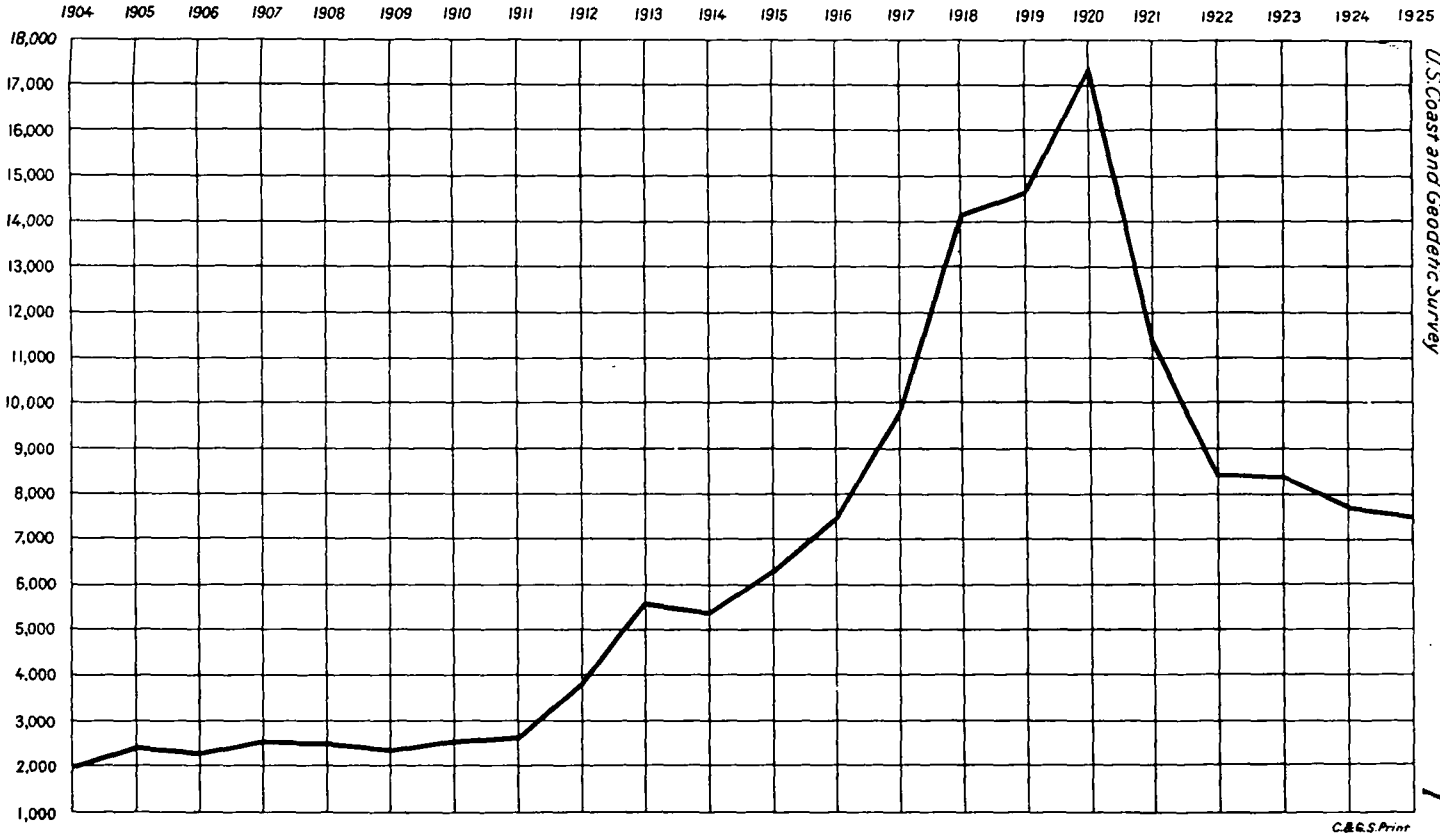
4000. Territory of Hawaii. May, 1925. Approximate scale, 1:3,167,500; dimensions, 34 by 36 inches. This is a sailing chart embracing the Territory of Hawaii. It extends from 5 to 30° N. and from 154 to 179° W., and is constructed on the Mercator projection. The natural scale is 1:3,167,500 in latitude 17° 30′.

1235. New River Inlet to Cape Fear, N. C. May, 1925. Scale, 1:80,000; dimensions, 33 by 42 inches. This is one of the new series of 1:80,000 scale coast charts. It is oriented with the meridian and constructed on the Mercator projection. The soundings are expressed in feet and give the depth at mean low water. It replaces chart No. 148 of the old series.

214. Goshen Point to Hatchett Point, including Niantic Bay, Conn. July, 1925. Scale, 1:20,000; dimensions, 28 by 31 inches. This chart completes the series of charts on a scale of 1:20,000 covering the shore of Connecticut. It overlaps chart 359 on the east and chart 215 on the west and includes Niantic Bay. The projection is Mercator and the depths are given in feet at mean low water.

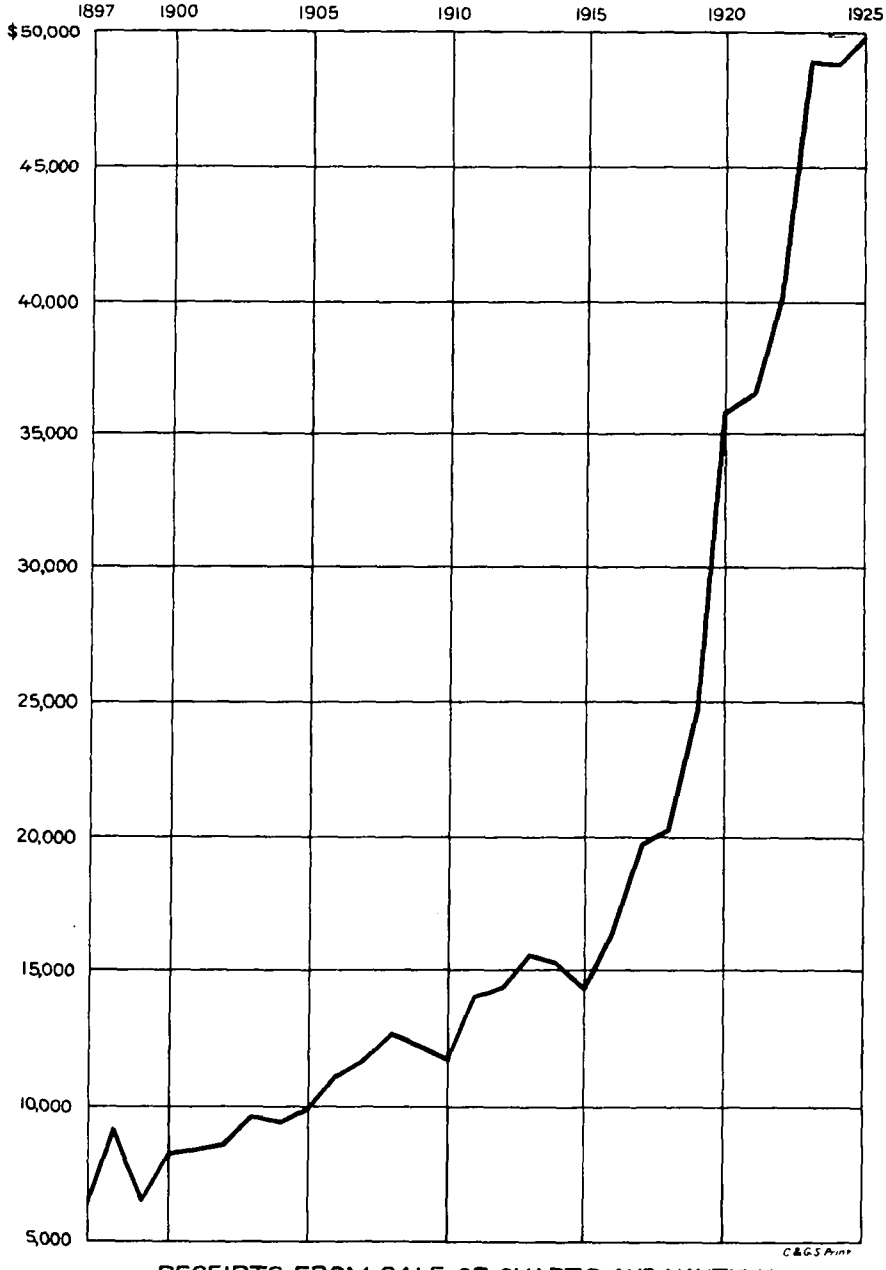


ISSUE OF CHARTS FROM 1899 TO 1925



ANNUAL DISTRIBUTION OF COAST PILOTS AND INSIDE ROUTE PILOTS

U.S. Coast and Geodetic Survey



RECEIPTS FROM SALE OF CHARTS AND NAUTICAL PUBLICATIONS — 1897 TO 1925

CHAPTER II

PROGRAM FOR THE CURRENT FISCAL YEAR IN THE WASHINGTON OFFICE

CHIEF CLERK

The program for this division will be, in addition to the routine duties of the division, the continuation of the renovation of the buildings occupied by the bureau and the installation of fixtures and equipment that result in better sanitation, economy in operation, and increased production.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

The program for this division for 1926 includes:

(*a*) Preparation of instructions for field work.

(*b*) Preparation of plans for construction of new vessels, for new field equipment, and for replacements and repairs to vessels and equipment. Preparation of plans for rebuilding and altering two survey vessels to provide additional accommodations.

(*c*) Preparation of service manuals of field work.

(*d*) Inspections in the field of equipment and operations.

(*e*) Publication of a new edition each of coast pilots: Alaska, Part I, Gulf Coast (new edition) and Inside Route Pilot, Key West to the Rio Grande (new publication). Compilation of the annual supplements to coast pilot volumes (10 in number) for which new editions have not been issued. Proof reading and indexing of publication, Construction and Operation of Wire Drag and Sweep. Preparation of copy for coast pilots: Pacific Coast, and Atlantic Coast, Cape Cod to Sandy Hook.

DIVISION OF GEODESY

The program of office computations for the division of Geodesy for 1926 by projects is as follows:

(*a*) TRIANGULATION AND TRAVERSE.—Wall, S. Dak., to Bozeman, Mont.; in South Carolina; in Alaska; readjustment of triangulation west of ninety-eighth meridian.

(*b*) LEVELS.—In California; in Colorado; in South Dakota.

(*c*) ASTRONOMIC.—Azimuths determined by the triangulation parties mostly in the western and northwestern part of the country, and longitudes, latitudes, and azimuths determined by an astronomic party operating from the ninety-eighth meridian to the northern part of the State of Washington.

(*d*) GRAVITY.—Special isostatic investigations and miscellaneous computations. No new field determinations of gravity are contemplated during the fiscal year.

(*e*) PUBLICATIONS.—Triangulation, coast of North Carolina; Precise Leveling in Oregon; Triangulation Manual; Precise Leveling Manual; Triangulation, Traverse, and Leveling in South Carolina; Earth Movements in California; Form of the Geoid; Investigation of Earth Tides.

DIVISION OF CHARTS

As stated in my preceding annual report, the division of charts, in its task of constructing new charts or reconstructing existing charts based on modern field surveys, is now so nearly caught up with the field work of the survey that the division can not lay out in advance a program of work of this character based on recently completed field work which will be adequate to tax its capacity for the year, nor can it anticipate the receipt of records of field work in progress with sufficient certainty as to date of receipt and condition of records to justify a general inclusion of such field work in the program for the year. A program of chart production calling for the completion of 14 new charts, reproduction of 14 old charts, and simplifying of 12 old charts has therefore been adopted tentatively.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

The program for 1926 is as follows:

MAGNETIC WORK

Complete the observatory publication for Cheltenham for the printer.

Complete the publication for Missouri.

Prepare the State publications for California and Texas. If possible, commence work on the publication for Georgia.

Prepare for publication magnetic results obtained during 1925.

Furnish information to local surveyors and those persons or institutions investigating difficulties in radio, telegraph, and cable communication.

Furnish magnetic information for charts.

Supervise investigations at Cheltenham in regard to magnetic instruments.

Carry out the necessary office work in connection with the completion of the Porto Rico observatory and placing it in operation.

Take part in the discussion of observatory results in cooperation with other organizations in an effort to solve some of the mysteries of the earth's magnetism. Execute such work on the preparation of observatory results as the limited personnel permits.

SEISMOLOGY

Secure reports of visible and felt effects of earthquakes and improve the system of obtaining these and the records themselves.

Prepare the quarterly reports on earthquake investigation.

Supervise improvements of instruments and installation of new instruments at Tucson, Ariz.

Study of earthquake literature and investigation of our results.

DIVISION OF TIDES AND CURRENTS

The program for the division of tides and currents for the fiscal year ending June 30, 1926, is as follows:

The predictions for the tide and current tables for the calendar year 1928 will be made and the manuscript submitted to the printer in time for issue on or before July 1, 1927.

The sounding records received from the hydrographic parties will be checked for tidal datum planes as received, so that the chart division will not be delayed in the publication of charts.

The bench mark records received from the field will be computed for those demanding immediate attention and the remainder kept up to date as the force of mathematicians will allow.

The manuscript of a publication on the currents and tides of Delaware Bay will be completed and sent to press toward the end of the fiscal year.

The manuscript of a publication on tidal bench marks in the District of Columbia will be completed and sent to press early in the fiscal year.

The manuscript of the publication Datum Planes and Their Determinations will be completed and sent to press near the end of the fiscal year.

The manuscript of the publication Coastal Currents along the Pacific Coast of the United States will be completed and sent to press early in the fiscal year.

It is planned, if practicable to do so, to install a light electric motor for operation of the tide-predicting machine and add an attachment for automatically printing the times and heights of the high and low waters, in lieu of the locking of the machine and the copying of these data by hand, as at present. Should the plan prove feasible, a considerable saving in time will be accomplished and, in addition, an increased accuracy obtained by the elimination of the human factor.

The observations obtained on the current survey in the passages of southeastern Alaska will be analyzed as soon as possible upon their receipt from the field, and the improvements to our present current predictions, made possible by this survey, will be incorporated in the present current tables for the use of the mariner.

The foregoing constitutes the outstanding features of the program for the next year in addition to the normal routine work of the division of tides and currents. In general, the work of the division will be so arranged as to take up immediately the work upon which the publication of charts and the prosecution of the general field work of the bureau depend; after that the energies of the division will be directed toward keeping the tide and current tabulations and computations up to date and to issuing in the form of publications the large mass of material that has been accumulated in the division and which is of considerable value to the navigator, the engineer, the scientist, and the public generally.

DIVISION OF ACCOUNTS

The program for this division will be a continuance of the duties incident to disbursing the funds appropriated for the operation of the bureau, including the financing of all chiefs of parties at work in the field, together with the verification of all accounts arising under such advances.

INSTRUMENT DIVISION

The program for the fiscal year 1925–26 will be to maintain the existing stock of instruments in readiness for use, making needed repairs and replenishing depleted stocks; to make improvements in instrumental design and construction and to design and build such new instruments and machines as may be needed; to construct new instruments of special types, including sounding clocks, automatic signal lamplighters, and a measuring device for more easily and accurately reading the sounding tube.

Part III.—IN THE FIELD

CHAPTER I

ACCOMPLISHMENTS IN THE FIELD DURING THE FISCAL YEAR

HYDROGRAPHIC WORK

The field work accomplished during the fiscal year 1925 has been extremely gratifying as, owing to adequate equipment, appropriations, and personnel, it has been possible to undertake the surveys of extremely difficult areas which hitherto it has been impracticable to accomplish on the scale warranted by their importance.

On the Atlantic coast two vessels have been continuously employed in executing surveys. Several detached parties have been doing revision work in the field. The survey of Lake Okeechobee was completed. On the Gulf coast one vessel has been employed in the survey of Tampa Bay and approaches, and a field party has been engaged in making a coast pilot revision from Key West to the Rio Grande.

On the Pacific coast one vessel has been continuously employed in offshore soundings. During the winter two of the survey vessels which have been working in western Alaska during the summer months were employed on offshore work along the California coast. Detached parties have been doing revision work in the field. A field revision of the coast pilot of California, Oregon, and Washington is being made. The Alaska surveys have been carried on by four vessels, two working in southeastern Alaska and two in western Alaska. In the outlying possessions of the United States one vessel has been employed on surveys in the Virgin Islands, three in the Philippine Islands, and one small party in the Hawaiian Islands during the entire year, and another for about three months during the wintertime in these islands.

The chief of the division of hydrography and topography made a personal inspection of the work being carried on in the Philippine Islands. His report contained recommendations for the future survey work in the islands, which program has been approved. It provides for the completion of the work in these islands at as early a date as practicable with the equipment and appropriations available.

The need has been felt for some time for a modified wire drag suitable for occasional use by survey vessels, the standard apparatus being too cumbersome for storage in the limited space usually available. By using inflated canvas buoys and modifying other parts of the equipment a light wire drag was developed by field parties on the vessels at Seattle during the winter. This apparatus can be stowed without difficulty and will result in considerable saving in the cost of developing shoals found during hydrographic surveys.

A method of buoy control of precise dead-reckoning work has been worked out by a party working on the east coast and has resulted in a considerable increase in accuracy.

Several special examinations were made in the field for the purpose of compiling supplements to the various coast pilots. Among these was the inspection voyage of the *Ranger* from Norfolk, Va., to Beaufort, S. C., via the inside route, to obtain information relative to the new system of aids to navigation in this waterway.

Necessary field examinations were made for a new edition of Coast Pilot, Gulf Coast, and a new Inside Route Pilot, Key West to the Rio Grande. An examination for a new edition of Coast Pilot, Pacific Coast, was in progress at the end of the fiscal year.

DETACHED PARTIES.—Detached parties made a resurvey of Scituate Harbor, Mass.; Fire Island Inlet, N. Y.; Beach Haven Inlet, N. J.; and completed the survey of Baltimore Harbor commenced during the previous fiscal year. A search was made for rocks reported in Bucks Harbor, Me.

Two small detached parties were engaged in work in the District of Columbia, for which instructions were issued at the request of the Director of Public Buildings and Public Parks. This work included the determination of the high-water line of Alexanders Island and the marking of the same and a survey of the Virginia side of the Potomac River from Jones Point, Alexandria, to the northwest boundary of the District of Columbia.

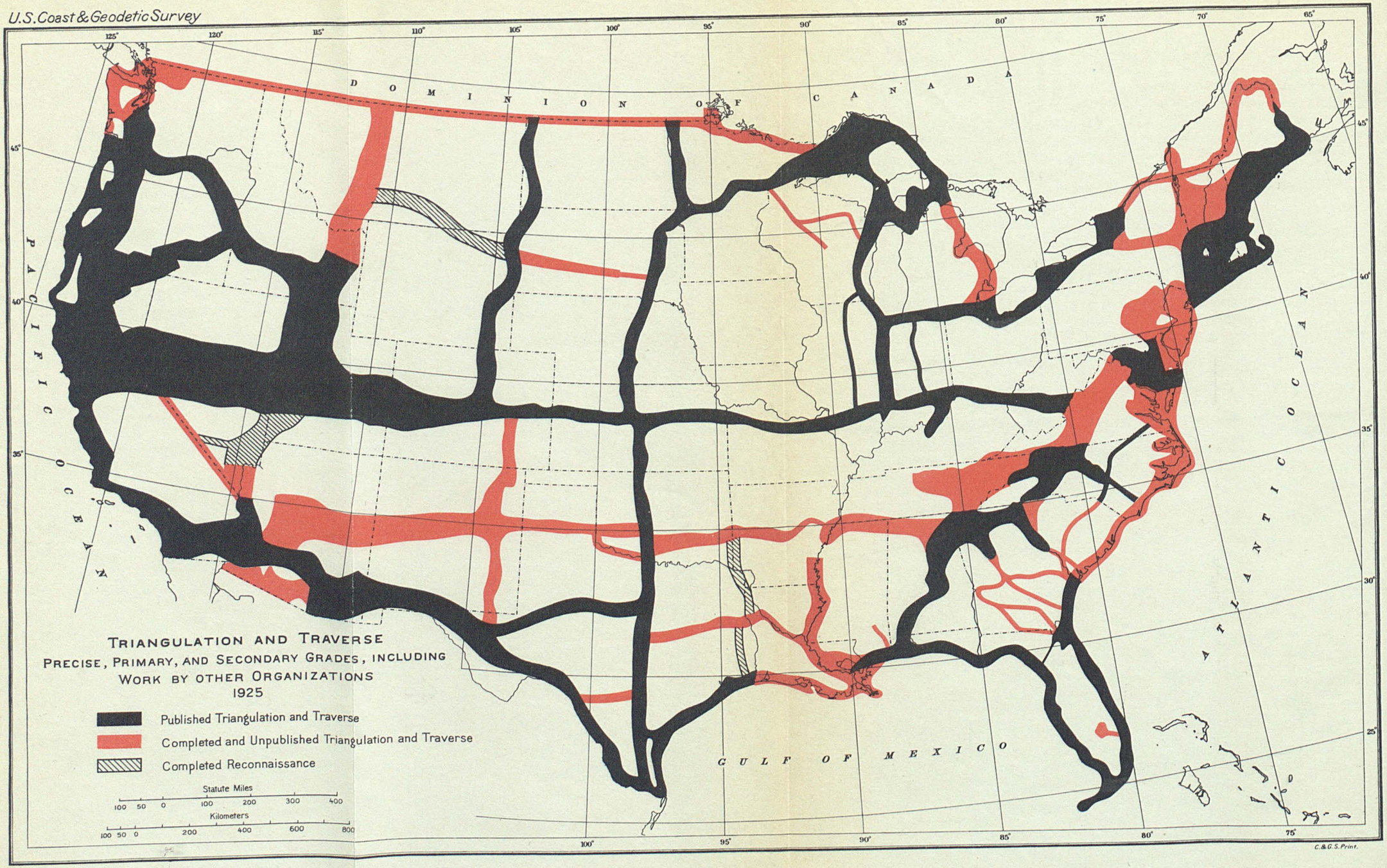
A party on the launch *Elsie* completed the survey of Lake Okeechobee. The topography of this lake was accomplished by the aerial photographic method, actual flying being done by officers working under the Bureau of Aeronautics, Navy Department.

Two resurveys of the bar at the entrance to Willapa Bay were made by detached parties, the first being made in July and the latter examination of the north channel across the bar being made in February. As this bar is continuously changing in depth, these frequent resurveys are valuable in determining the deepest water at the entrance to the bay. A detached party made a survey of the entrance to the Quillayute River.

SHIP AND LAUNCH HYDROGRAPHY PERFORMED DURING THE FISCAL YEAR

	Area in square miles	Number of soundings
Ship hydrography:		
North Carolina, vicinity Cape Fear River	1,491.0	32,918
Georgia and east coast Florida, St. Augustine to Savannah	574.0	94,806
Florida east coast, vicinity Ormond	242.0	13,925
Florida west coast, Tampa Bay and approaches	478.6	42,423
Virgin Islands	146.2	20,860
California—		
Southern coast	9,734.0	16,041
Vicinity Monterey Bay	489.0	4,471
San Francisco and approaches	4.3	3,072
Oregon, vicinity Cape Blanco	2,691.0	7,275
Washington, Drayton Harbor	.5	1,143
Alaska—		
Outside coasts Baranof and Chichagof Islands	3,120.5	27,314
Kasaan, Thomas, Gambier Bays, Twelve Mile Arm and west coast Kuiu Island	150.7	20,746
Pavlof Bay, Cold Bay and vicinity	482.5	31,921
Ship hydrography—Continued.		
Alaska—Continued.		
Shelikof Strait and Chignik Bay	879.7	20,290
Philippine Islands	3,257.1	275,230
Total	23,741.1	612,435
Launch and small-boat hydrography:		
Massachusetts, Scituate and New York, Fire Island Inlet	7.0	8,158
New Jersey, Beach Haven Inlet	3.0	5,486
Maryland, Baltimore Harbor	5.4	8,272
Lake Okeechobee	604.4	66,087
Washington—		
Quillayute River entrance	1.2	1,044
Willapa Bay	5.8	3,401
Hawaiian Islands	19.0	22,204
Total	645.8	114,651
Wire-drag surveys:		
Virgin Islands	300.1	153

U.S. Coast & Geodetic Survey



C.&G.S. Print.

SHIP AND LAUNCH HYDROGRAPHY PERFORMED DURING THE FISCAL YEAR—CON.

	Area in square miles	Number of soundings
Wire-drag surveys—Continued.		
Southeastern Alaska	124.4	142.0
California—		
San Francisco	2.2	
Total	426.7	295.0

	Area in square miles	Number of miles shore line
Topography:		
Massachusetts, Scituate	5.0	10.0
New York, Fire Island Inlet		
New Jersey, Beach Haven Inlet	2.5	5.8

	Area in square miles	Number of miles shore line
Topography—Continued.		
Virginia and D. C.	6.0	21.4
Maryland, Baltimore	3.0	8.5
North Carolina, vicinity Cape Fear River	17.0	54.7
Georgia and Florida, St. Augustine to Savannah River	117.0	467.8
Florida—		
East coast, vicinity Ormand	9.2	60.4
West coast, Tampa Bay and approaches	33.0	66.0
Lake Okeechobee	146.0	189.0
California, outside coast	9.5	20.0
Oregon, vicinity Cape Blanco	12.0	24.2
Washington, Quillayute River		7.2
Alaska	777.3	1,065.9
Hawaiian Islands	3.0	27.5
Philippine Islands	269.2	495.1
Total	1,409.7	2,518.5

GEODETIC WORK

	Length of scheme	Area covered
	Miles	*Square miles*
Triangulation, first order:		
Alaska, Cook Inlet—Fairbanks	60	550
South Dakota, Chamberlain-Wall	175	2,500
Montana, west of Glacier National Park	50	1,000
Minnesota, Namakan and Basswood Lakes	60	350
Alaska, Dixon Entrance	40	1,250
California, Imperial Valley	85	3,800
California, Santa Barbara Channel	60	1,200
Texas, San Antonio-Del Rio	165	2,500
New York, Rochester	8	40
California, Sacramento-Ukiah	140	4,500
California and Utah, Needles-Salt Lake City	100	6,000
South Dakota and Montana, Black Hills to Bozeman	100	2,500
Montana, forty-ninth parallel	20	400
Washington, forty-ninth parallel west of Loomis	0	0
Washington, Umatilla-forty-ninth parallel	0	0
Total	1,063	26,590
Triangulation, second order:		
South Carolina, Charleston-Winyah Bay	25	90
Alaska, Frederick Sound and Chatham Strait	75	700
California, lower San Francisco Bay	20	150
Total	120	940
Triangulation, third order:		
California, vicinity Cresent City	30	300
Alaska, Baranof Island	75	325
Alaska, Twelve Mile Arm, Chatham Strait, Pybus Bay	30	180
Alaska, Chignik and Castle Bays	20	100
Alaska, Isanotski Strait, Belkofski Bay, Pavlof Bay	90	500
Oregon, Coos Bay	10	10
California and Washington, San Francisco Bay and Blaine	15	80
Florida and Georgia, St. Johns River, St. Simon Island, St. Catherine Sound, and Wassaw Sound	40	65

	Length of scheme	Area covered
	Miles	*Square miles*
Triangulation, third order—Contd.		
Florida, Tampa Bay	10	25
Florida, vicinity of Daytona	5	15
Florida, Lake Okeechobee	20	90
District of Columbia and Virginia, boundary line	5	5
Hawaiian Islands, Molokai and Maui	10	10
Washington, Willapa Bay	5	15
New Jersey, Beach Haven Inlet	5	10
Total	370	1,730
Traverse, first order:		
South Dakota, Salem-Chamberlain	83	
New York, Rochester	33	
Total	116	
Traverse, second order: South Carolina, Charleston-Winyah Bay	5	
Traverse, third order: District of Columbia and Virginia, boundary line	4	
Base Lines, first order:		
Alaska, Broad Pass	3.7	
South Dakota, Kimball	4.7	
Alaska, Metlakatla	2.0	
South Dakota, Wall	8.2	
New York, Conesus	0.8	
New York, Lakeville	0.7	
Alaska, Holkham	1.4	
South Dakota, Presho	14.5	
Alaska, Gastineau Channel	1.4	
New York, Mount Read	2.0	
New York, Winton	2.0	
Alaska, Eagle River	1.8	
Total	43.2	
Base Lines, second order: South Carolina, Cape Romain	4.3	
Base Lines, third order: Alaska, Chignik	1.4	

GEODETIC WORK—continued

	Length of scheme	Area covered
	Miles	*Square miles*
Reconnaissance:		
Alaska, Cooks Inlet-Fairbanks	70	1,400
Idaho, Washington, and British Columbia, forty-ninth parallel	265	5,800
Minnesota, Namakan and Basswood Lakes	60	350
South Dakota, Wyoming, and Montana, Sioux Falls-Bozeman	470	10,000
Texas, San Antonio-Del Rio	165	2,500
New York, Rochester	58	40
Texas and Arkansas, Houston-Fort Smith	380	1,200
Alaska, Fairbanks-Eagle	0	0
Washington, Umatilla-forty-ninth parallel	50	1,000
Alaska, Chilkoot Inlet	30	200
Total	1,548	22,490
Leveling, first order:		
California, Santa Ana-Barstow; Burbank, Fernando; and Riverside-Ontario	177	-------
Leveling, first order—Continued.		
New Jersey and Pennsylvania, Perth Amboy-Atlantic City, Pleasantville-Cape May, and Delair-Philadelphia	207	-------
New Jersey, Perth Amboy	10	-------
California, San Francisco Bay	3	-------
Total	397	-------
SUMMARY		
First order triangulation	1,063	26,590
Second order triangulation	120	940
Third order triangulation	370	1,730
First order traverse	116	-------
Second order traverse	5	-------
Third order traverse	4	-------
First order base lines	43.2	-------
Second order base lines	4.3	-------
Third order base lines	1.4	-------
Reconnaissance	1,548	22,490
First order leveling lines	397	-------

A brief description of the principal field projects on which work was done during the year is given below.

The first order triangulation along the forty-ninth parallel was continued throughout the months when observations could be made. One party worked in Montana on that project during the early part of the fiscal year, and three parties were put into the field in the spring of 1925 in an effort to finish the triangulation to the Pacific Ocean during that field season. The high mountain peaks are covered deeply with snow from early autumn until late spring, making the working season very short, while forest fires in midsummer greatly hinder the progress of the work.

In order that a better adjustment of the triangulation along the forty-ninth parallel may be made, a belt of first-order triangulation was begun in the spring of 1925, to extend from the forty-ninth parallel to a connection with the Utah-Washington arc of first-order triangulation along the Columbia River south of Pasco, Wash. It is expected that this cross link of first-order triangulation will be completed during the field season of 1925.

In South Dakota a line of first-order traverse was run from Sioux Falls to Chamberlain, where first-order triangulation was begun and was extended to the Black Hills and to a connection with the one hundred and fourth meridian arc of triangulation in that region.

The informal agreement with the Geodetic Survey of Canada for cooperative work in completing the first-order control along the international boundary from Lake Superior to the Pacific Ocean provided for the Coast and Geodetic Survey to execute the control from the Lake of the Woods to the first-order triangulation near Lake Superior. This was completed the early part of the fiscal year.

In southeast Alaska the task of measuring bases along the arc of first-order triangulation from Dixon Entrance to the head of Lynn Canal was carried on by a party during all the working months. All bases were completed by the end of the fiscal year except one in Lynn Canal. This party also observed the large figure spanning Dixon

Entrance which connects the Canadian first-order arc from Puget Sound with the United States arc in southeast Alaska.

Another party in southeast Alaska began in the spring of 1925 to observe second-order triangulation in Chatham Strait and Frederick Sound, connecting to first-order work in Frederick Sound and to third-order triangulation at the north and south ends of Chatham Strait.

In western Alaska a party was engaged during the late summer of 1924 in extending the first-order arc of triangulation from Cook Inlet toward Fairbanks, and at the close of the season was almost to the south edge of the Tanana Valley. No observing was done in western Alaska during the spring of 1925 because of lack of funds, but a reconnaissance was begun to connect the north end of the triangulation with the international boundary triangulation near Eagle on the Yukon River.

Several years ago a reconnaissance was made for first-order triangulation from Needles, Calif., to Salt Lake, Utah, to connect the thirty-ninth parallel triangulation with the Texas-California arc. Observations on this project were begun late in the fiscal year.

In western Texas a party during the early winter completed a belt of first-order triangulation connecting the ninety-eighth meridian triangulation near San Antonio with the Rio Grande arc near Del Rio.

The triangulation and leveling executed in earthquake regions to measure movements in the crust of the earth included triangulation across the Imperial Valley in California and in the vicinity of Santa Barbara Channel. The line of levels from Santa Ana to Barstow, Calif., touching upon bench marks established in 1906, was completed during the early part of the year. A belt of triangulation was begun to connect the International Latitude Observatory at Ukiah, Calif., with the first-order triangulation near Sacramento, but the appropriation for that work was exhausted before the connection was completed.

For some years the Coast and Geodetic Survey has recommended the use of first-order control, or better, for topographic surveys of cities and has acted in an advisory capacity on a number of city surveys. During the winter of 1924–25 a cooperative arrangement was entered into with the city officials of Rochester, N. Y., whereby extremely accurate first-order triangulation and traverse would be extended over the urban area, the Coast and Geodetic Survey, furnishing the instruments and observers and the city of Rochester paying all field expenses. Not only will the points so determined be available for public use in the files and publications of this survey, but the work has afforded our engineers an opportunity to test out certain appliances and methods which were especially adapted to very precise city surveys. At the end of the fiscal year the work had made very satisfactory progress both in quantity and in accuracy of the results obtained.

A line of first-order leveling was extended from Perth Amboy, through Trenton, Camden, and Atlantic City to Cape May, N. J., connecting with the tidal stations at Atlantic City and Cold Spring Inlet. A connection was also made with the tidal and city bench marks at Philadelphia.

A reconnaissance for first-order triangulation was extended from Fairbanks toward Eagle, Alaska, to connect the arc of triangulation from Cooks Inlet northward with the triangulation along the one hundred and forty-first meridian.

An astronomic party working through the southwest determined 12 longitudes during the summer and fall of 1924, as follows: 4 in California, 1 in Arizona, 4 in Texas, 1 in Oklahoma, 1 in Kansas, and 1 in Colorado. Latitude was also determined at three of these stations and azimuth at two. Nearly all of this work was to provide additional Laplace stations for the contemplated readjustment of the triangulation net from the ninety-eighth meridian westward. Near the end of the fiscal year an astronomic party started work in Nebraska and South Dakota and by June 30 had completed four longitude, three latitude, and four azimuth determinations.

The wireless method for determining longitude was used with continued success during the year, giving on the average somewhat more accurate results than did the wire method previously used. A new determination of the overall lag of the reception of time signals was made during the winter at the Naval Observatory and a very close agreement with the previous values was obtained.

MAGNETIC AND SEISMOLOGICAL WORK

The magnetic work accomplished during the year is as follows:

The magnetic resurvey of North Carolina, made in cooperation with the geological and economic survey of that State (now the department of conservation and development), was completed during the year.

A large number of stations were occupied in Texas, especially in the northern part, and observations were made at eight county seats where there had been no previous observations.

Repeat stations were occupied in the Middle Atlantic and New England States and in the Northwest States. Two new county seats were occupied in Montana.

Magnetic observations were made during the total solar eclipse at Ithaca, N. Y., January 24, 1925, and special observations were also made at the observatories.

Repeat stations were occupied in the Hawaiian Islands.

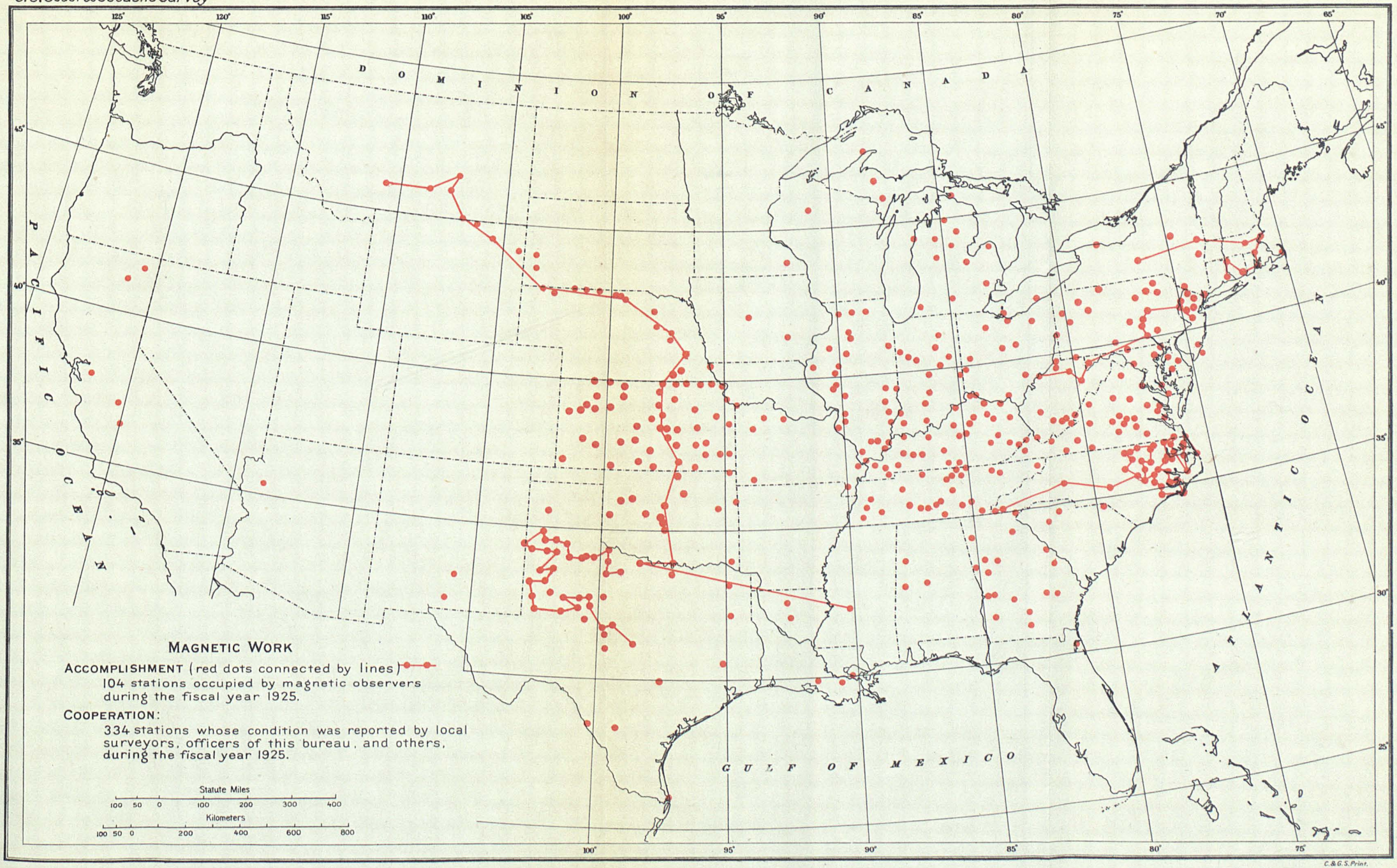
With the cooperation of the Philippine Government, repeat stations were occupied throughout the islands and new stations were established on the islands north of Luzon.

Magnetic observations were made by the survey vessels in Alaska.

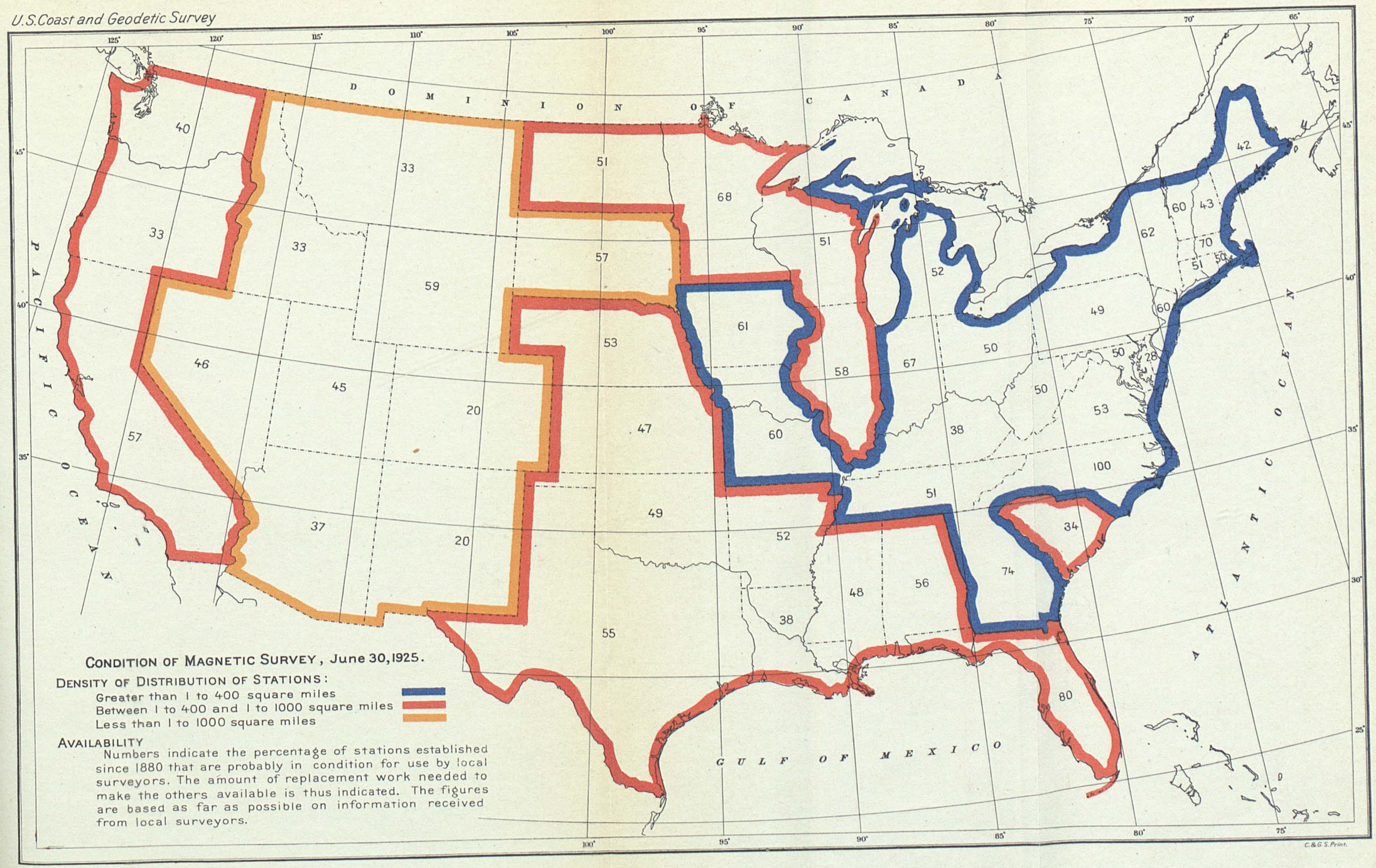
A party engaged in reconnaissance of the Aleutian Islands obtained some much needed observations at points hitherto unoccupied.

Routine observations of the magnetic elements were continued at all magnetic observatories, and in addition special work was done as follows:

CHELTENHAM.—Investigation of temperature control for the H variometer was completed. An investigation of earthquake effect on variometers was started, as were numerous minor investigations. A very large number of instruments were standardized during the year.


DOMINION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MAGNETIC WORK
ACCOMPLISHMENT (red dots connected by lines)
104 stations occupied by magnetic observers during the fiscal year 1925.
COOPERATION:
334 stations whose condition was reported by local surveyors, officers of this bureau, and others, during the fiscal year 1925.
Statute Miles
100 50 0 100 200 300 400
Kilometers
100 50 0 200 400 600 800
125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°

C. & G. S. Print.


DOMINION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
CONDITION OF MAGNETIC SURVEY, June 30, 1925.
DENSITY OF DISTRIBUTION OF STATIONS:
Greater than 1 to 400 square miles
Between 1 to 400 and 1 to 1000 square miles
Less than 1 to 1000 square miles
AVAILABILITY
Numbers indicate the percentage of stations established since 1880 that are probably in condition for use by local surveyors. The amount of replacement work needed to make the others available is thus indicated. The figures are based as far as possible on information received from local surveyors.
C.&G.S. Print.

SITKA.—Investigation of auroras in relation to telephone and telegraph disturbances was undertaken. Changes were made in the variation building to reduce the temperature change.

PORTO RICO.—On November 1, 1924, observations were stopped, the buildings were sold, and the land reverted to the owner. The equipment was stored in Porto Rico and the instruments were shipped to Washington for complete overhauling. An officer proceeded to Porto Rico in November and investigated a large number of possible sites. It was found that a site belonging to the city of San Juan could be used without expense to anyone, and the offer was accepted. Construction of buildings was in progress at the end of the year.

HONOLULU.—A number of sites were investigated, as the possibility of necessary removal from the present site has arisen.

SEISMOLOGY

The Bosch-Omori seismographs were kept in operation at Tucson, Sitka, and Cheltenham, and at Porto Rico until the observatory was closed. The usual analyses and reports were made, including the reports of important earthquakes. A number of earthquakes were recorded on the magnetographs. The investigation of earthquake effects on the magnetograph at Cheltenham is of interest to seismologists.

In Honolulu the Milne-Shaw instrument was kept in operation and was improved in several particulars.

TIDE AND CURRENT WORK

TIDAL OBSERVATIONS, PRIMARY STATIONS.—Automatic tide gauge stations were operated at the following primary tide stations during the fiscal year. These stations are for tidal control of the different sections and also furnish datum planes based on a long-period tidal definition.

Portland, Me.
Boston, Mass.
Atlantic City, N. J.
Cape May, N. J. (new station).
Philadelphia, Pa.
Baltimore, Md.
Washington, D. C. (new station).
Charleston, S. C.
Galveston, Tex.
Galveston Jetty Light (new station).
Daytona Beach, Fla.
Key West, Fla.
Cedar Keys, Fla.
Pensacola, Fla.
San Diego, Calif.
La Jolla, Calif.
Los Angeles, Calif.
San Francisco, Calif.
Astoria, Oreg. (new station).
Seattle, Wash.
Olympia, Wash.
Ketchikan, Alaska.
Sitka, Alaska.
Valdez, Alaska.
Honolulu, Hawaii.
Manila, P. I.

TIDAL OBSERVATIONS, SECONDARY STATIONS.—In addition to the primary stations, tidal observations were made at 146 secondary stations in connection with hydrographic work, the records from these secondary stations totaling 16 years.

TIDAL OBSERVATIONS, OUTSIDE SOURCES.—Tidal records were received from sources outside the survey from 28 tide stations, totaling 18½ years of record.

Following is a brief summary of tide records for the full fiscal year:

SUMMARY OF TIDE RECORDS RECEIVED

	Stations	Years	Months
Eastern division	59	18	7.2
Gulf division	12	5	.4
Western division	19	13	8.4
Alaskan division	36	6	11.4
Outlying territory	62	13	.2
Total	188	57	3.6

CURRENT OBSERVATIONS

During the year current observations were made by the crews on the following light vessels: Nantucket Shoals, Overfalls, Blunts Reef, Diamond Shoals, and Savannah.

In addition short series of current observations were made at the following places: Delaware Bay and River; Fire Island Inlet and Frying Pan Shoals, N. C.; coast of North Carolina; False Pass, Alaska; Roncador Reef, Serrano Bank, and Quito Sueno Light, Caribbean Sea.

Summary of current observations

	Stations	Years	Months
Light vessels	5	3	10.5
Short series	55	0	6.1
Total	60	4	4.6

Cooperating with the Engineer Corps of the Army a tide station was established at Benning Bridge, D. C., and maintained simultaneously with the Washington station for three months for the determination of tide planes.

The Bureau of Fisheries cooperated with this bureau by establishing and maintaining a portable automatic tide gauge on the Pribilof Islands, Alaska.

In July, 1924, an automatic tide gauge station was installed on the wharf of the Scripps Institution for Biological Research, at La Jolla, Calif. This station will be maintained as a primary tide station of this survey and as an ocean station similar to the station at Atlantic City.

During the past year an important current and tide survey of Delaware Bay and tributaries was made. This work, extending over a period of three months, was carried on from 70 current stations covering the entire bay and tributaries.

A portable automatic tide gauge, a recent development of this bureau, was purchased by the Carnegie Institution of Washington and installed at the Apia Observatory, western Samoa, in connection with magnetic work. The Coast and Geodetic Survey, in return for the observational data, is tabulating and discussing the records.

In September, 1924, a tide station was installed at Cape May (Cold Spring Inlet), N. J. This station is to be operated for a secondary determination of mean sea level in connection with precise leveling in New Jersey.

Current and other oceanographic observations in Bering Sea and the Arctic Ocean were received during the year from Capt. Robert A.

Bartlett, to whom instruments were loaned in April, 1924. Captain Bartlett spent the summer in Alaska on the Coast Guard steamer *Bear*, obtaining meteorological and other observations for the National Geographic Society.

In November, 1924, current apparatus was loaned to Dr. Robert Cushman Murphy, American Museum of Natural History, New York. Doctor Murphy made current and density observations in connection with his work last winter off the coast of Peru, and turned over to this bureau the data obtained from these observations.

A tide station was established in November, 1924, at Washington, D. C., on the lighthouse wharf. Four different types of automatic tide gauges were installed at this station for the purpose of making tests and improvements to automatic tide gauges in use in this service.

This bureau is cooperating with the State of New Jersey in the study of apparent tidal fluctuations in a well 800 feet deep in connection with an investigation of the water supply of Atlantic City. A portable automatic tide gauge is installed in this well.

In April, 1925, a tide gauge station was established at Galveston South Jetty Light to furnish tidal control for the open coast of the Gulf of Mexico.

For the preservation of tidal planes in San Francisco Bay, defined by long-period tide observations, tidal bench marks in the vicinity were connected by precise leveling in March, 1925, and additional bench marks established.

A primary tide station for tidal control along the South Atlantic coast of the United States was established at Daytona Beach, Fla., in April, 1925.

A current station has been established on Savannah Light Vessel, and is being operated in connection with coast-erosion studies at the mouth of the Savannah River.

A primary tide station was established in May, 1925, at Seward, Alaska. This is intended as a long-period station for the tidal control of that general region and to furnish a long-period mean sea level datum for precise leveling.

The secondary tide station on the Duwamish River at Seattle was discontinued on April 30. This station was established a year ago in order to obtain data on tidal conditions in this river.

Temperature and density observations, frequently requested of this office by prospective builders in connection with cold-storage plants, by fishing concerns, and especially by investigators in the study of pile-boring limnoria, are being made at the following stations:

Portland, Me.
Boston, Mass.
Nantucket Shoal Light Vessel.
Atlantic City, N. J.
Philadelphia, Pa.
Baltimore, Md.
Diamond Shoal Light Vessel.
Charleston, S. C.
Cedar Keys, Fla.
Pensacola, Fla.
Duwamish River, Wash.
Galveston, Tex.
San Diego, Calif.
La Jolla, Calif.
Los Angeles, Calif.
San Francisco, Calif.
Astoria, Oreg.
Seattle, Wash.
Ketchikan, Alaska.
Sitka, Alaska.

In addition, short series of temperature and density observations were made at 61 stations during the current and tide survey of Delaware Bay. All these observations are obtained at no increased cost to the survey.

CHAPTER II

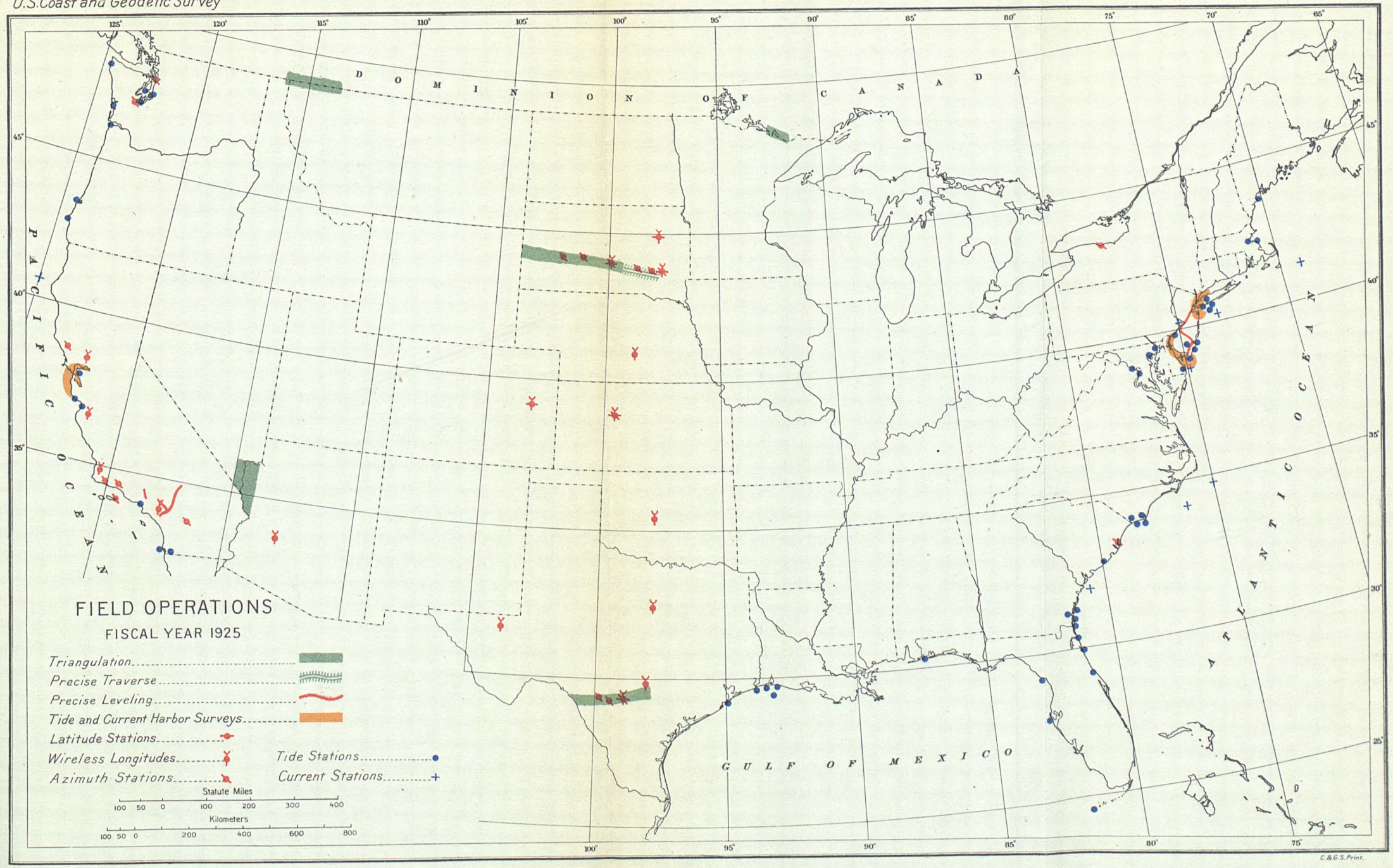
BRIEF SUMMARY OF HYDROGRAPHIC, GEODETIC, MAGNETIC, AND TIDE AND CURRENT SURVEYS

The tinted areas on the accompanying chart, Condition of Field Operations, United States, indicate where additional surveys are needed on coasts of this country. The Atlantic and Gulf of Mexico coasts require similar treatment, namely, detailed surveys to the 100-fathom depth, and also wire-drag surveys in several rocky or coral regions. The Pacific is less changeable and requires but one comprehensive survey, carried to the 1,000-fathom depth, which is comparatively close to the shore.

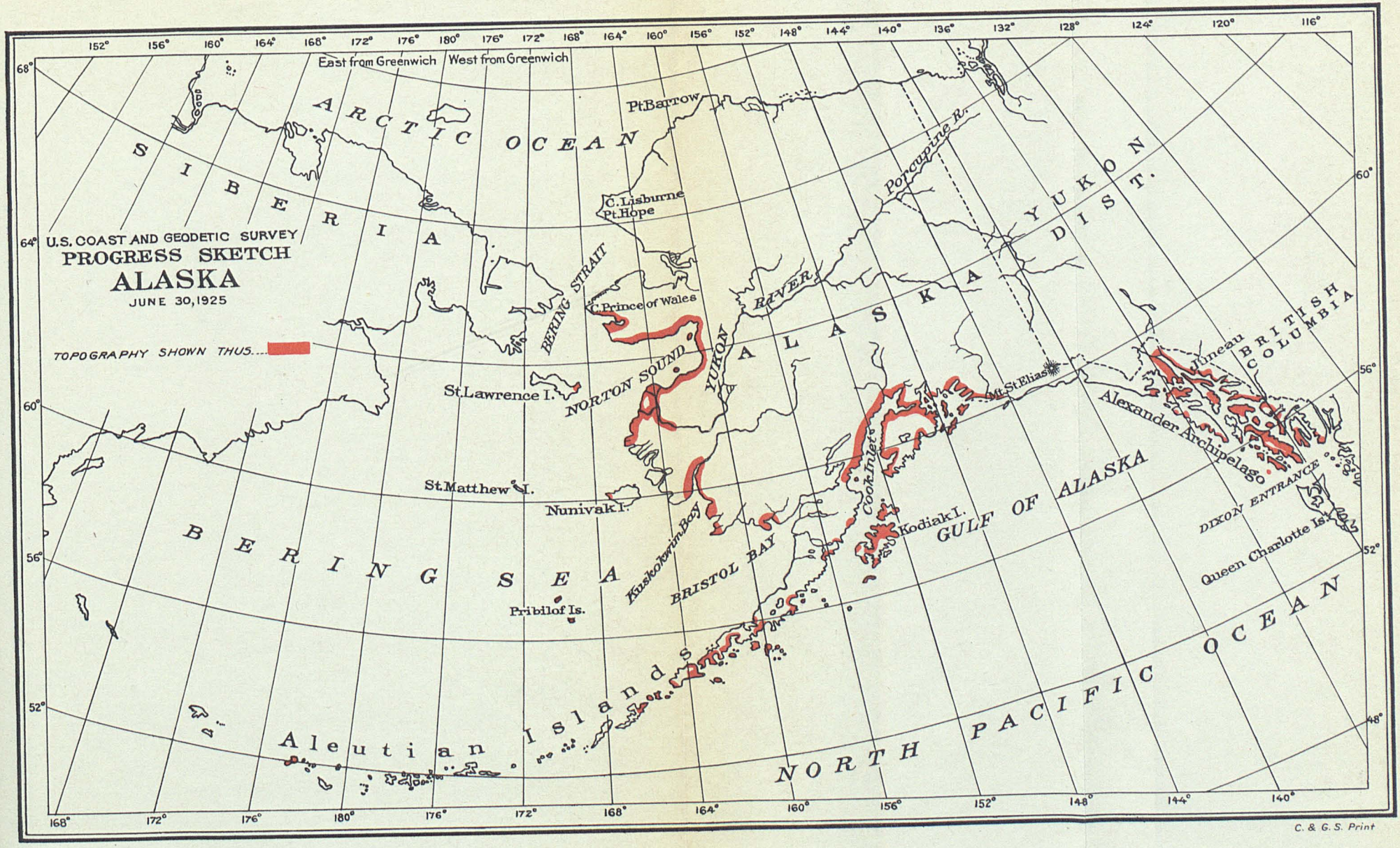
Rapid progress has been made in southeast Alaska, as shown by the accompanying chart. Hydrographic work in Porto Rico and in the Virgin Islands is nearing completion. The most important shores of the Hawaiian Islands have been surveyed, though some work remains. The islets and shoals westward of Midway should be surveyed. A program for completion of Philippine Island surveys has been drawn up and will expedite that work, which is, however, already in good condition.

Two cooperative projects with the Geodetic Survey of Canada are almost completed. The first is the international boundary triangulation from Lake Superior to the Pacific, and the second is the connecting of first-order triangulation in the State of Washington with that in British Columbia and Alaska. First-order work was executed in Alaska and on the Nevada-Utah and South Dakota-Montana projects. Some astronomic work was done with the aid of the United States Naval Observatory. The Geological Survey cooperated in the extension of control for the topographic map of the country. The Forest Service rendered important aid to the bureau. Reobservation from Mount Lola-Round Top on the transcontinental arc, westward to the coast, and thence southward to San Diego, was completed. This is an important contribution to seismological investigation, as was also the running of levels from Santa Ana to Barstow, Calif.

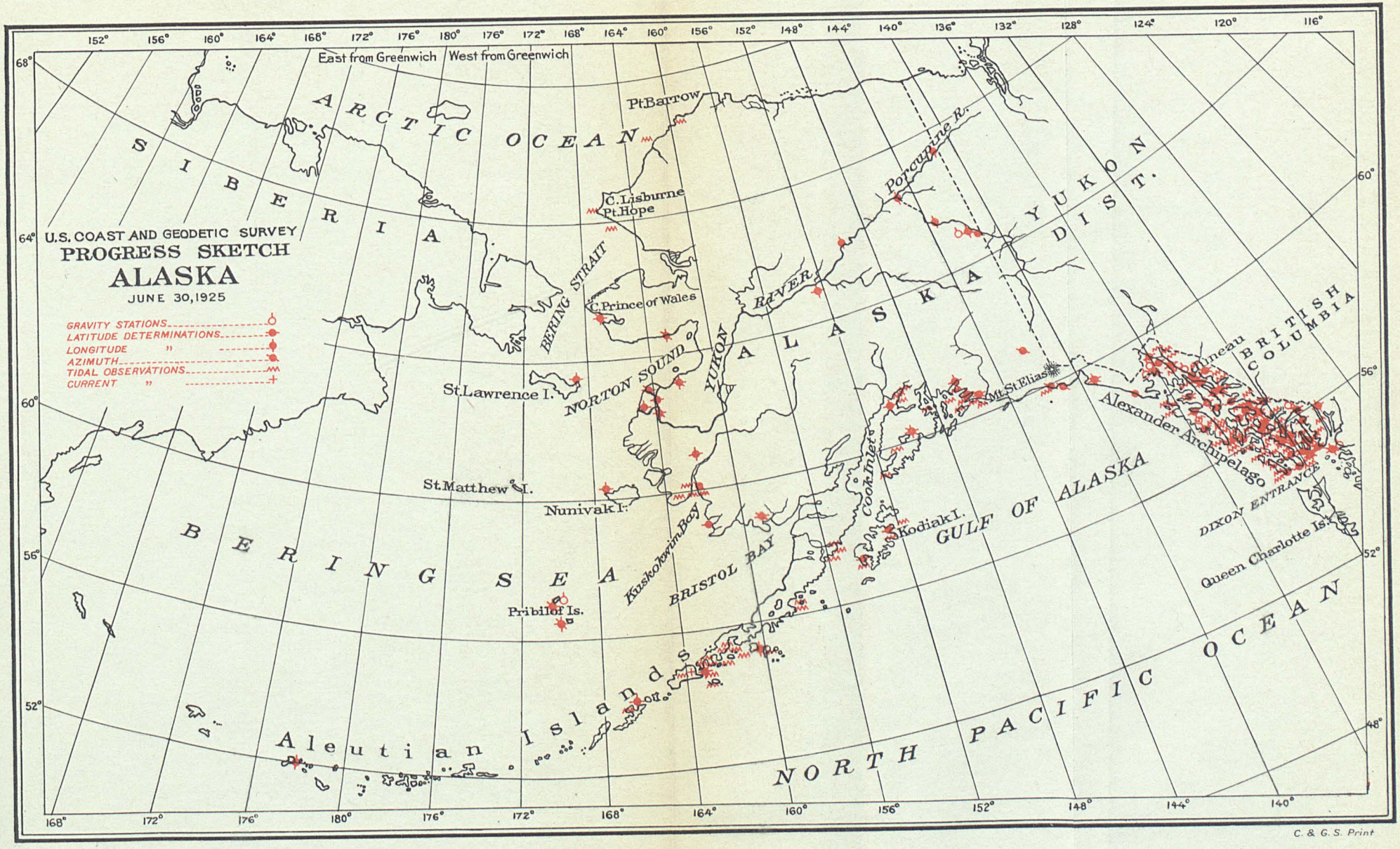
There are now magnetic stations at almost all county seats. Reoccupation of stations will cover the entire country every five years. In the replacement of old stations the bureau is receiving aid from local surveyors. Some magnetic observations have been made by survey vessels in Alaska, but work in the interior is needed. No repeat work will be needed in Hawaiian and Philippine Islands for some time nor in Porto Rico. Complete records of magnetic elements have continued throughout the year and will continue at the five observatories, except for an interval at Porto Rico while the new observatory is being constructed. Magnetic observations by the nonmagnetic vessel *Carnegie* have been utilized by the bureau. Collection of data concerning felt and visible effects of earthquakes has become an important part of the work.


FIELD OPERATIONS
FISCAL YEAR 1925
Triangulation
Precise Traverse
Precise Leveling
Tide and Current Harbor Surveys
Latitude Stations
Wireless Longitudes
Azimuth Stations
Tide Stations
Current Stations
Statute Miles
100 50 0 100 200 300 400
Kilometers
100 50 0 200 400 600 800
DOMINION OF CANADA
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°

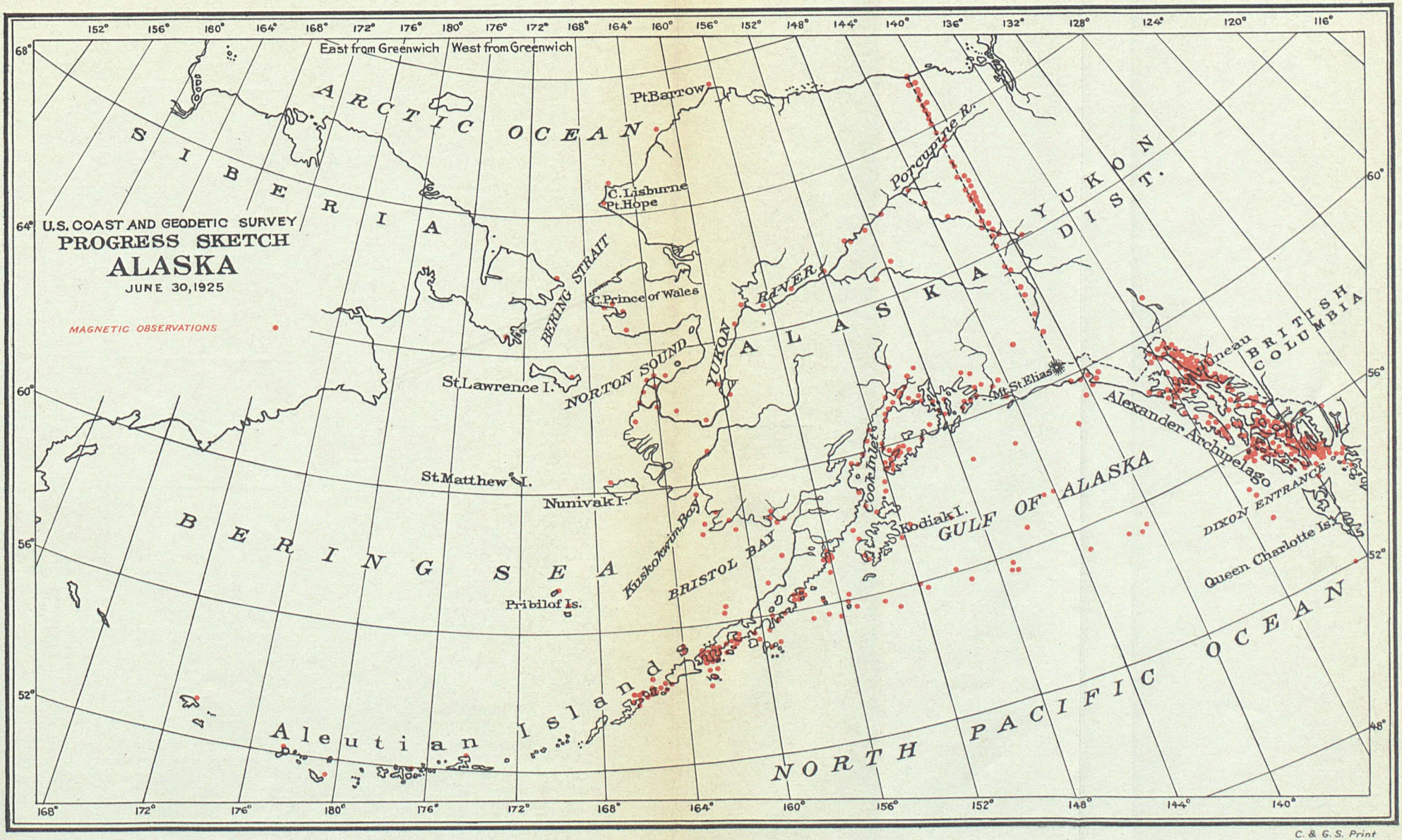
C.&G.S.Print.


U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
ALASKA
JUNE 30, 1925
TOPOGRAPHY SHOWN THUS
East from Greenwich
West from Greenwich
ARCTIC OCEAN
SIBERIA
Pt. Barrow
C. Lisburne
Pt. Hope
BERING STRAIT
C. Prince of Wales
NORTON SOUND
St. Lawrence I.
YUKON RIVER
Porcupine R.
YUKON DIST.
ALASKA
BRITISH COLUMBIA
Juneau
Mt. St. Elias
Alexander Archipelago
DIXON ENTRANCE
Queen Charlotte Is.
Cook Inlet
Kodiak I.
GULF OF ALASKA
St. Matthew I.
Nunivak I.
Kuskokwim Bay
BRISTOL BAY
BERING SEA
Pribilof Is.
Aleutian Islands
NORTH PACIFIC OCEAN

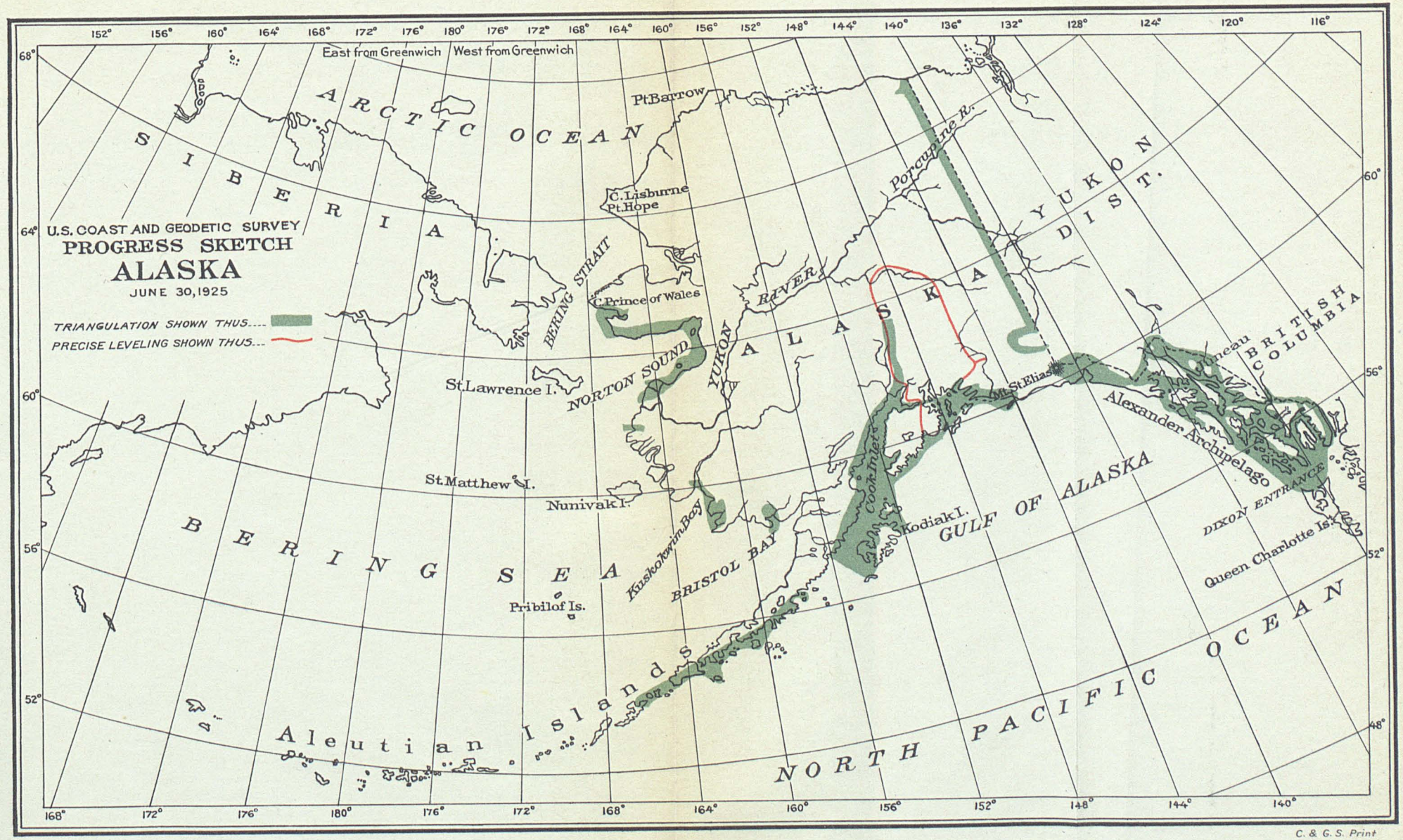
C. & G. S. Print


U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
ALASKA
JUNE 30, 1925
GRAVITY STATIONS
LATITUDE DETERMINATIONS
LONGITUDE "
AZIMUTH
TIDAL OBSERVATIONS
CURRENT "
East from Greenwich
West from Greenwich
ARCTIC OCEAN
SIBERIA
Pt. Barrow
C. Lisburne
Pt. Hope
BERING STRAIT
C. Prince of Wales
NORTON SOUND
St. Lawrence I.
YUKON RIVER
Porcupine R.
YUKON DIST.
ALASKA
BRITISH COLUMBIA
Juneau
Mt. St. Elias
Alexander Archipelago
St. Matthew I.
Nunivak I.
Kuskokwim Bay
BRISTOL BAY
Cook Inlet
Kodiak I.
GULF OF ALASKA
DIXON ENTRANCE
Queen Charlotte Is.
BERING SEA
Pribilof Is.
Aleutian Islands
NORTH PACIFIC OCEAN

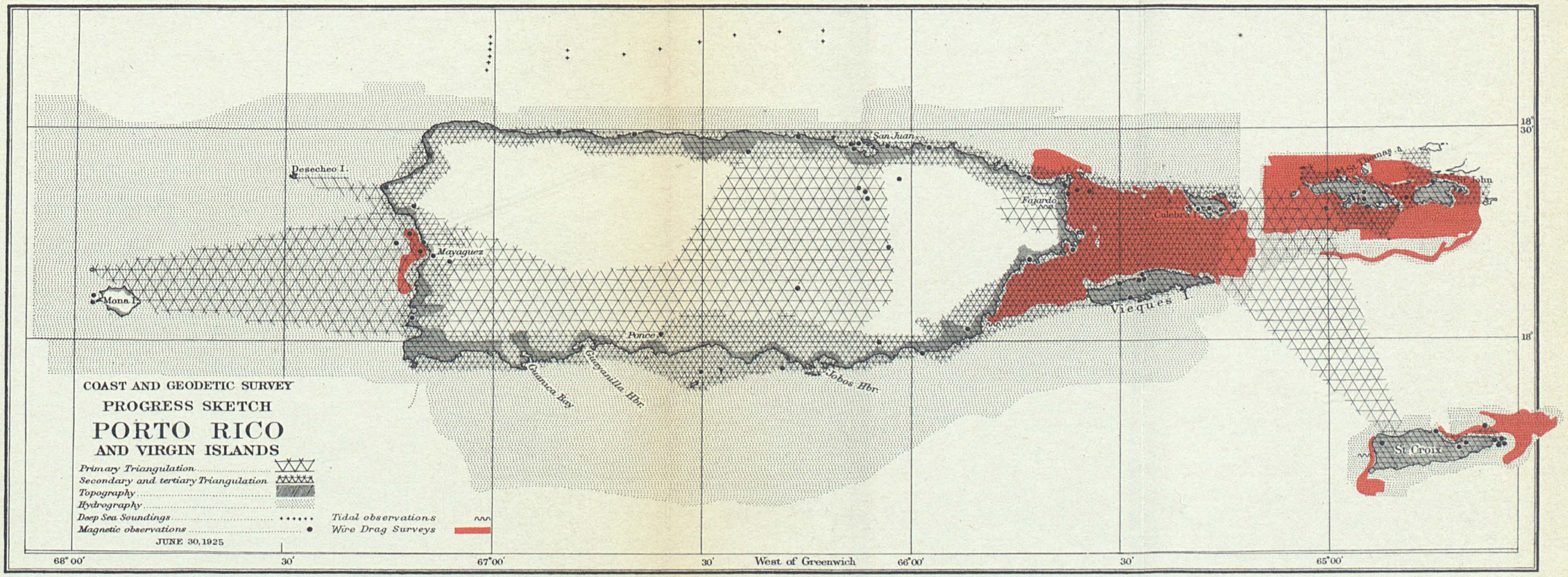
C. & G. S. Print


U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
ALASKA
JUNE 30, 1925
MAGNETIC OBSERVATIONS
East from Greenwich
West from Greenwich
ARCTIC OCEAN
SIBERIA
Pt. Barrow
C. Lisburne
Pt. Hope
BERING STRAIT
C. Prince of Wales
St. Lawrence I.
NORTON SOUND
YUKON RIVER
Porcupine R.
YUKON DIST.
ALASKA
BRITISH COLUMBIA
Juneau
Mt. St. Elias
Alexander Archipelago
DIXON ENTRANCE
Queen Charlotte Is.
Cook Inlet
Kodiak I.
GULF OF ALASKA
St. Matthew I.
Nunivak I.
Kuskokwim Bay
BRISTOL BAY
BERING SEA
Pribilof Is.
Aleutian Islands
NORTH PACIFIC OCEAN

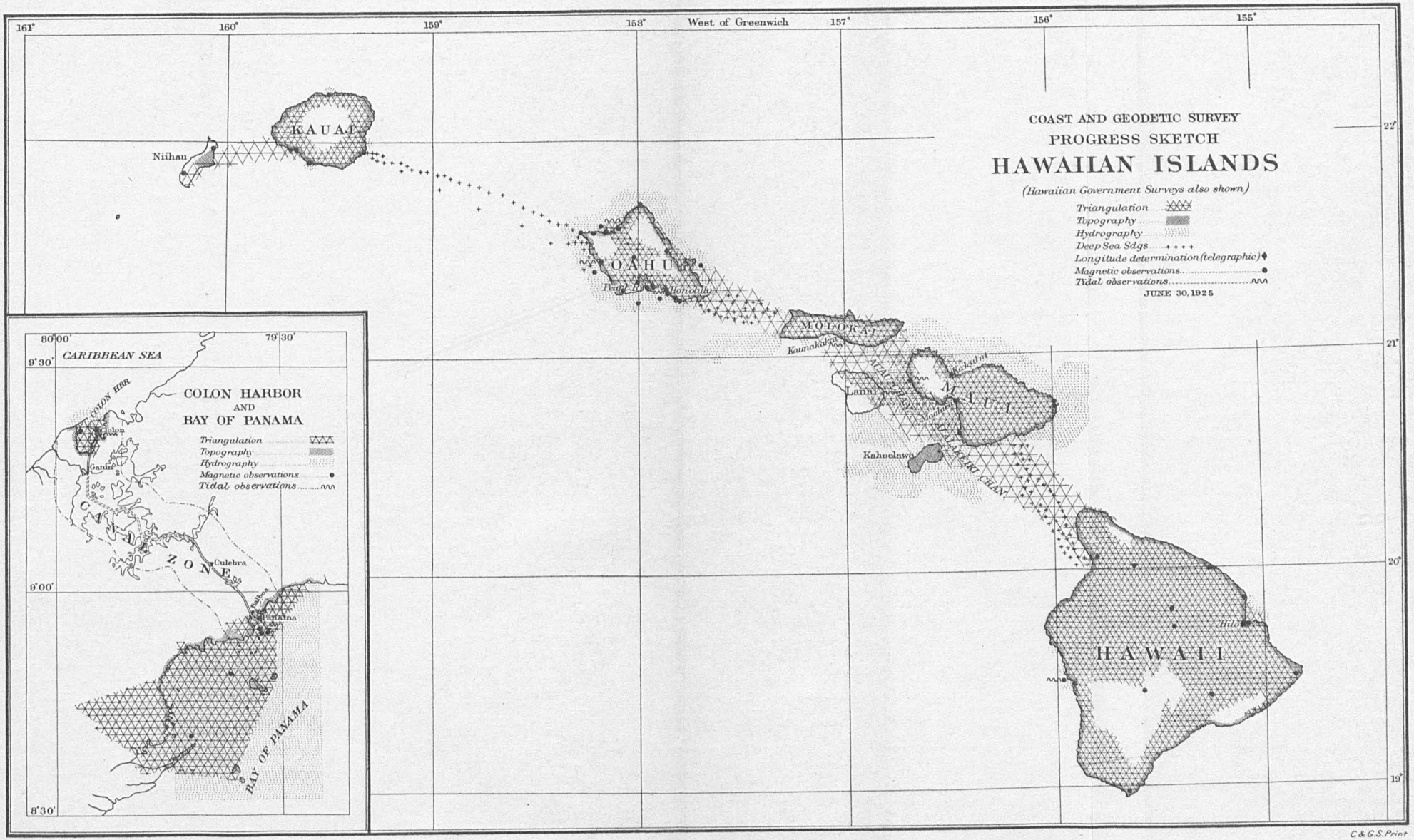
C. & G. S. Print


U.S. COAST AND GEODETIC SURVEY
PROGRESS SKETCH
ALASKA
JUNE 30, 1925
TRIANGULATION SHOWN THUS....
PRECISE LEVELING SHOWN THUS...
East from Greenwich
West from Greenwich
ARCTIC OCEAN
SIBERIA
Pt. Barrow
C. Lisburne
Pt. Hope
BERING STRAIT
C. Prince of Wales
NORTON SOUND
St. Lawrence I.
YUKON RIVER
Porcupine R.
YUKON DIST.
ALASKA
BRITISH COLUMBIA
Juneau
Mt. St. Elias
Alexander Archipelago
St. Matthew I.
Nunivak I.
Kuskokwim Bay
BRISTOL BAY
Cook Inlet
Kodiak I.
GULF OF ALASKA
DIXON ENTRANCE
Queen Charlotte Is.
BERING SEA
Pribilof Is.
Aleutian Islands
NORTH PACIFIC OCEAN

C. & G. S. Print


COAST AND GEODETIC SURVEY
PROGRESS SKETCH
PORTO RICO
AND VIRGIN ISLANDS
Primary Triangulation
Secondary and tertiary Triangulation
Topography
Hydrography
Deep Sea Soundings
Magnetic observations
Tidal observations
Wire Drag Surveys
JUNE 30, 1925
Desecheo I.
Mayaguez
Mona I.
San Juan
Fajardo
Culebra
Vieques I.
St. Thomas
St. John
Ponce
Guanica Bay
Guayanilla Hbr.
Jobos Hbr.
St. Croix
18° 30'
18°
68° 00'
30'
67° 00'
30'
West of Greenwich
66° 00'
30'
65° 00'

C.& G.S. Print


COAST AND GEODETIC SURVEY
PROGRESS SKETCH
HAWAIIAN ISLANDS
(Hawaiian Government Surveys also shown)
Triangulation
Topography
Hydrography
Deep Sea Sdgs
Longitude determination (telegraphic)
Magnetic observations
Tidal observations
JUNE 30, 1925
West of Greenwich
161°
160°
159°
158°
157°
156°
155°
22°
21°
20°
19°
KAUAI
Niihau
OAHU
Honolulu
MOLOKAI
Kaunakakai
Lanai
MAUI
Kahoolawe
HAWAII
Hilo
COLON HARBOR
AND
BAY OF PANAMA
Triangulation
Topography
Hydrography
Magnetic observations
Tidal observations
CARIBBEAN SEA
80°00'
79°30'
9°30'
9°00'
8°30'
COLON HBR
Colon
Gatun
CANAL ZONE
Culebra
Balboa
Panama
BAY OF PANAMA

C & G.S. Print

TRIANGULATION
TOPOGRAPHY
HYDROGRAPHY
Survey work completed but not shown by symbol
Fiscal year 1925
Total to End of Fiscal year 1925
Longitude determinations 0 stations 49 stations
Magnetic determinations 30 " 228 "
Gravity determinations 0 " 2 "
Tidal observations 12 " 220 "
U. S. COAST AND GEODETIC SURVEY
CONDITION OF FIELD OPERATIONS
PHILIPPINE ISLANDS
1925
Statute Miles
Nautical Miles
BASHI CHANNEL
BATAN ISLANDS
BASCO
BALINTANG CHANNEL
BABUYAN ISLANDS
BABUYAN CHANNEL
LAOAG
VIGAN
BANGUED
TUGUEGARAO
Port Bicobian
ILAGAN
BONTOC
SAN FERNANDO
LINGAYEN GULF
BAYOMBONG
LINGAYEN
TARLAC
CABANATUAN
IBA
LUZON
S. FERNANDO
MALOLOS
BALANGA
MANILA
CAVITE
PASIG
POLILLO ISLANDS
LAMON BAY
STA CRUZ
DAET
LUCENA
BATANGAS
CATANDUANES I
NAGA
BOAC
MARINDUQUE I
CALAPAN
ALBAY
SORSOGON
MINDORO
MINDORO STRAIT
SIBUYAN SEA
San Bernardino Strait
ROMBLON
TABLAS I
SIBUYAN I
MASBATE
CALAMIAN GROUP
CAPIZ
CATBALOGAN
BILIRAN I
VISAYAN SEA
TACLOBAN
CUYO ISLANDS
S. JOSE DE BUENAVISTA
ILOILO
BACOLOD
CAMOTES IS
LEYTE GULF
Suluan I
PANAY GULF
CEBU
DINAGAT I
BOHOL
TAGBILARAN
SURIGAO
PUERTO PRINCESA
CAGAYAN IS
DUMAGUETE
SIQUIJOR I
CAMIGUIN I
BUTUAN
CAGAYAN
SULU SEA
DANSALAN
MALAYBALAY
MINDANAO
BALABAC STRAIT
COTABATO
DAVAO
CAGAYAN SULU I
ZAMBOANGA
MORO GULF
BASILAN I
Traverse
JOLO
SULU ARCHIPELAGO
BORNEO
CELEBES SEA
SARANGANI IS.
SIBUTU I
PHILIPPINE SEA
120°
125°
20°
15°
10°
5°

Increased appropriations have permitted the bureau to make necessary tide and current surveys in important harbors. A number of others require surveys, but for this year such work will be confined to the narrow passages from Dixon Entrance to Cross Sound, Alaska, where strong currents menace our shipping. For the preservation of tidal planes the bureau has releveled old bench marks and has established standard disks, the majority of this work being done between Chesapeake Bay and Connecticut and in the vicinity of San Francisco Bay.

Lack of funds has kept the bureau from making important investigations in physical oceanography to obtain densities and temperatures of sea water, ocean currents, and related matters. Such work should be done in the Gulf Stream.

The tide station in the Duwamish River was discontinued. New stations were installed at Cape May, Washington, Daytona, Galveston, La Jolla, Astoria, and Seward. Stations at Sitka, Anchorage, Portland, and San Diego will be discontinued this year and those at Galveston and Valdez in 1926.

CHAPTER III

PROGRAM FOR THE CURRENT FISCAL YEAR IN THE FIELD

HYDROGRAPHIC AND TOPOGRAPHIC WORK

ATLANTIC AND GULF COASTS.—The steamships *Bache* and *Lydonia* will be employed on offshore work, as follows: *Bache* off Cape Henry, searching for reported shoals and extending southward an offshore survey from the southern limit of the recent survey. Next fall the *Bache* will take up similar work on the Gulf coast eastward from Pensacola Bay. The *Lydonia* will endeavor to complete the offshore work between Cape Fear and Winyah Bay. When weather becomes unfavorable for work in this locality the vessel will take up similar work southward from Daytona. Both parties will also execute inshore hydrography and shore-line revision in these vicinities.

The launch *Mikawe* will complete the inshore hydrography and shore-line revision between Bull and Winyah Bays and then will cooperate with the party on the *Lydonia* in extending similar work northward of Winyah Bay.

The steamship *Hydrographer* will be employed on the resurvey of Tampa Bay, approach and tributaries, begun during the fiscal year 1924.

The steamship *Ranger* will continue sounding and wire dragging around the Virgin Islands until all of this work has been completed and will then take up work on the Atlantic or Gulf coasts.

Wire-drag surveys will be resumed in northern New England waters and along the Florida Keys if funds are available. Several small harbor resurveys will be accomplished if possible.

PACIFIC COAST AND ALASKA.—The steamship *Guide* will be employed in the vicinity of Cape Blanco during the year, except during the winter, when the vessel will be operated on the coast of southern California. The steamship *Pioneer*, upon completing the present season's work, will take up surveys along the southern California coast, continuing until spring, when work on the Oregon coast from Coos Bay northward will be undertaken. The steamship *Discoverer*, at the close of the present season in western Alaska, will repair in San Francisco, and during the remainder of the winter will be employed on surveys in the Hawaiian Islands. Early in the spring operations will be taken up along the Washington coast from Cape Flattery southward. The steamship *Surveyor* will continue on the coast of southeastern Alaska until it has been surveyed out to a depth of 1,000 fathoms and as far northward as Icy Point. The *Explorer* will continue work in the southern part of Chatham Strait and in the bays and arms on each side of that strait. Broken bottom areas will also be dragged. The motor ship *Natoma* will survey Kaigani Strait, two harbors on Tlevak Strait, and will then take up inshore work on the west coast of Kruzof Island. At least one vessel will be engaged during the winter in resurveys of Puget Sound.

HAWAIIAN ISLANDS.—As stated, the steamship *Discoverer* will work in Hawaiian waters during the winter. In addition to this party

a shore party will continue detailed inshore hydrography around the island of Oahu.

PHILIPPINE ISLANDS.—The steamship *Pathfinder* will work north of Luzon until next fall and then in the southern part of the Sulu Sea. The steamships *Fathomer* and *Marinduque* will work in the southern part of the Sulu Archipelago. One of these vessels will also make a current survey of San Bernardino Strait. These operations are in conformity with a program for the completion of the survey of the entire archipelago, which was drawn up this year after an inspection of the islands and a study of the work already accomplished.

GEODETIC WORK

TRIANGULATION.—The greater part of the geodetic work planned for the fiscal year 1926 lies in the western portion of the United States. It consists in completing the initial development of first-order triangulation west of the ninety-eighth meridian. During the first half of the fiscal year four parties will be engaged in northern Idaho and in Washington, along the forty-ninth parallel and in regions south of the boundary. Another party will complete the belt of triangulation begun last year, which will extend from the ninety-eighth meridian near Sioux Falls, S. Dak., westward to the Black Hills, and thence northwestward to the vicinity of Bozeman, Mont., connecting with the triangulation of both the one hundred and fourth and the one hundred and eleventh meridians. Another party is extending triangulation from the vicinity of Needles, Calif., to Great Salt Lake, connecting at each end with first-order triangulation arcs already in existence. In order to complete the initial scheme in the western portion of the United States, it was necessary to discontinue triangulation in Alaska begun three years ago and also to omit all first order traverse. Indications are that little triangulation will be executed during the second half of the fiscal year 1926 because the funds available will be more urgently needed on traverse and leveling.

TRAVERSE.—As already stated, no traverse will be executed during the first half of 1926. It is probable, however, that one or two parties will be started in either Minnesota or Wisconsin in the spring of the calendar year 1926.

PRECISE LEVELING.—Only three leveling parties will be operating during the latter part of the field season of 1925. One will work in South Dakota, running westward from Sioux Falls over the line of first order traverse executed in 1924, and extending toward the Black Hills where a connection will be made with an existing line of levels. A second party will be operating in eastern California, first between Laws and Mojave, and later for a short period in the vicinity of Los Angeles. The party will then be transferred to western Arizona where a line will be run across country from Yucca by way of Swansea, Bouse, Salome, and Hassayampa to Gila Bend where it will connect with a line of levels run by the Geological Survey. The third party will operate in Colorado from Colorado Springs by way of Pueblo and Salida to Leadville. The party is operating in cooperation with the Geological Survey, which bureau is furnishing the funds for party expenses. In the spring of 1926 there will probably be two parties in west central Texas, and if funds permit perhaps another party in

California, both of which will be working on projects requested by the Geological Survey.

ASTRONOMIC WORK.—One astronomic party will observe for longitude and latitude and occasionally for azimuth at triangulation stations in several western States, beginning in South Dakota and ending in Washington. It is not likely that any astronomic work will be done in the spring of 1926. No gravity observations are contemplated, although some experimental work may be done in connection with the testing of new apparatus.

RECONNAISSANCE.—A single reconnaissance party will operate during the summer of 1925 in central Alaska selecting stations for triangulation, from Fairbanks eastward along the Tanana and Goodpaster Rivers to a connection with the international boundary triangulation in the vicinity of Eagle.

MAGNETIC AND SEISMOLOGICAL WORK

PROPOSED FIELD WORK.—Repeat stations will be occupied throughout the northwestern States, in northern New England, and in the middle Western States. It is hoped to place a party in the interior of Alaska to carry on needed repeat work and extension of the survey. Additional magnetic results are expected in the Aleutian Islands. The observatories will continue their usual routine work. Special investigations will be made at Cheltenham. The Porto Rico Observatory will be completed and placed in operation. The improvement of instrumental details at the observatories will be continued.

TIDE AND CURRENT WORK

During the months of July, August, and September, 1925, it is proposed to make current observations in the narrow passes of southeastern Alaska from Dixon Entrance to Cross Sound. This work can not be considered comprehensive and final as in the case of the surveys in New York Harbor, San Francisco Harbor, and Delaware Bay. The territory to be covered is too considerable for the funds available for current and tide work.

Primary tide stations representative of tide conditions along different stretches of the coast will be maintained for the full year at the following places:

Boston.	Galveston Jetty Light.
Atlantic City.	Los Angeles.
Cape May.	La Jolla.
Philadelphia.	San Francisco.
Baltimore.	Astoria.
Washington.	Seattle.
Charleston.	Olympia.
Daytona.	Honolulu.
Key West.	Ketchikan.
Cedar Key.	Seward.
Pensacola.	Valdez.

These stations are for the purpose of determining the tidal planes of mean sea level for the control of precise level nets and also for the control of hydrographic work along the coasts of the United States.

Density and temperature observations will be continued at a number of these stations.

A precise-level party will visit the locations of discontinued tidal stations along a section of the Atlantic coast for the purpose of leveling to old nonregulation bench marks as they may be recovered. Sufficient standard disk bench marks will be installed to comply with the present policy of the bureau of maintaining five standard marks at all stations having a year of observations and one for each additional year of observations with a maximum of 10 standard marks. This work is necessary in order to perpetuate long series of observations now protected by only a few nonregulation bench marks, many of which have been destroyed and others in danger of being lost. It is intended to extend this work over a long period and to bring it up to date gradually by doing only as much work each year as the appropriation permits.

During the year the bureau will recover, if possible, old tidal bench marks protecting tidal planes obtained from a long series of observations made many years ago at Port Townsend, Wash. Sufficient new standard bench marks will be established to bring the number up to standard requirements.

Current observations will be continued on the Atlantic coast at Diamond Shoals and Savannah Light Vessels and on the Pacific coast at Blunts Reef Light Vessel. Instead of hourly observations throughout the entire day observations will be made only at 8 a. m., noon, 4 and 8 p. m.

Part IV.—DISTRIBUTION OF PARTIES OF THE COAST AND GEODETIC SURVEY DURING THE FISCAL YEAR ENDED JUNE 30, 1925

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

Abbreviations used: A=area square statute miles; M=statute miles; P=number geographic positions; S=number soundings; Sta.=stations]

Operations	Persons conducting operations	Localities of work
Topography, A5, M10; hydrography, A7, S8,158; tidal work, 4 sta.; current work, 4 sta.	Lt. G. L. Bean, July 1-Aug. 18; P. R. Hathorne, D. O.	Scituate Harbor, Mass.; Fire Island Inlet, N. Y.
Triangulation, A5.8, P1; topography, A2.5, M5.8, hydrography, A3, S5,485; tidal work, 1 sta.	Lt. E. H. Bernstein, Oct. 7-30; P. R. Hathorne, D. O.	Beach Haven Inlet, N. J.
Triangulation, A2.5, P28; traverse, 4 miles; topography, A3, M15.	Lt. E. W. Eickelberg, Sept. 1-Dec. 8..	Shore line Potomac River from Alexandria, Va., to Rosslyn, Va. (Virginia side).
Triangulation, A3, P17; topography, A3, M6.4; leveling, length 5 miles, B. M. 13.	Lt. G. L. Bean, Mar. 24-Apr. 23; Lt. (J. G.) N. B. Smith.	Potomac River, Key Bridge to northwest boundary D. C. (Virginia side).
Topography, A3, M3.5; hydrography, A5.4, S8,272; tidal work, 1 sta.	Lt. R. J. Auld, July 1-Sept. 2; Ensign L. H. Hubbard.	Baltimore Harbor, Md.
Topography, A17, M54.7; hydrography, A1,491, S32,918; tides, 3 sta.; currents, 79 sta.; magnetics, 3 ship swings.	Steamer Lydonia, July 1-Dec. 20; Lt. H. A. Cotton, comd'g; Lt. R. P. Eyman, exec. off.; John Wyer, ch. engr.; Lt. R. D. Horne; Lt. E. H. Bernstein to Aug. 18; Lt. (J. G.) W. G. Craib after July 26; Ensign H. J. Petersen; S. B. Grenell (D. O.); W. M. Gibson (D. O.) after Sept. 6.	Offshore hydrography east and south of Frying Pan Shoals and topographic work and inshore hydrography from completed work in vicinity of Cape Fear River to Little River Inlet.
Hydrography, tall signals erected; buoys placed and located.	Steamer Lydonia, June 8-30; Lt. Comdr. F. G. Engle, comd'g; Lt. E. W. Eickelberg, exec. off.; Harry Ely, ch. engr.; Lt. (J. G.) H. C. Warwick; Lt. (J. G.) W. G. Craib; Lt. (J. G.) Alfred Ogram; W. M. Gibson, D. O.	Offshore work Cape Fear River south.
Triangulation, A95, P14; topography, A117, M467.8; hydrography, A574, S94,806; tidal work, 12 sta.; current work, 1 sta.	Steamer Bache, July 1-June 20; Lt. F. S. Borden, comd'g; C. A. Egner, exec. off., from Mar. 14; Lt. L. D. Graham to Nov. 10 (in charge launch Elsie); Lt. Geo. L. Bean, Oct. 18-Dec. 15 (in charge launch Mikawe); Lt. W. D. Patterson, exec. off. to Nov. 26; Lt. (J. G.) L. C. Wilder, Dec. 16-June 15 (in charge launch Mikawe); C. N. Conover, ch. engr., to Feb. 15; Lt. (J. G.) J. A. McCormick, Dec. 22-June 19; Lt. (J. G.) W. G. Craib to July 19; Lt. (J. G.) T. B. Reed to Nov. 10; Lt. (J. G.) I. Rittenberg to June 15; Ensign C. L. Aslakson to Mar. 24; Ensign Daniel Fivel to Sept. 29; Ensign J. M. Neal; E. J. Burke, D. O.; F. G. Johnson, D. O., Sept. 20 to Nov. 3; Laurence Burroughs, D. O. from Mar. 30.	Topography and inshore hydrography from about 6 miles south of St. Augustine Inlet north to the Savannah River, including surveys of entrances to the many sounds and bays along the coast.
Triangulation, A17.5, P2; topography, A9.2, M60.4, hydrography, A242, S13,925; tidal work, 2 sta.; current work, 1 sta.	Steamer Lydonia, Mar. 5 to May 23; Lt. Comdr. F. G. Engle, comd'g; Lt. E. W. Eickelberg; John Wyer, to Mar. 20, ch. engr.; Lt. (J. G.) H. C. Warwick, Lt. (J. G.) W. G. Craib; Lt. (J. G.) Alfred Ogram, from Apr. 30; W. M. Gibson, D. O.	East coast of Florida, vicinity Ormond; sounding line taken to 1,000-fathom curve to test fathometer.
Triangulation, A92, P13; topography, A146, M189; hydrography, A604.4, S66,087; tidal work, 8 sta.	Launch Elsie, Dec. 12 to Apr. 24; Lt. L. D. Graham in charge; Lt. (J. G.) T. B. Reed; Ensign F. G. Johnson.	Lake Okeechobee, Fla.
Triangulation, A28, P7; hydrography, A300, S20,226; tidal work, 8 work, 2 sta.	Steamer Hydrographer, July 16-Dec. 12; Lt. G. C. Jones, comd'g; Lt. (J. G.) C. M. Thomas; Lt. (J. G.) J. A. Kibler; Ensign R. C. Wilson; G. J. Danielson, D. O., from Sept. 20.	West coast of Florida, Tampa Bay and approaches.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY—Continued

Operations	Persons conducting operations	Localities of work
Triangulation, A270, P23; topography, A5, M66; hydrography, A178.6, S22,197; tidal work, 2 sta.; magnetics, 1 ship swing.	Steamer Hydrographer, Jan. 10-June 30, Lt. R. P. Eyman, comd'g.; Lt. (J. G.) W. T. Combs, from Feb. 8; Lt. (J. G.) C. M. Thomas, Jan. 10-Feb. 28; Ensign R. C. Wilson, Feb. 1-Mar. 23; Ensign P. A. Smith, from Mar. 22; G. J. Danielson, D. O. to Apr. 5; W. E. Strohm, D. O. from Mar. 6; Fred Olsen, asst. engr.	West coast of Florida, Tampa Bay and approaches.
Topography; A4.5, M7.0; hydrography, A5,744, S13,551; tidal work, 1 sta.	Steamer Guide, Jan. 12-May 21, Lt. Comdr. R. F. Luce to Feb. 9, comd'g; Lt. Comdr. T. J. Maher from Feb. 10, comd'g.; Lt. K. T. Adams to Jan. 25, exec. off.; Lt. G. D. Cowie from Jan. 26, exec. off.; Harry Ely, ch. engr.; Lt. L. P. Raynor; Lt. (J. G.) J. H. Service; Lt. (J. G.) G. W. Tatchell; Lt. (J. G.) H. B. Brown; Lt. (J. G.) R. C. Wilson; Ensign V. A. Powell from May 21; F. D. Porcher, D. O.	California coast offshore work, vicinity of San Clemente and Santa Catalina Islands.
Topography, M2; hydrography, A3,990, S2,490.	Steamer Pioneer, Dec. 23-Feb. 18, Lt. R. R. Lukens to Feb. 14, comd'g; Lt. Comdr. R. F. Luce from Feb. 15, comd'g.; Lt. O. S. Reading, exec. off.; Wm. E. Greer, ch. engr.; Lt. (J. G.) F. W. Hough; Lt. (J. G.) C. J. Itter; Lt. (J. G.) L. B. Clore; Lt. (J. G.) H. L. Bloomberg; Lt. (J. G.) E. P. Morton; Lt. (J. G.) D. W. Taylor; Ensign C. L. Nyman; Dr. F. P. Nevius, surgeon.	Offshore work, southern California coasts, vicinity of San Pedro.
Topography, A5, M11; hydrography, A489, S4,471; tidal work, 2 sta.	Steamer Discoverer, Oct. 29-Feb. 21, Lt. Comdr. C. L. Garner, comd'g; Lt. R. L. Schoppe, exec. off.; J. C. Herman, ch. engr.; Lt. M. O. Witherbee; Lt. H. W. Hemple to Feb. 28; Lt. (J. G.) W. T. Coombs to Dec. 13; Lt. (J. G.) J. M. Smook to Dec. 27; Lt. (J. G.) G. H. Dell; Lt. (J. G.) Charles Pierce to Dec. 6; Ensign G. E. Boothe to Dec. 18; T. T. Davey, D. O., to Dec. 16; W. Weidlich (mate) to Nov. 24; Dr. W. R. Scroggs, surgeon; Ensign H. A. Paton to Dec. 16.	Coast of California, vicinity Monterey Bay; small quantity revision work San Francisco Bay.
Triangulation, A9, P17; topography, A12, M24.2; hydrography, A1,116, S5,455; tides, 2 sta.	Steamer Guide, July 1-Nov. 12, Lt. Comdr. R. F. Luce, comd'g; Lt. K. T. Adams, exec. off.; Harry Ely, ch. engr.; Lt. G. D. Cowie; Lt. L. P. Raynor from Aug. 10; Lt. (J. G.) L. B. Clore; Lt. (J. G.) E. P. Morton from Aug. 10; Lt. (J. G.) J. H. Service from July 12; Lt. (J. G.) G. W. Tatchell; Lt. (J. G.) H. B. Brown; F. D. Porcher, D. O.	Oregon coast, vicinity Cape Blanco.
Hydrography, A1,575, S1,820; tides, 1 sta.	Steamer Guide, June 3-30, Lt. Comdr. T. J. Maher, comd'g; Lt. G. D. Cowie, exec. off.; R. P. Marshall, ch. engr.; Lt. L. P. Raynor; Lt. (J. G.) J. H. Service; Ensign V. A. Powell.	Do.
Hydrography, A6.5, S3,115; tidal work, 1 sta.	Lt. L. P. Raynor, July 7-22; Lt. (J. G.) E. P. Morton.	Coast of Washington, Willapa Bar.
Hydrography, A1.8, S286.	Comdr. R. B. Derickson, Feb. 9-15; Lt. (J. G.) H. E. Finnegan; Lt. (J. G.) R. W. Knox; Ensign A. F. Jankowski.	Willapa Bar, Wash.
Topography, M7.2; hydrography, A1.2, S1,044.	Comdr. R. B. Derickson, Dec. 15-Jan. 3; Lt. (J. G.) F. E. Joekel; Ensign P. C. Doran; Ensign A. F. Jankowski.	Quillayute River.
Triangulation, P37; hydrography, A4.8, S4,215; wire drag, A2.25, tide work, 3 sta.	Steamer Natoma, Mar. 10-June 30, Lt. H. B. Campbell, comd'g; Lt. O. S. Reading, exec. off.; A. Silva, ch. engr.; Lt. M. O. Witherbee from Mar. 31; Ensign C. I. Aslakson from May 29; Lt. (J. G.) A. J. Hoskinson to Apr. 4.	Examination Naval Anchorage, San Francisco; resurvey South Channel Entrance, San Francisco Bay; examination for rock near Point Wilson, Puget Sound; examination, entrance, Drayton Harbor, Wash.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY—Continued

Operations	Persons conducting operations	Localities of work
Triangulation, P64; topography, A136, M201; hydrography, A1,125.5, S17,116; tides, 2 sta.; magnetic work, 8 sta., 2 ship swings.	Steamer Surveyor, July 1-Oct. 15, Lt. A. M. Sobieralski, comd'g.; Lt. H. B. Campbell, exec. off.; H. G. Locke to July; R. P. Marshall, Aug.-Oct., ch. engr.; Lt. C. M. Durgin; Lt. R. R. Moore; Lt. R.W. Woodworth; Lt. (J. G.) H. E. Finnegan; Lt. (J. G.) A. W. Skilling; Lt. (J. G.) R. W. Knox; Ensign A. C. Zimmerman; R. W. Healy, mate; Dr. F. J. Soule, surgeon.	West Coast Baranof Island, Cape Ommaney to Crawfish Inlet, including numerous deep bays and arms; east coast Baranof Island from Cape Ommaney to Port Alexander, including detailed survey of latter port; hydrography from beach to 1,000-fathom curve and development of bays, etc.
Triangulation, A126, P29; topography, A98, M259; hydrography, A1,995, S10,198; tidal work, 2 sta.; magnetic work, 3 sta., 2 ship swings.	Steamer Surveyor, Apr. 4-June 30, Lt. A. M. Sobieralski, comd'g; Lt. H. A. Cotton, exec. off.; R. P. Marshall, ch. engr. to May 22; Lt. C. M. Durgin; Lt. (J. G.) A. P. Ratti; Lt. (J. G.) W. M. Scalfe; Lt. (J. G.) E. B. Roberts; Lt. (J. G.) A. F. Jankowski; Ensign P. R. Hathorne; R. W. Healy, mate; Dr. F. J. Soule, surgeon; G. Johanson, asst. engr. in charge engine room from May 23.	West Coast Baranof and Chichagof Islands, southeast Alaska.
Triangulation, A10, P11; topography, A71, M132; hydrography, A73.4, S11,235; wire drag, A101.4, S95; magnetics, 11 sta.	Steamer Explorer, July 1-Oct. 9, Lt. F. B. T. Siems, comd'g; Lt. Chas. Shaw, exec. off.; A. N. Loken, ch. engr.; Lt. J. A. Bond; Lt. (J. G.) F. E. Joekel; Lt. (J. G.) H. W. Tyler; Ensign B. Williams; A. A. Parker, D. O.; D. H. Askew, D. O., from July 10.	Kasaan Bay, Twelve-Mile Arm; Skowl Arm, Grindall Passage, and Thomas Bay.
Triangulation, A260, P19; topography, A70, M110; hydrography, A77.3, S9,511; wire drag, A23, S47; tidal work, 2 sta.	Steamer Explorer, Mar. 28-June 30, Lt. F. B. T. Siems, comd'g; Lt. R. D. Horne, exec. off.; A. Loken, ch. engr.; Lt. (J. G.) F. E. Joekel; Lt. (J. G.) H. W. Tyler; Lt. (J. G.) B. E. Lancaster; W. Weidlich, mate to Mar. 24; Ensign D. H. Askew, E. B. Latham, June 22-30.	Alaska, Gambier Bay, west coast Kuiu Island from Cape Decision north toward Point Harris.
Triangulation, A164, P26; topography, A253.8, M147.3; hydrography, A818.7, S19,268; tides, 2 sta.; magnetic work, 7 sta.	Steamer Discoverer, July 1-Sept. 26, Lt. Comdr. C. L. Garner, comd'g; Lt. R. L. Schoppe, exec. off.; J. C. Herman, ch. engr.; Lt. H. W. Hemple; Lt. M. O. Witherbee; Lt. W. T. Combs; Lt. (J. G.) J. M. Smook; Lt. (J. G.) G. H. Dell; Ensign H. A. Paton; W. Weidlich, mate; Dr. W. R. Scroggs, surgeon.	Shelikof Straits, Alaska, approaches to Wide and Portage Bay; survey of Jute Bay and Chignik Bay.
Triangulation, A2,200, P38; topography; M2, hydrography, A61, S1,022; tidal work, 3 sta.; magnetic work, 1 sta., 1 ship swing.	Steamer Discoverer, May 30-June 30, Lt. Comdr. C. L. Garner, comd'g; Lt. R. L. Schoppe, exec. off.; J. C. Herman, ch. engr.; Lt. (J. G.) Charles Pierce; Lt. (J. G.) R. W. Knox; Lt. (J. G.) L. S. Hubbard; Ensign H. J. Peterson; Dr. W. R. Scroggs, surgeon; T. T. Davey, D. O.; J. C. Partington, D. O.	Western Alaska; Chignik Bay and approaches.
Topography, A148.5, M152.6; hydrography, A352.5, S26,752; magnetic work, 1 ship swing; tides, 2 sta.; currents, 2 sta.	Steamer Pioneer, July 1-Sept. 26, Lt. R. R. Lukens, comd'g; Lt. O. S. Reading, exec. off.; William E. Greer, ch. engr.; Lt. (J. G.) C. J. Itter, jr.; Lt. (J. G.) A. J. Hoskinson; Lt. (J. G.) H. L. Bloomberg; Lt. (J. G.) D. W. Taylor; Lt. (J. G.) Charles Pierce; Ensign C. L. Nyman; Dr. F. P. Novius, surgeon; T. T. Davey, D. O.	Alaska, Cold and Pavlof Bays, Isanotski Straits.
Triangulation, A61, P15; topography, M62; hydrography, A130, S5,169; tidal work, 3 sta.; magnetic work, 1 ship swing.	Steamer Pioneer, Apr. 23-June 30, Lt. Comdr. R. F. Luce, comd'g; Lt. Chas. Shaw, exec. off.; W. E. Greer, ch. engr.; Lt. F. W. Hough; Lt. (J. G.) A. J. Hoskinson; Lt. (J. G.) E. P. Morton; Ensign S. D. Grenell; W. Weidlich, mate; Dr. H. E. Lawn, surgeon; R. L. Pfau, D. O.	Alaska, Ikatan Bay and work east along Alaska Peninsula. Line deep-sea soundings Cape Spencer to working grounds.
Topography; hydrography; magnetic work.	Lt. G. C. Jones, Apr. 15-June 30, Lt. (J. G.) J. C. Bose.	Alaska, reconnaissance, Aleutian Islands.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY—Continued

Operations	Persons conducting operations	Localities of work
Hydrography, A140.2, S20,860; wire drag, A102.1.	Steamer Ranger, July 1 to Dec. 4, May 7 to June 30, Lt. G. C. Mattison, comd'g; Lt. C. K. Green, exec. off.; H. W. Peerce, ch. engr.; Lt. E. H. Bernstein, Nov. 22–May 10; Lt. (J. G.) A. P. Ratti to Feb. 15; Lt. (J. G.) Alfred Ogram to Apr. 14; Lt. (J. G.) H. E. Finnegan from Mar. 22; Ensign V. A. Powell to Mar. 16; Ensign R. C. Rowse; Ensign C. F. Ehlers, from Oct. 4; H. W. Retter, D. O., from June 6; A. C. Thorsen, D. O., from May 7.	Virgin Islands, St. Thomas, St. Johns, St. Croix Islands.
Wire drag, A198, S153	Lt. C. K. Green, Dec. 4–May 7; Lt. (J. G.) Alfred Ogram to Apr. 14; Ensign R. C. Rowse; Ensign V. A. Powell to Mar. 16; C. F. Ehlers, D. O.; A. C. Thorsen, D. O., from Feb. 21.	Virgin Islands, St. Johns, and St. Thomas Islands.
Topography, M17.5; hydrography, A15.5, S14,267.	Lt. E. R. Hand, July 1–June 30	Hawaiian Islands, Island Oahu.
Triangulation, P16; topography, A3, M10; hydrography, A3.5, S7,937; tidal work, 5 sta.	Lt. (J. G.) R. W. Woodworth, Jan. 1–May 31; W. F. Malnate, D. O.	Hawaiian Islands; various harbors.
Triangulation, A2,660, P70; topography, A1, M11; hydrography, A33, S11,456; tidal work, 2 sta.; magnetic work, 3 sta.	Steamer Pathfinder, July 1–Oct. 24, Lt. O. W. Swainson, comd'g; Lt. C. A. Egner, exec. off.; John Collins, ch. engr.; Lt. (J. G.) R. F. A. Studds; Lt. (J. G.) R. W. Byrns; Ensign J. C. Sammons; R. C. Overton, mate.; Dr. J. V. Tormey, surgeon; A. Hunnycutt, ch. writer.	Philippine Islands, north coast of Luzon, and islands north of Luzon.
Triangulation, A2,070, P62; topography, M7; hydrography, A4, S4,274; tidal work, 3 sta.	Steamer Pathfinder, Mar. 6–June 30, Lt. O. W. Swainson, comd'g; Lt. F. L. Gallen, exec. off.; John Collins, ch. engr.; Lt. (J. G.) R. F. A. Studds; Lt. (J. G.) H. L. Bloomberg from May 2; Lt. (J. G.) J. C. Sammons; R. C. Overton, mate, to May 4; Ensign H. A. Paton; Dr. J. V. Tormey, surgeon; A. Hunnycutt, ch. writer.	Philippine Islands, detailed survey small bay west coast Negros, Mar. 6–17; inspection trip north and northeast coast of Luzon, Apr. 6–26; surveys north coast Luzon and islands north May 4–June 30.
Triangulation, A12, P36; topography, A1, M22.7; hydrography, A12.7, S22,102; tidal work, 1 sta.; current work, 4 sta.	Steamer Pathfinder, Nov. 6–Dec. 28, Lt. O. W. Swainson, comd'g; Lt. C. A. Egner to Nov. 8, exec. off.; Lt. F. L. Gallen from Nov. 21–Dec. 28; John Collins, ch. engr.; Lt. (J. G.) R. F. A. Studds; Ensign J. C. Sammons; R. C. Overton, mate; Dr. J. V. Tormey, surgeon; A. Hunnycutt, ch. writer.	Philippine Islands; resurvey Cebu Harbor.
Triangulation, A30, P28; topography, A17.5, M150.6; hydrography, A49, S53,320; tidal observations, 2 sta.; magnetic observations, 1 ship swing, 9 sta.	Steamer Marinduque, Apr. 6–June 30, Lt. F. L. Peacock, comd'g.; Lt. J. A. Bond, exec. off.; F. L. Chamberlain, ch. engr. to June 11; C. N. Conover, ch. engr., June 12–30; Lt. (J. G.) G. L. Anderson; Lt. (J. G.) K. G. Crosby; F. E. Okeson, mate; P. A. Davis, surgeon, from May 4.	Philippine Islands, west Coast Palawan Island, Malampaya Sound.
Triangulation, A1139.5, P86; topography, A130, M46.4; hydrography, A 489.6, S45,059; magnetic work, 16 sta., 2 ship swings; current work, 3 sta.	Steamer Fathomer, July 1–Oct. 20, Lt. J. H. Peters, comd'g.; Lt. F. L. Gallen, exec. off.; G. W. Hutchinson, ch. engr.; Lt. (J. G.) B. H. Rigg; Lt. (J. G.) H. A. Karo; Ensign V. A. Bishop; Dr. W. H. Spinks, surgeon from Sept. 28.	Philippine Islands, Sulu Archipelago, vicinity of Jolo.
Triangulation, A150, P10; topography, A95.7, M138.5; hydrography, A881.8, S85,351; tidal work and current work, 3 sta.; magnetic work, 4 sta., 1 ship swing.	Steamer Fathomer, Jan. 11–June 30, Lt. J. H. Peters, comd'g; Lt. R. R. Moore, exec. off. from Feb. 7; G. W. Hutchinson, ch. engr.; Lt. (J. G.) C. D. Meaney, exec. off. to Feb. 6; Lt. (J. G.) H. A. Karo; Ensign V. A. Bishop.	Do.
Triangulation, A120, P10; topography, A24, M118.9; hydrography, A1787, S53,668; tidal work, 3 sta.; current work, 1 sta.; magnetic work, 1 sta.; ship swings, 1 sta.	Steamer Marinduque, July 11–Nov. 25, Lt. F. L. Peacock, comd'g; Lt. (J. G.) C. D. Meaney, exec. off.; F. L. Chamberlain, ch. engr.; Lt. (J. G.) H. C. Warwick to Sept. 20; Lt. (J. G.) G. L. Anderson; Lt. (J. G.) K. G. Crosby; F. E. Okeson, mate.	Philippine Islands, Sulu Archipelago, south and east coasts Basilan Island.

DIVISION OF HYDROGRAPHY AND TYPOGRAPHY—Continued

Operations	Persons conducting operations	Localities of work
Planning and issuing instructions for field work; compilation and publishing charts and sailing directions of the Philippine Islands; all drafting, adjustments, and computing needed on field records; furnishing information to the public; sale of charts and nautical publications.	Field station, Manila, July 1-June 30, Lt. Comdr. H. A. Seran, director of coast surveys; John Bach, ch. drafting division; R. Christman to Apr. 17, chief chart division; W. L. G. Perry, chief, photolithographic division; C. F. Maynard, chief computing division; C. E. Christopherson, asst. chief drafting division; Lloyd Miles, chief clerk.	Philippine Islands.
Furnishing information relative to our coasts to the public; inspection of navigable waters of district for purpose of keeping charts and other nautical publications of the Coast and Geodetic Survey correct to date.	Field station, Boston, July 1-June 30, Lt. Comdr. D. B. Wainwright (ret.) in charge; H. R. Russell, clerk.	408 Atlantic Avenue, Boston, Mass.
Do	Field station, New York, July 1-June 30, Lt. Comdr. F. G. Engle, to Feb. 11, in charge; Lt. K. T. Adams, from Feb. 12, in charge; T. T. Lyons, clerk.	312 Maritime Exchange Building, 78 Broad Street, New York, N. Y.
Do	Field station, New Orleans, July 1-June 30, Robert Boyd, clerk, in charge.	314 Customhouse, New Orleans, La.
Do	Field station, San Francisco, July 1-June 30, Comdr. H. C. Denson, to Feb. 24, in charge; Comdr. P. C. Whitney, May 7 to June 30, in charge; H. A. Ballard, tide observer, temporarily in charge, Feb. 25 to May 6.	305 Customhouse, San Francisco, Calif.
Furnishing information relative to our coasts to the public; inspection of navigable waters of district for purpose of keeping charts and other nautical publications of the Coast and Geodetic Survey correct to date; furnishing stationery and surveying equipment for vessels and field parties working in this district.	Field station, July 1-June 30, Comdr. R. B. Derickson in charge; Lt. (J.G.) D. E. Whelan, jr., May 1 to June 30; Mary A. Palmer, clerk; W. C. Meyers, tide observer and skilled laborer.	202 Burke Building, Seattle, Wash.

DIVISION OF GEODESY

Triangulation and reconnaissance, first order: Triangulation 60 miles, 550 square miles; reconnaissance 70 miles, 1,400 square miles.	Lt. (J. G.) W. M. Scaife, chief; Ensign P. C. Doran; Sam O. White.	Cook Inlet to Fairbanks, Alaska.
Traverse and triangulation, first order: Traverse, 83 miles; triangulation, 175 miles, 2,500 square miles.	Lt. H. Odessey, chief; Lt. (J. G.) G. E. Boothe; Lt. (J. G.) L. G. Simmons.	Salem to Chamberlain to Wall, S. Dak.
Triangulation, first order, 50 miles, 1,000 square miles.	Lt. (J. G.) A. H. Wagener, chief; Lt. (J. G.) H. M. Hill.	West of Glacier National Park, Mont., part of cooperation plan with Geodetic Survey of Canada.
Reconnaissance, triangulation, first order, 265 miles, 5,800 square miles.	Lt. (J. G.) E. O. Heaton, chief; Lt. (J. G.) Dan W. Taylor.	Along forty-ninth parallel in Idaho, Washington, and British Columbia.
Triangulation and reconnaissance, 60 miles, 350 square miles.	W. Mussetter, chief; Lt. (J. G.) E. M. Buckingham; W. J. Bilby.	Northern Minnesota.
Triangulation, first order, 40 miles, 1,250 square miles.	Lt. Jack Senior, chief; Lt. (J. G.) Jas. F. Downey, jr.; Lt. (J. G.) W. H. Bainbridge.	Triangulation figure spanning Dixon Entrance, connecting triangulation brought up by Canadians from Puget Sound with first-order triangulation in southeast Alaska.
Reconnaissance, triangulation, first order, 470 miles, 10,000 square miles.	J. S. Bilby, chief	In South Dakota, Wyoming, and Montana toward one hundred eleventh meridian
Triangulation, first order, 85 miles, 3,800 square miles.	Lt. (J. G.) F. W. Hough, chief	Imperial Valley.
Triangulation, first order, 60 miles, 1,200 square miles.	do	Along Santa Barbara Channel, Calif.

DIVISION OF GEODESY—Continued

Operations	Persons conducting operations	Localities of work
Triangulation, first order, 165 miles, 2,500 square miles.	Lt. H. Odessey, chief; Lt. (J. G.) L. G. Simmons; Ensign P. A. Smith; Lt. (J. G.) D. W. Taylor.	San Antonio westward to Del Rio, Tex.
Triangulation, third order, 75 miles, 325 square miles.	Steamer Surveyor, Lt. A. M. Sobieralski.	Baranof Island, Alaska.
Triangulation, third order, 30 miles, 180 square miles.	Steamer Explorer, Lt. F. B. T. Siems.	Twelve Mile Arm, Chatham Strait, Pybus Bay, Alaska.
Triangulation, third order, 20 miles, 100 square miles.	Steamer Discoverer, Lt. Comdr. C. L. Garner.	Chignik and Castle Bays, Alaska.
Triangulation, third order, 90 miles, 500 square miles.	Steamer Pioneer, Lt. R. R. Lukens and Lt. Comdr. R. F. Luce.	Isanotski Strait, Belkofski Bay, Pavlof Bay, Alaska.
Triangulation, third order, 10 miles, 10 square miles.	Steamer Guide, Lt. R. F. Luce and Lt. Comdr. T. J. Maher.	Coos Bay, Oreg.
Triangulation, third order, 15 miles, 80 square miles.	Steamer Natoma, Lt. H. B. Campbell.	San Francisco Bay, Calif.; Blaine, Wash.
Triangulation, third order, 40 miles, 65 square miles.	Steamer Bache, Lt. F. S. Borden	St. Johns River, Fla.; St. Simon Island, Ga.; St. Catherine Sound, Ga.; Wassaw Sound, Ga.
Triangulation, third order, 10 miles, 25 square miles.	Steamer Hydrographer, Lt. G. C. Jones and Lt. R. P. Eyman.	Tampa Bay, Fla.
Triangulation, third order, 5 miles, 15 square miles.	Steamer Lydonia, Lt. H. A. Cotton and Lt. Comdr. F. G. Engle.	Vicinity of Daytona, Fla.
Triangulation, third order, 20 miles, 90 square miles.	Lt. L. D. Graham	Lake Okeechobee, Fla.
Triangulation, third order; triangulation 5 miles, 5 square miles; traverse, 4 miles.	Lt. E. W. Eickelberg and Lt. G. L. Bean.	District of Columbia-Virginia boundary, District of Columbia and Virginia.
Triangulation, third order, 10 miles, 10 square miles.	Lt. (J. G.) R. W. Woodworth	Molokai and Maui Islands; Hawaiian Islands.
Triangulation, third order, 5 miles, 15 square miles.	Comdr. R. B. Derickson	Willapa Bay, Wash.
Triangulation, third order, 5 miles, 10 square miles.	Lt. E. H. Bernstein	Beach Haven Inlet, N. J.
Reconnaissance and signal building, trinagulation, first order, 165 miles, 2,500 square miles.	J. S. Bilby, chief	San Antonio to Del Rio, Tex.
Triangulation and traverse, first order and reconnaissance: Reconnaissance, 8 miles, 40 square miles; triangulation, 8 miles, 40 square miles; traverse 33 miles; reconnaissance for traverse 50 miles.	Lt. (J. G.) E. O. Heaton, chief; Lt. (J. G.) A. H. Wagener; Lt. (J. G.) L. G. Simmons; Lt. G. L. Bean; Ensign R. J. Sipe; Lt. (J. G.) D. B. Pheley.	Region of City of Rochester N. Y.
Triangulation, first order, 140 miles, 4,500 square miles.	W. Mussetter, chief; Ensign P. C. Doran; Lt. (J. G.) D. W. Taylor.	Sacramento to Ukiah Latitude Station, Calif.
Reconnaissance, triangulation, and traverse, first order: Reconnaissance, 80 miles, 1,200 square miles; traverse, 300 miles.	J. S. Bilby, chief; W. J. Bilby	Vicinity of Houston, Tex., to Fort Smith, Ark.
Reconnaissance, triangulation, and traverse, first order.	do	Making connections between traverse of first order at mouth of Red River and the Mississippi River triangulation; in Tennessee and Kentucky.
Traingulation, first order, 100 miles, 6,000 square miles.	W. Mussetter, chief; Lt. (J. G.) E. A. Deily.	Needles, Calif., to Salt Lake City, Utah.
Reconnaissance, triangulation, first order.	Sam O. White, chief	Fairbanks to Eagle, Alaska.
Triangulation, first order, 100 miles, 2,500 square miles.	Lt. H. Odessey, chief; Lt. (J. G.) C. M. Thomas; Lt. (J. G.) D. B. Pheley.	From Black Hills westward to vicinity of Bozeman, Mont., connection to be made to arc of first order triangulation extending from vicinity of Pocatello, Idaho, northward to Canadian boundary.
Marking and preparing stations for triangulation, first order, 150 miles, 3,500 square miles.	W. J. Bilby, chief	From Black Hills westward to Bozeman, Mont.
Triangulation, first order, 20 miles, 400 square miles.	Lt. (J. G.) A. H. Wagener, chief; Lt. (J. G.) E. M. Buckingham.	Forty-ninth parallel, high mountains west of Glacier National Park.
Triangulation, first order	Lt. G. L. Bean, chief	Forty-ninth parallel.
Triangulation, first order	Ensign P. C. Doran, chief; John Bowie, jr.	Forty-ninth parallel, westward of Loomis, Wash.

DIVISION OF GEODESY—Continued

Operations	Persons conducting operations	Localities of work
Triangulation, first order	Lt. (J. G.) W. H. Bainbridge, chief; Lt. (J. G.) D. W. Taylor.	In State of Washington, triangulation joining forty-ninth parallel and Utah-Washington arc.
Reconnaissance and preparing stations for triangulation, first order, 50 miles, 1,000 square miles.	J. S. Bilby, chief	Do.
Reconnaissance, triangulation, first order, 30 miles, 200 square miles.	Lt. Jack Senior, chief; Lt. J. W. Hemple.	Chilkoot Inlet, Alaska.
Triangulation and traverse, second order; triangulation, 25 miles, 90 square miles, traverse, 5 miles.	Lt. (J. G.) E. B. Roberts, chief; Ralph L. Pfau.	Charleston to Winyah Bay, S. C.
Triangulation, second order, 75 miles, 700 square miles.	Lt. (J. G.) J. M. Smook, chief; B. S. Williams.	Frederick Sound and Chatham Strait, Alaska.
Triangulation, second order, 20 miles, 150 square miles.	W. Mussetter, chief; Ensign P. C. Doran; Lt. (J. G.) D. W. Taylor.	Lower San Francisco Bay, Calif., revision work.
Triangulation, third order, 30 miles, 300 square miles.	Lt. (J. G.) J. M. Smook, chief; Bruce E. Lancaster.	Coastal triangulation, vicinity of Crescent City, Calif.
Leveling, first order, 177 miles	Lt. (J. G.) F. W. Hough, chief	Santa Ana to Barstow, Calif.; Burbank to Fernando, Calif.; Riverside to Ontario, Calif.
Leveling, first order, 207 miles	Lt. (J. G.) E. B. Roberts, chief; Lt. (J. G.) J. C. Bose.	Perth Amboy-Atlantic City, N. J.; Pleasantville-Cape May, N. J.; Delair, N. J.-Philadelphia, Pa.
Leveling, revision, 10 miles	Lt. H. Odessey, chief	Perth Amboy, N. J.
Leveling, first order, 3 miles	Lt. (J. G.) G. E. Boothe, chief	San Francisco Bay, Calif.
Longitude, first order	Lt. (J. G.) D. B. Pheley, chief	California, Arizona, Texas, Oklahoma, Kansas, Colorado.
Longitude, first order	Lt. (J. G.) D. B. Pheley, chief; Lt. (J. G.) E. J. Brown.	Kansas, Colorado.
Latitude, longitude, azimuth, first order, azimuth, second order.	Lt. H. Odessey, chief; Lt. (J. G.) E. J. Brown; Lt. (J. G.) L. G. Simmons.	San Antonio-Del Rio, Tex.
Latitude, longitude, azimuth, first order.	Lt. (J. G.) E. J. Brown, chief; Ensign R. J. Sipe.	South Dakota, Nebraska.

DIVISION OF TIDES AND CURRENTS

Tide observations	C. H. Hudson	Series of tide observations at Portland, Me.
Do	Lt. Comdr. D. B. Wainwright; H. F. Russell.	Series of tide observations at Boston, Mass.
Current observations	W. B. Studley	Series of current observations on Nantucket Light Vessel.
Tide observations	S. S. Day	Series of tide observations at Atlantic City, N. J.
Tide and current observations	Lt. (J. G.) W. H. Overshiner; L. M. Zeskind; F. G. Outcalt; Ensigns A. F. Jankowski, Wm. F. Malnate, R. J. Sipe, J. M. Neal.	Tide and current survey of Delaware Bay and tributaries, from Trenton to the Capes.
Tide observations	J. R. Swartz	Series of tide observations at Philadelphia, Pa.
Do	Kent M. Redgraves	Series of tide observations at Cape May, N. J.
Do	Fred A. Kummell	Series of tide observations at Baltimore, Md.
Do	E. S. Brown	Series of tide observations at Washington, D. C.
Current observations	C. L. Swanberg	Series of current observations on Diamond Shoals Light Vessel.
Tide observations	L. C. Lockwood	Series of tide observations at Charleston, S. C.
Current observations	A. Nielson	Series of current observations on Savannah Light Vessel.
Tide observations	T. J. Wright, jr	Series of tide observations at Daytona Beach, Fla.
Do	R. H. Sands	Series of tide observations at Key West, Fla.
Do	T. C. Hodges	Series of tide observations at Cedar Keys, Fla.
Do	G. S. Kennedy	Series of tide observations at Pensacola, Fla.
Do	O. F. Southwick	Series of tide observations at Galveston, Tex.

DIVISION OF TIDES AND CURRENTS—Continued

Operations	Persons conducting operations	Localities of work
Tide observations	J. R. Watkins	Series of tide observations at San Diego, Calif.
Do	George R. McEwen	Series of tide observations at La Jolla, Calif.
Do	Harbor department, city of Los Angeles.	Series of tide observations at Los Angeles, Calif.
Do	H. C. Denson; Comdr. P. C. Whitney; H. S. Ballard.	Series of tide observations at San Francisco, Calif.
Current observations	P. E. Henriksen	Series of current observations on Blunts Reef Light Vessel.
Tide observations	J. M. Coleman	Series of tide observations at Astoria, Oreg.
Do	State engineer, State of Washington	Series of tide observations at Olympia, Wash.
Do	Comdr. R. B. Derickson; W. C. Meyer.	Series of tide observations at Seattle, Wash.
Do	Comdr. R. B. Derickson; T. C. Boalen.	Series of tide observations on the Duwamish River, Wash.
Do	Adolph Anderson	Series of tide observations at Ketchikan, Alaska.
Do	C. M. McGrath	Series of tide observations at Sitka, Alaska.
Do	Sam Knudson	Series of tide observations at Valdez, Alaska.
Do	E. J. Snyder	Series of tide observations at Seward, Alaska.
Do	E. D. Buchanan	Series of tide observations at Anchorage, Alaska.
Do	Territorial Government, Hawaii	Series of tide observations at Honolulu, Hawaii.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Repeat stations	R. R. Bodle, magnetic observer	Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, West Virginia.
Eclipse observations	do	Ithaca, N. Y.
Observatory	Geo. Hartnell and S. G. Townshend, jr., magnetic observers.	Cheltenham, Md.
Replacements	Lt. (J. G.) John A. McCormick	North Carolina.
Replacements and new stations	R. L. Anderson, junior engineer	Texas.
Repeat stations	R. R. Bodle, magnetic observer	Mississippi, Texas, Oklahoma, Kansas, Nebraska, Wyoming, Montana.
Observatory	Albert K. Ludy, magnetic observer	Tucson, Ariz.
Do	Franklin P. Ulrich, magnetic observer	Sitka, Alaska.
Declination	Steamers Explorer, Surveyor, Pioneer, Discoverer.	Observations at triangulation stations in southeastern and western Alaska.
New stations and repeat stations	Lt. G. C. Jones	Aleutian Islands.
Observatory	Wallace M. Hill and H. E. McComb, magnetic observers.	Ewa, Oahu, Hawaii.
Repeat stations	Wallace M. Hill, magnetic observer	Hawaii, Maui, Oahu, Hawaiian Islands.
Repeat stations and new stations	do	Philippine Islands.
Observatory	J. B. Goldsmith, magnetic observer	Vieques, P. R.
Selection of site and erection of new observatory.	Lt. R. J. Auld	Porto Rico.

Respectfully,

E. LESTER JONES, *Director.*

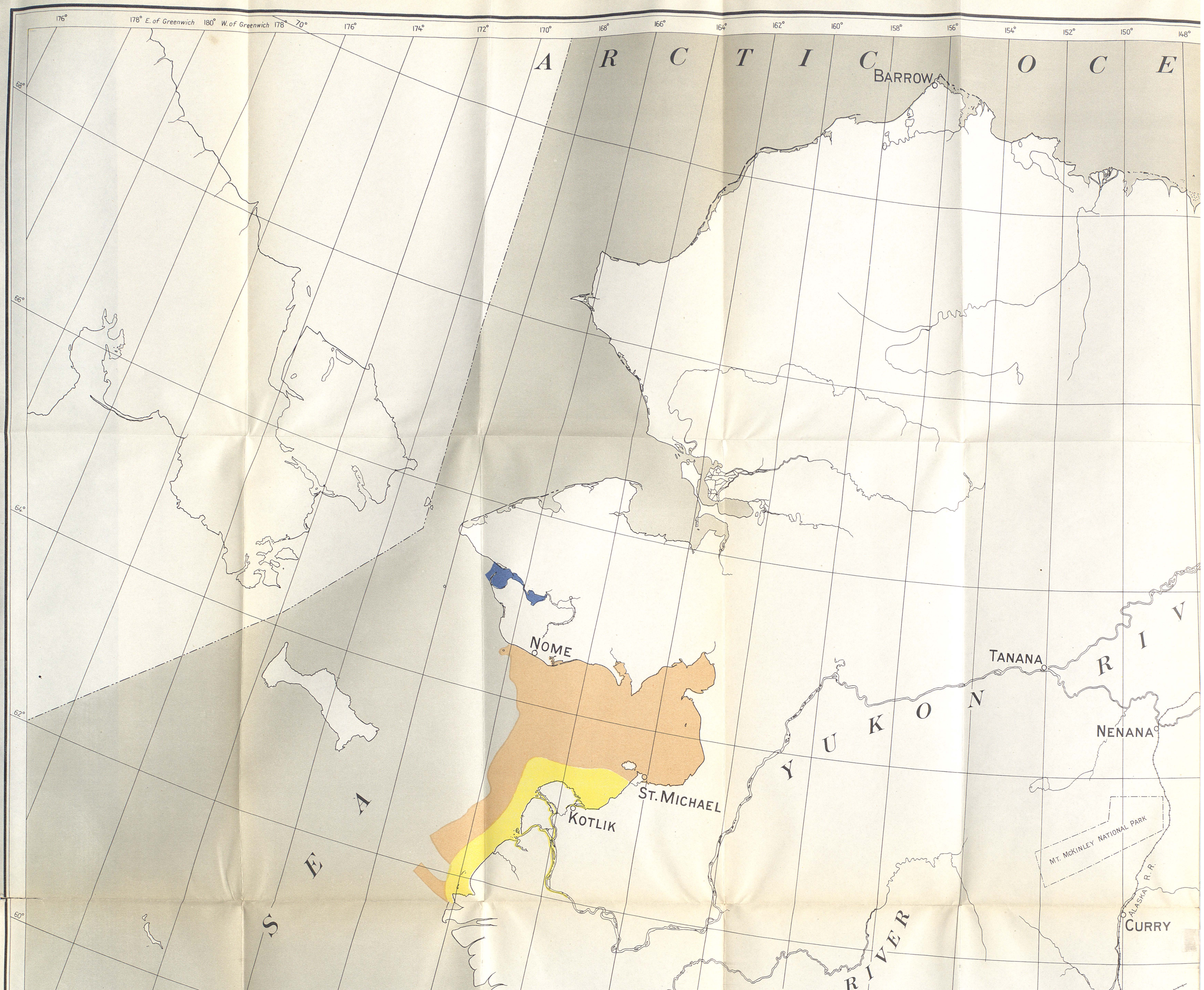
To Hon. HERBERT HOOVER,
Secretary of Commerce.

O

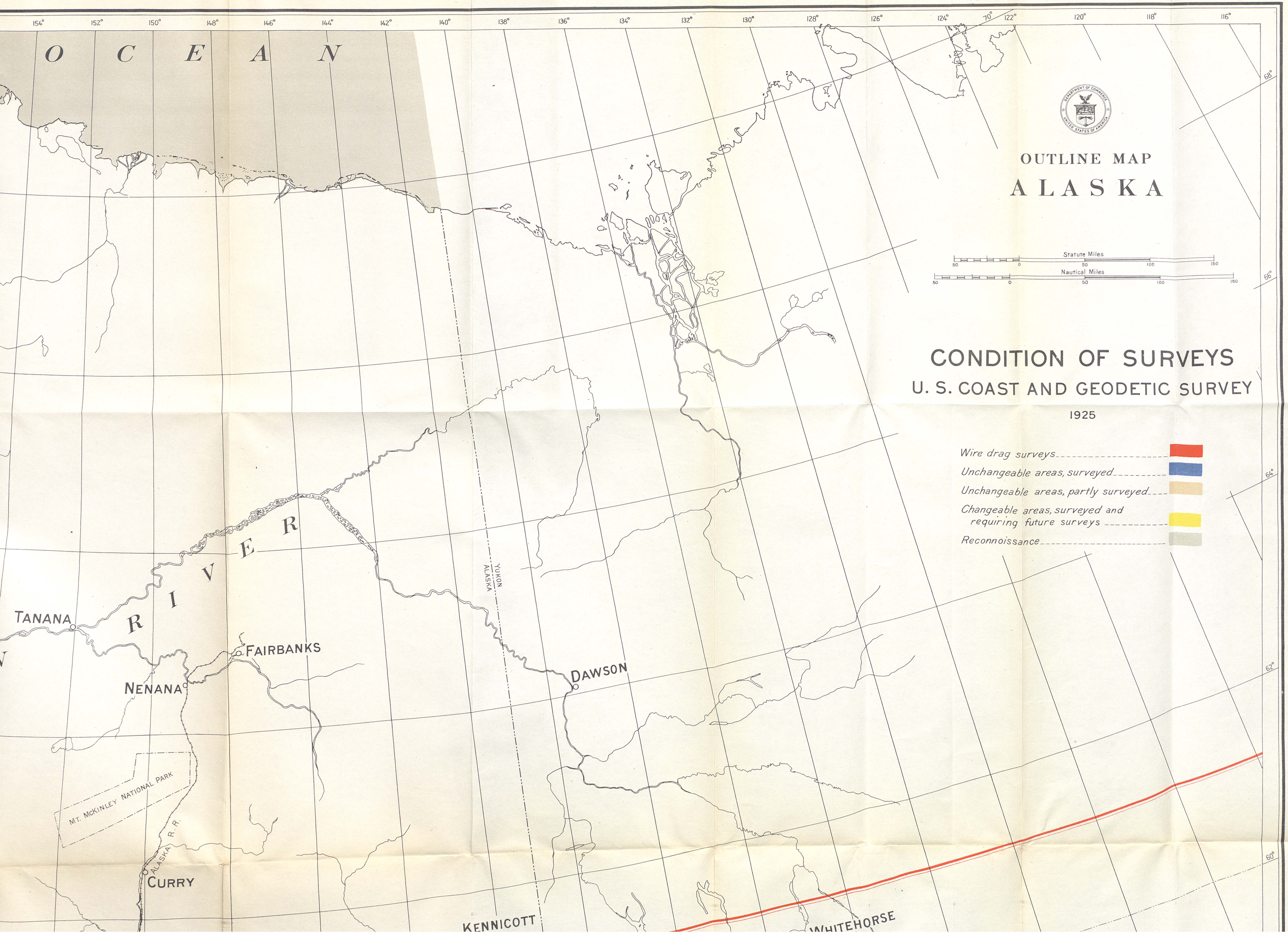
U.S. COAST AND GEODETIC SURVEY
CONDITION OF FIELD OPERATIONS
UNITED STATES
1925
Wire drag surveys
Unchangeable areas, surveyed
Unchangeable areas, partly surveyed
Changeable areas, surveyed and requiring future resurveys
Reconnoissance or unsurveyed
Triangulation completed
Triangulation begun
Precise traverse completed
Precise leveling completed
Precise traverse and precise leveling completed
Gravity stations, positions
Statute Miles
Nautical Miles
DOMINION OF
WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
NEBRASKA
NEVADA
UTAH
COLORADO
KANSAS
OKLAHOMA
TEXAS
ARIZONA
NEW MEXICO
IOWA
MINNESOTA
MISSOURI
ARKANSAS
LOUISIANA
CALIFORNIA
LOWER CALIFORNIA
PACIFIC OCEAN
GULF
SEATTLE
OLYMPIA
PORTLAND
SALEM
HELENA
BUTTE
BISMARCK
FARGO
DULUTH
BOISE
MERIDIAN
PIERRE
MINNEAPOLIS
ST. PAUL
POCATELLO
SIOUX FALLS
SIOUX CITY
OGDEN
SALT LAKE CITY
RENO
CARSON CITY
SACRAMENTO
SAN FRANCISCO
CHEYENNE
OMAHA
LINCOLN
DES MOINES
DENVER
TOPEKA
KANSAS CITY
JEFFERSON
PUEBLO
WICHITA
SANTA FE
ALBUQUERQUE
OKLAHOMA CITY
MUSKOGEE
FORT SMITH
LOS ANGELES
PHOENIX
TUCSON
DALLAS
AUSTIN
SAN ANTONIO
GALVESTON
Guadalupe
125°
120°
115°
110°
105°
100°
95°
45°
40°
35°
30°
25°

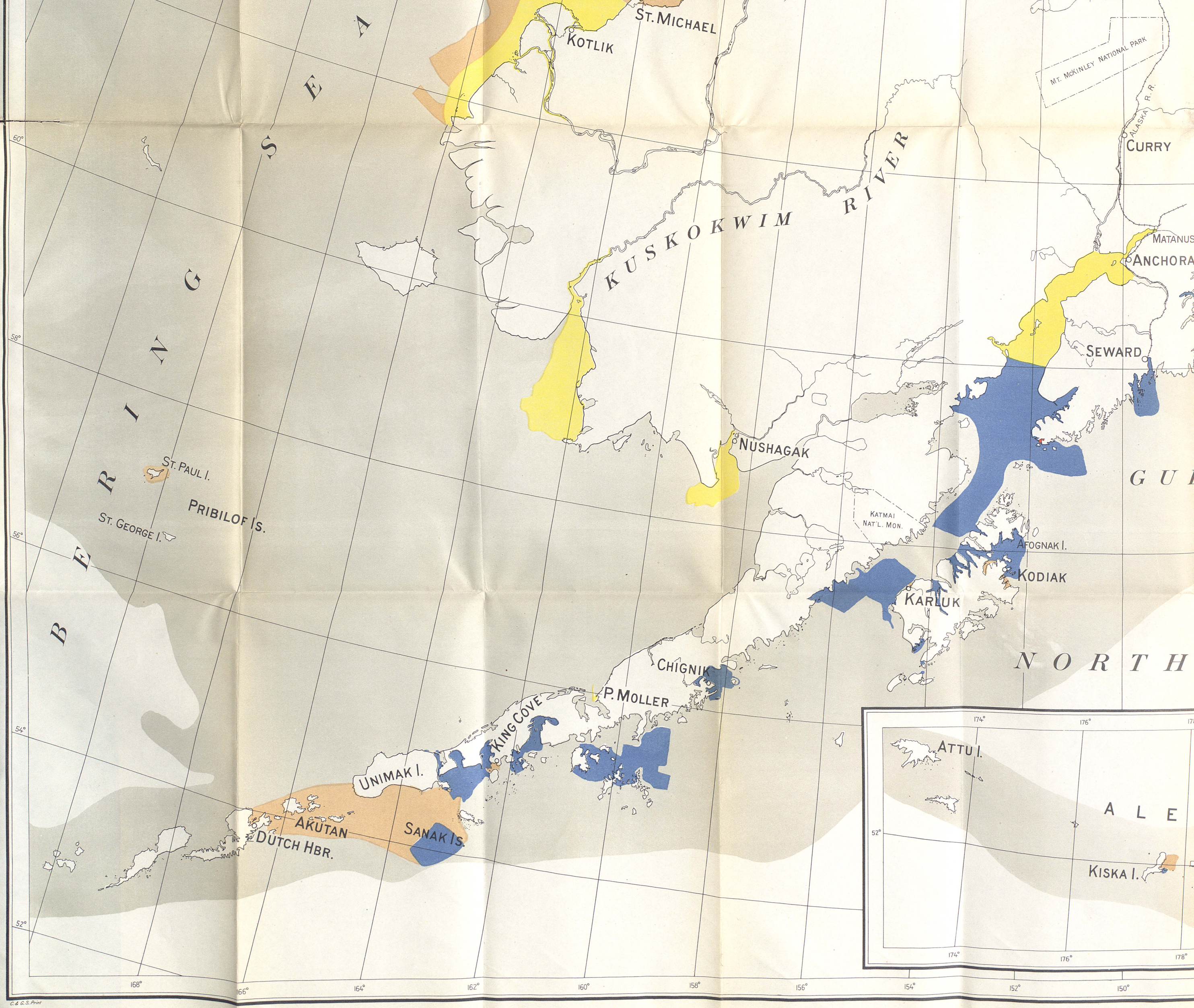
C. & G. S. Print

95°
90°
85°
80°
75°
70°
65°
46°
40°
35°
30°
25°
OF CANADA
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
VERMONT
NEW HAMP.
MAINE
MASS.
CONN.
R.I.
N.J.
DEL.
MD.
W. VIRGINIA
VIRGINIA
KENTUCKY
TENNESSEE
NORTH CAROLINA
S. CAROLINA
GEORGIA
ALABAMA
MISSISSIPPI
LOUISIANA
ARKANSAS
MISSOURI
KANSAS
NEBRASKA
OKLAHOMA
TEXAS
FLORIDA
ATLANTIC OCEAN
GULF OF MEXICO
BAHAMA ISLANDS
CUBA
FARGO
DULUTH
MINNEAPOLIS
ST. PAUL
SIOUX FALLS
SIOUX CITY
MADISON
MILWAUKEE
LANSING
DETROIT
CHICAGO
DES MOINES
OMAHA
LINCOLN
SPRINGFIELD
INDIANAPOLIS
CINCINNATI
COLUMBUS
CLEVELAND
BUFFALO
ALBANY
BURLINGTON
MONTPELIER
AUGUSTA
PORTLAND
CONCORD
PORTSMOUTH
BOSTON
WORCESTER
PROVIDENCE
HARTFORD
NEW HAVEN
NEW YORK
NEWARK
TRENTON
HARRISBURG
PHILADELPHIA
WILMINGTON
PITTSBURGH
WHEELING
DOVER
BALTIMORE
ANNAPOLIS
WASHINGTON, D.C.
CHARLESTON
RICHMOND
NORFOLK
FRANKFORT
LOUISVILLE
EVANSVILLE
NASHVILLE
RALEIGH
WILMINGTON
COLUMBIA
CHARLESTON
ATLANTA
BIRMINGHAM
MONTGOMERY
SAVANNAH
MERIDIAN
JACKSON
MOBILE
TALLAHASSEE
JACKSONVILLE
BATON ROUGE
NEW ORLEANS
GALVESTON
TAMPA
KEY WEST
HABANA
TOPEKA
KANSAS CITY
ST. LOUIS
JEFFERSON CITY
WICHITA
MUSKOGEE
FORT SMITH
MEMPHIS
LITTLE ROCK
DALLAS
AUSTIN

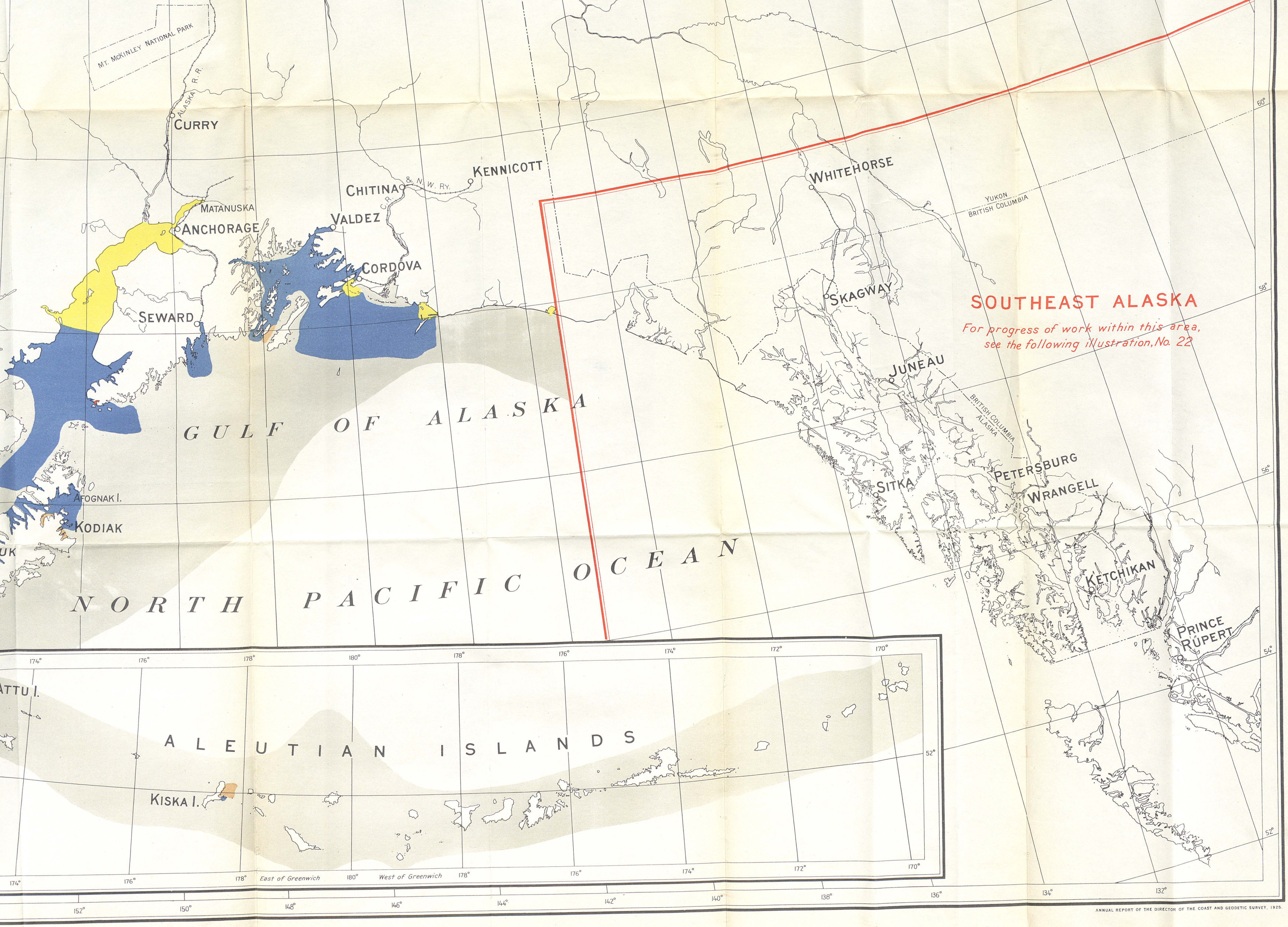

176°
178° E. of Greenwich
180° W. of Greenwich
178°
70°
176°
174°
172°
170°
168°
166°
164°
162°
160°
158°
156°
154°
152°
150°
148°
68°
66°
64°
62°
60°
ARCTIC OCE
BARROW
NOME
ST. MICHAEL
KOTLIK
SEA
YUKON RIV
YUKON RIVER
TANANA
NENANA
MT. McKINLEY NATIONAL PARK
ALASKA R.R.
CURRY

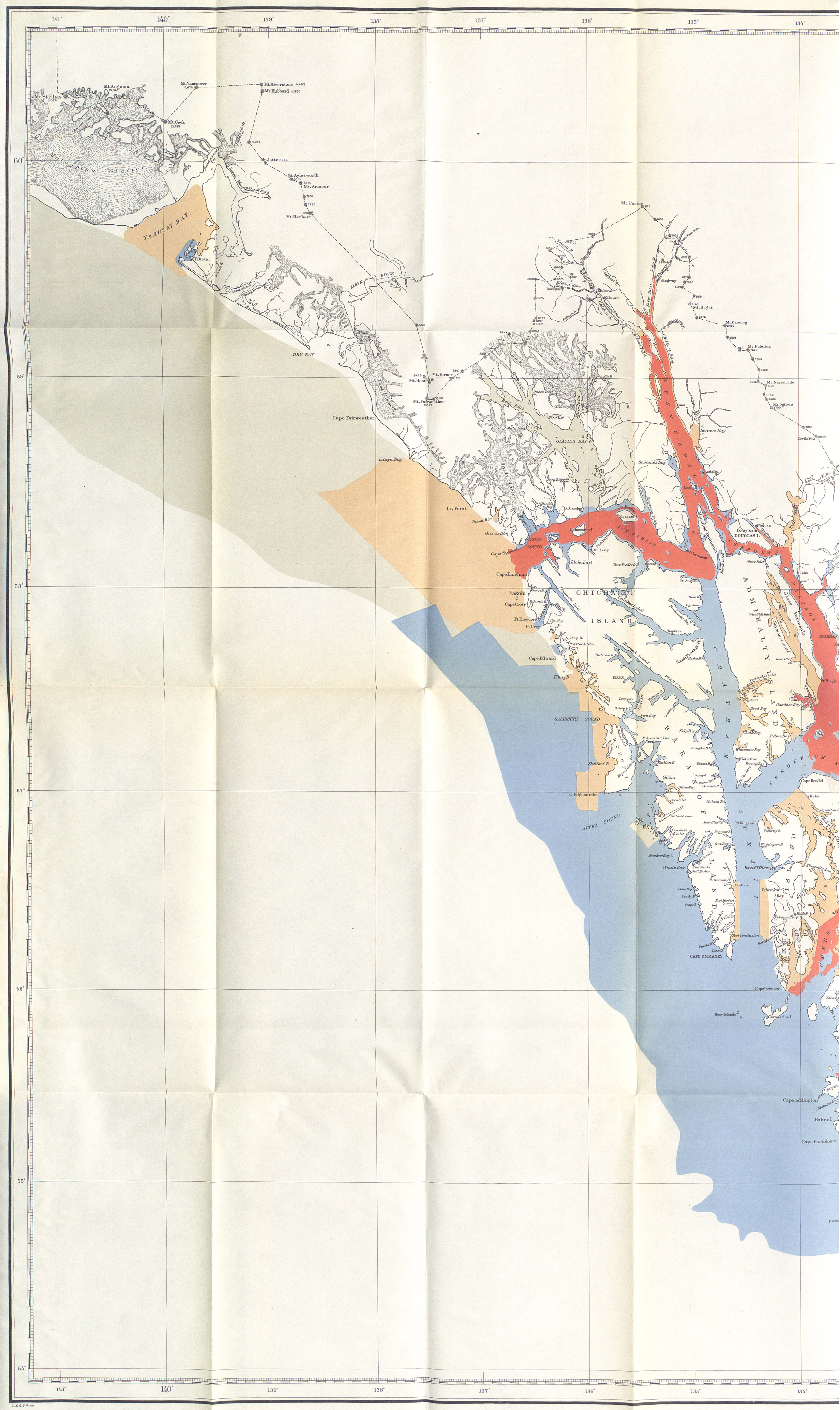
Scale 2500000 Lambert Conformal Conic Projection




BERING SEA
KOTLIK
ST. MICHAEL
MT. MCKINLEY NATIONAL PARK
ALASKA R.R.
CURRY
KUSKOKWIM RIVER
MATANUS
ANCHORA
SEWARD
NUSHAGAK
KATMAI NAT'L. MON.
AFOGNAK I.
KODIAK
KARLUK
GUL
NORTH
ST. PAUL I.
PRIBILOF IS.
ST. GEORGE I.
CHIGNIK
P. MOLLER
KING COVE
UNIMAK I.
AKUTAN
DUTCH HBR.
SANAK IS.
ATTU I.
ALE
KISKA I.
60°
58°
56°
54°
52°
168°
166°
164°
162°
160°
158°
156°
154°
152°
150°
174°
176°
178°

C. & G. S. Print


MT. McKINLEY NATIONAL PARK
ALASKA R.R.
CURRY
MATANUSKA
ANCHORAGE
SEWARD
CHITINA
C.R. & N.W. RY.
KENNICOTT
VALDEZ
CORDOVA
WHITEHORSE
YUKON
BRITISH COLUMBIA
SKAGWAY
JUNEAU
BRITISH COLUMBIA
ALASKA
SITKA
PETERSBURG
WRANGELL
KETCHIKAN
PRINCE RUPERT
SOUTHEAST ALASKA
For progress of work within this area, see the following illustration, No. 22
GULF OF ALASKA
NORTH PACIFIC OCEAN
AFOGNAK I.
KODIAK
UK
ATTU I.
ALEUTIAN ISLANDS
KISKA I.
East of Greenwich
West of Greenwich
60°
58°
56°
54°
52°
174°
176°
178°
180°
178°
176°
174°
172°
170°
152°
150°
148°
146°
144°
142°
140°
138°
136°
134°
132°


141°
140°
139°
138°
137°
136°
135°
134°
60°
59°
58°
57°
56°
55°
54°
Mt. St. Elias 18,024
Mt. Augusta 13,947
Mt. Vancouver 15,676
Mt. Alverstone 14,493
Mt. Hubbard 14,950
Mt. Cook 13,755
Malaspina Glacier
YAKUTAT BAY
Yakutat
ALSEK RIVER
DRY BAY
Cape Fairweather
Lituya Bay
Icy Point
Mt. Jette 8466
Mt. Aylesworth
Mt. Armour
Mt. Herbert
Mt. Turner
Mt. Root
Mt. Fairweather 15399
Mt. Foster
Skagway
Klukwan
Kalwatta
Mt. Bagot
Mt. Canning
Mt. Poletica
Mt. Nesselrode
Mt. Ogilvie
Devils Paw
Berners Bay
St. James Bay
GLACIER BAY
Muir Glacier
Reid Inlet
Queen Inlet
Tidal Inlet
Hugh Miller Inlet
Brady Glacier
Berg Bay
Bartlett Cove
Icy Strait
Pt. Gustavus
Pt. Carolus
Lemesurier I.
Pt. Adolphus
Mud Bay
Idaho Inlet
Port Frederick
Pt. Augusta
Pt. Gardner
Cross Sound
Cape Spencer
Cape Bingham
Yakobi I.
Cape Cross
Pt. Theodore
Pt. Urey
CHICHAGOF ISLAND
Tenakee Inlet
Tenakee
False B.
Gypsum
Freshwater Bay
Hoonah Sound
Cape Edward
Khaz B.
Slocum Arm
SALISBURY SOUND
Deep Bay
Suloia B.
Fish Bay
Kelp Bay
Nakwasina Pas
Katlian B.
Takatz B.
Baranof
Sitka
Silver Bay
Cascade B.
Deep Inlet
Nelson B.
Redoubt Lake
Red Bluff B.
Hoggatt B.
Gut Bay
Crawfish Inlet
Neckar Bay
Whale Bay
Port Banks
Still Harbor
Patterson B.
Pt. Patterson
Port Herbert
Port Conclusion
Puffin B.
Laren B.
CAPE OMMANEY
SITKA SOUND
C. Edgecumbe
Haxy Islands
Coronation I.
Cape Decision
Cape Addington
Baker I.
Cape Bartolome
Cape Bendel
Kake
Douglas I.
JUNEAU
Taku
Pt. Hugh
Gambier Bay
Hood Bay
Chatham Strait
Lynn Canal
Stephens Passage
Frederick Sound
Admiralty Island
Glass Peninsula
Chilkoot Inlet
Taiya Inlet
Skagway R.
Chilkat R.
Klehini River
Kelsall R.
Alsek Glacier
Grand Plateau Gl.
Hubbard Gl.
Nunatak Fiord
Yakutat Bay
Dangerous R.
Akwe R.
Malaspina Gl.
Agassiz Gl.
Seward Gl.
Tyndall Gl.
Muir Inlet
Tarr Inlet
Glacier Bay
Taku Inlet
Port Snettisham
Seymour Canal
Windfall Hbr.
Mole Hbr.
Kootznahoo Inlet
Pybus Bay
Whitewater Bay
Herring Bay
Oliver Inlet
Port Althorp
Surge B.
Takanis B.
Ilin Bay
Deep B.
Portlock Hbr.
Patterson B.
Basket B.
Ushk B.
Redman B.
Sitkoh B.
Kasnyku B.
Silver Bay
Warm Spr. B.
Security B.
Washington B.
Tebenkof Bay
Port Malmesbury
Port Walsh
Port Bucharin
Port Lucy
Port Chatham
Bear B.
Ice B.
Reids B.
Gedney Hbr.
Sumner I.
Kuiu I.
Kupreanof I.
Kuiu Strait
Frederick Sound
Edna B.
Noyes I.
St. Nicholas Cr.
Forrester I.

C. & G. S. Print

U. S. COAST AND GEODETIC SURVEY
PROGRESS MAP
SOUTHEAST ALASKA
1925
Wire drag surveys
Unchangeable areas, surveyed
Unchangeable areas, partly surveyed
Changeable areas, surveyed and requiring future surveys
Reconnoissance
Areas tinted red show portions of the main steamer route made safe by the use of the wire drag.
136°
135°
134°
133°
132°
131°
130°
129°
60°
59°
58°
57°
56°
55°
54°
Mt. Foster
Skagway
Mt. Bagot
Mt. Canning
Mt. Poletica
Mt. Nesselrode
Mt. Ogilvie
Devils Paw
Mt. Ogden
LYNN CANAL
Chilkat Inlet
Chilkoot Inlet
Berners Bay
St. James Bay
ICY STRAIT
JUNEAU
Douglas
DOUGLAS I.
STEPHENS PASSAGE
ADMIRALTY ISLAND
CHICHAGOF ISLAND
CHATHAM STRAIT
BARANOF ISLAND
Sitka
FREDERICK SOUND
KUPREANOF ISLAND
KUIU ISLAND
Mitkof I.
Wrangell
Zarembo I.
Wrangell I.
Etolin Island
SUMNER STRAIT
CLARENCE STRAIT
PRINCE OF WALES ISLAND
CLEVELAND PENINSULA
REVILLAGIGEDO ISLAND
BEHM CANAL
Ketchikan
Annette I.
Duke I.
PORTLAND CANAL
PORTLAND INLET
Stewart
Pearse Island
Cape Decision
CAPE OMMANEY
Cape Addington
Cape Bartolome
CAPE MUZON
Cape Chacon
Cape Fox
Dall Island
Cordova Bay
DIXON ENTRANCE
Dundas I.
CHATHAM SOUND
Port Simpson
Prince Rupert
SKEENA RIVER
Nass River
Porcher I.
Cape Knox
GRAHAM I.